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Preface

The histories of European civilization and European forests are closely intertwined. Prior to industrialization wood, fodder and food from forests helped support our rural economies. Since then forest management has continuously adapted to meet the needs of industry and of urbanized society. Today cultural, amenity and environmental objectives inform all forest management, reflecting the concerns and requirements of contemporary society.

In the late twentieth Century lifestyle-related health problems emerged as an important new concern in all developed countries. Should this lead to a new objective for forestry in Europe? Can forests and forest management help in the promotion of healthier lifestyles and improved mental health?

This book summarizes research on these questions. Between 2004 and 2008 some 160 scientists from 24 European countries, with contributors from Asia, Australia, Canada and the United States, worked together in COST Action E39 'Forests, Trees and Human Health and Wellbeing' to promote our understanding of how forests contribute to health in Europe and elsewhere.

Funded by the EU through the European Science Foundation, COST is an intergovernmental framework for European Cooperation in Science and Technology. Its function is to encourage coordination of nationally funded research on a European level so that Europe will continue to hold a strong position in scientific and technical research.

In addition to this book, which has many contributors, the scientists and professionals in COST Action E39 prepared state-of-the-art reports on national research initiatives concerned with forests and health. National health policies and priorities of European countries have been described and the possibilities for forestry to help meet them have been analyzed.

A successful COST action leads to continuing collaboration. Members of the action continue to work together in new primary research and have produced individual and jointly authored peer-reviewed papers in international scientific journals. International co-operation continues between researchers from the USA, Australia and Asia through joint arrangements with IUFRO and ASEM.

Coordinating such a large group of participants has been a major task made possible by the professionalism, commitment and hard work of the COST secretariat in Brussels. Particular thanks are due to Arne Been and Günter Siegel, and most recently to Melae Langbein.

We gratefully acknowledge the help of Cecil Konijnendijk and Chris Baines, who facilitated and edited our efforts towards identifying future research needs. Jasper Schipperijn played an invaluable role in coordinating the final text and liaising with our publishers.

This action not only encompassed many different countries it was also highly interdisciplinary. The leaders of the five working groups in E39 appear here as editors (Part I – Christos Gallis, Part II – Terry Hartig, Part III – Sjerp de Vries, Part IV – Klaus Seeland, Paul Mitchell-Banks/Fabio Sabitano) in cooperation with the Action's chairman and vice-chair. Over the slightly more than 4 years of the Action their leadership and inspiration has helped us navigate the rocks and shallows on which so many multi-disciplinary projects can founder.

Forests and woods occupy about 30% of the land area of Europe and extend from the centers of our towns to the most remote areas. Most forests are accessible at little or no cost. If by encouraging a new way of seeing forests, as a resource for health, we have made a difference in the quality of life of people in Europe then all participants of COST Action E39 have reason to take pride and find encouragement for future work in the field.

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Chairman, COST E39

Marcus Sangster
Vice-chair, COST E39

Contents

Chapter 1
Forests, Trees and Human Health and Well-being: Introduction

Kjell Nilsson, Marcus Sangster, and Cecil C. Konijnendijk

1.1 Background

Traditional medical and public health approaches to illness and health are among the successes of modern science. However, society today is faced with the increasing incidence of various forms of poor health related to modern lifestyles. Contributing factors include an increasingly sedentary population, increasing levels of psychological stress related to urban living and contemporary work practices. In addition people with disabilities and chronic illness demand a transition from institutional care to care in society. These problems encourage thinking about alternative ways to prevent disease and promote health. Lack of physical activity and stress have led to increased occurrence of certain diseases where medication is perhaps only reducing the symptoms rather than combating the true cases of illness and reduced quality of life. Efforts to promote public health and well-being in Europe have thus become increasingly complex.

Natural outdoor areas and natural elements such as forests, parks, trees and gardens are known to provide opportunities to enhance public health and well-being (Photo 1.1). For example, activities in natural outdoor environments are intuitively known to be good for mental and physical health. But we lack knowledge on many aspects of this positive relationship between nature and health. What are the precise effects and mechanisms? Which outdoor environments or interactions with plants or animals work best for whom? The structured, empirical knowledge that exists has accumulated slowly, developed by research groups in disciplines as diverse as environmental psychology, landscape architecture, forestry and epidemiology, and without the wealth of resources so commonly made available to research in medical fields.

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Photo 1.1 Natural elements such as big trees and access to the sea are known to be good for mental and physical health (Photo: Kjell Nilsson) (*See Color Plates*)

1.2 Fragmented Research

In 2001, Dr Karen Henwood at the School of Medicine, Health Policy and Practice, University of East Anglia reviewed the international literature for the UK Government. Her aim was to assess the evidence linking natural environments to human health. She found that there was a large body of literature supporting such links. However, the published literature had a strong US focus. The subject was less well covered in the European health and health policy literature.

However, in various European countries, including Sweden, Denmark, Norway, the UK and the Netherlands, substantial activity in the field was ongoing in 2001.

The research activities were spanning a wide range of culturally embedded practices such as the requirement for a proportion of formal education to be in an outdoor setting, as is found in Scandinavian countries; the use of forest environments as part of the therapy for children with behavioral difficulties in the UK; and, scientifically evaluated initiatives as pioneered in Sweden.

Much of this activity was related to domestic health policy, and was often empirical or with a practical emphasis. It tended to be circulated domestically and was not written up in the international literature or was scattered across journals from many disciplines. It did not fit easily with mainstream health journals that give emphasis to medical and theoretical writing or with the forestry and environmental literature. The fragmentation and national focus of ongoing research, as well as debates on health policy across Europe at start of this millennium, showed that this was an emerging scientific field that would clearly benefit from more trans-European cooperation and coordination.

Scientific evidence and understanding in this field requires crosscutting collaboration between researchers in health, environment and social science, and through close involvement of implementing agencies and practitioners. It seems that the reasons why the research on this area is limited, or research is not being fully recorded at present, include (a) that sector-based funding bodies do not feel mandated to support crosscutting research and (b) that environmental scientists have little profile in medical science.

1.3 COST Action E39 – Forests, Trees and Human Health and Well-Being

The European Cooperation in Science and Technology (COST) is one of the longest-running European instruments supporting cooperation among scientists and researchers across Europe. To bring together European researchers working with various aspects of the relation between nature and health, COST Action E39 ‘Forests, Trees, and Human Health and Well-being’ started in 2004 and lasted until 2008.

The Action had a strong role in drawing attention to and acknowledging the importance of existing national activities, encouraging new research in this area. Many national activities are culturally embedded, so that practitioners might not realize that they are internationally relevant. For example, in Sweden there is a long-established network of therapeutic gardens, and in Finland, Norway and Sweden there are programs for taking children into forests and the natural environment as part of their normal schooling. Similar programs have been identified in Denmark, Estonia and in Germany. The UK has national programs promoting outdoor exercise, evaluated by Oxford Brookes University. This COST Action provided an important opportunity to bring such domestic activities into the international light, as well as giving researchers interested in more basic science of nature and an opportunity to gather together with practitioners.

1.3.1 Objectives

The main objective of the Action was to increase the knowledge about the contribution that forests, trees and natural places make, and might make, to the health and well-being of people in Europe. Secondary objectives were:

- To identify and record key lessons from national research and initiatives to promote forests and health
- To set out the key health priorities identified within European countries and the possibility for forestry to contribute to meeting them
- To gain experiences from good practice
- To join efforts to set up innovative, international research and development projects within this field
- To engage health policy interests in the identification of information gaps in this field
- To develop a network of researchers and research institutions in forestry, health, environment and the social sciences

1.3.2 Scientific Approach

Scientifically the Action covered quantitative and qualitative scientific approaches and economic analysis. In order to develop a broad evidence base the Action has drawn on numerate disciplines such as epidemiology and physiology and on phenomenological disciplines such as psychology and social geography. A description and evaluation of the institutional aspects of health and forestry has also been pursued.

In respect of spatial aspects, the Action has covered all forests, recognizing that there are likely to be differences in the contributions of forests in remote or wilderness areas and those close to and within urban areas, including urban forests. More than 75% of Europeans live in and around towns, so their regular access will be to forests close to urban areas. But a number of national surveys have shown that more remote forests are also highly valued by urban populations.

When looking at the direct contribution of forest products, e.g., pharmaceuticals from forest plants, process-related aspects such as the cultural and social aspects of gathering berries and fungi, have been included.

1.3.2.1 Crosscutting Approaches

Health and the environment each have their own professions and stakeholders and have distinctive research cultures. An important part of the Action therefore has been to explore opportunities and barriers to cross-disciplinary working. This was based on an exploration of how the different disciplines and research cultures might address research questions identified by the group, and identification of common ground.

The Action consisted of a network of approximately 160 researchers from 24 different countries, spanning health, environment, forestry and social science. The Action has encouraged crosscutting approaches not only across the environmental and health sectors but also within them. Within health research, for example, physical exercise is accepted as a vital contributor to physical health and prevention of illness. But it is increasingly recognized that there are psychosocial pathways to physical health and illness prevention. Within the social sciences there is an increasing interest in embodiment – the physical aspects of self. Mental and physical health are therefore increasingly recognized as interlinked.

There is considerable scope for engaging economists from across different sectors and countries. The economic implications of any positive contribution to health are likely to be substantial. For example, the Scottish Executive in the UK reports that typical medical treatments of one individual diagnosed as liable to heart attack costs approximately €21,000 over 5 years. On the other hand, inexpensive and enjoyable physical activity can be expected to reduce the risks of heart attack, stroke and diabetes by 50%, and colon and breast cancer by 30%. Economists in both the health and environmental sectors have to deal with complex valuations of social benefits. The Action has been an opportunity to draw such experience together.

1.4 A New Perspective on Human Health and Well-Being

Public health and modern medicine are continuously making progress in fighting diseases and ill health. However the majority of all causes of ill health, disease and premature death in Europe cannot be explained from simple relationships, such as proximity to pathogenic bacteria or genetic factors. An increasing number of future health hazards relate to our lifestyles, which are more sedentary, more stressful, and increasingly oriented indoors. A large part of the population is overweight and many diseases are related to this. Depression and pain are in greater focus, as they have a major impact on the number of years lived in good health.

There is a growing awareness of the multiple linkages between health and its various determinants, at individual as well as population level. The need for and value of intersectoral action between health and other sectors is increasingly recognized in Europe. It is also recognized that the complex nature of many health determinants and their interplay with social factors require more multi- and interdisciplinary efforts. Politicians and citizens seem to be increasingly attracted to a broader concept of health, which incorporates well-being and the quality of life.

Healthier societies offer potential long-term social and economic benefits and are therefore a main aim of international and national policy makers. Strategies for health-friendly decision making are led by organizations such as the World Health Organization (WHO). Apart from concentrating on special target groups, such as children, these strategies reflect more focus on prevention and thus take a more proactive stance. More attention is given to factors that determine health instead of diseases themselves. New health strategies look at the full magnitude of health effects and their distribution across the population, contrasting this distribution with the allocation of benefits.

The positive (or salutogenic) effects of the relationships between nature and health are largely unexplored due to a focus on negative effects of environment on health. Yet there is a very long-established view that personal contact with plants, animals and natural green surroundings can benefit human health and well-being. The importance of this is being seen as increasingly important as the human habitat becomes more urbanized. These interactions may have been somewhat overlooked so far in the public health debate, perhaps partly because of lack of awareness and of hard evidence on effects and mechanisms at work. The range of different public health benefits is wide and varied and their full extent needs to be better understood and more effectively communicated.

Contact with the natural environment can provide an antidote to some of the unhealthy aspects of an urban lifestyle, and there is a growing realization that this should influence the way that our surroundings are planned and managed (Photo 1.2). Trees and other vegetation have been used in traditional, modern and alternative medicine as sources of pharmaceuticals and other chemicals. But they also help to moderate the effects of other physical environmental factors by acting as a biological buffer. They can filter potentially harmful air pollution and solar radiation, they provide natural shelter against the wind and they help to cool and moisten the air. Contact with nature and contacts with animals and plants can have a powerful therapeutic or preventative effect on many people, by reducing stress and helping to

Photo 1.2 Green spaces designed with nature like a Heempark in the Hague can provide antidote to some of the unhealthy aspects of an urban lifestyle (Photo: Kjell Nilsson) (*See Color Plates*)

Photo 1.3 Old ladies enjoying life in the Deer Park outside Copenhagen (Photo: Kjell Nilsson) (*See Color Plates*)

improve both mental and physical ability. Moreover, access to natural green spaces, particularly if they are conveniently close to work or home, may provide a supportive setting for physical exercise and restorative relaxation (Photo 1.3).

1.5 Health-Related Products from Natural Sources

Plants, including trees, have traditionally been used by conventional and alternative medicine as a source of many different pharmaceuticals, as well as a source of other chemical products. However, there is a great scope for using more advanced techniques in order to identify and extract a greater range of natural products beneficial to health.

Europe's sustainably managed forests and other green areas provide a wide range of products. Trees, besides timber, produce large quantities of wood residues, foliage, twigs, and bark produced during harvesting and manufacturing. Trees have through evolution developed unique chemical defense systems based on advanced functional molecules. Thus trees are exceptionally rich in bioactive, protective substances. Bioactive compounds found in trees include flavonoids, lignans, stilbenes, terpenoids, phytosterols, fatty acids and vitamins which are known to exert many beneficial effects, for example, antioxidant, anticarcinogenic, and estrogenic effects.

Some bioactive compounds can be used as nutraceuticals, that is, a combination of nutrition and pharmaceuticals. These can contribute to public health as ingredients in dietary supplements and health-promoting ‘functional’ foods and as pharmaceuticals. In fact, such forest-derived health products have already been developed and marketed at a commercial scale. Xylitol products, for example, promote dental health, while sitosterol products lower cholesterol levels and consequently prevent cardiovascular diseases. Pycnogenol is the trade name for an extract from the bark of the maritime pine growing in France. It is a powerful antioxidant and its impacts on cardiovascular health, skincare, diabetes and inflammations, among others, are studied. In 2006 a new lignan product came on the dietary supplement market. The HMR lignan is extracted from knots (the place where a branch is attached to a tree) in spruce trees and can inhibit the development and growth of hormone-related cancer forms (breast, prostate and colon cancers). It is also a strong antioxidant with estrogenic properties. These three products are extracted from process waste streams in the forest industry and are thus contributing to a more efficient use of natural resources.

Although especially forests represent large natural pharmacies by virtue of their enormous source of tree and plant material with known or potential medicinal or nutritional value, more research is still needed to identify and develop the best applications and products. Nutritional supplements and functional foods are currently of high research interest and are recognized internationally as potential health-promoting agents if consumed on a regular basis and at effective levels. The polyphenols which are particularly abundant in knots and bark have potential not only as health-promoting substances but also as technical antioxidants and biocides. There is also potential in using natural, traditionally known extracts from trees as health-promoting products offered locally by enterprises in rural areas. Examples of such products are pine bark as an ingredient in bread and birch sap as a drink or syrup.

1.6 Therapeutic Interactions: Plants and Landscapes, Garden Therapy and Ecotherapy

As seen, the role of nature, gardens and plants in the improvement of ill health and the maintenance and fortification of good health is not a new phenomenon. Recent studies on these salutogenic effects of the green environment have shown that nature can lower stress levels, restore powers of concentration, and alleviate irritability, while correlations with strengthening of muscles and preventing aches and pain all over the body have also been noted.

Horticultural therapy can be defined as a process by which individuals may improve well-being using the garden environment by passive involvement, through stimulation of the senses, or by active involvement, through the practice of horticulture (Photo 1.4). Taking place in therapeutic gardens, horticultural therapy has its origins in the rehabilitation of British and American soldiers returning from the Second World War. It has a strong focus on healing effects of meaningful activities in the pleasant environment offered by a garden, such as weeding, raking and sowing. This shows its close links with occupational therapy. Distinct values of horticulture to support the healing process include people’s physical dependency

Photo 1.4 The healing garden in Alnarp, Sweden. In horticultural therapy both the garden environment and the practice of horticulture are used for improving the individual's well-being (Photo: Kjell Nilsson) (*See Color Plates*)

on plants (related to harvesting crops for food and the like), observing beauty, nurturing of life, and social interaction. There is also growing attention to the key elements of ecotherapy or conservation therapy based on the active participation of all those involved in effective conservation or habitat development work, through the collaborative efforts of group participants. These meaningful activities carry a social value in terms of the participants' own community integration and in terms of social capital through public green space establishment.

A challenge is that there is still a need for a sound basis of evidence as to the health effects and mechanisms. Research must involve health outcomes related to therapy settings (for example, a garden or a forest) as compared to results from clinical therapeutic activities. Very few studies so far have reached a standard that can constitute a basis for evidence-based medicine.

Having said this, various relevant theories have been developed. One focus has been on restorative experiences, such as captured in the attention-restoration theory. This theory explains how natural environments can help people renew a depleted capacity for focusing attention. Good restorative environments should enable experiences such as being away, fascination, and compatibility. The aesthetic-affective theory looks at stress reducing effects of nature as a matter of unconscious processes initiated in the oldest, emotion-driven parts of the brain. The scope of meaning/scope of action theory studies how the surrounding environment communicates with visitor on many levels. Less known and still largely untested theories include that of phytoresonance, which looks at the influence of plant qualities on the human experience and the human reaction to plants. This ranges from passive, merely being outside, to active participation, actively working with plants and soil. Active participation is thought to help develop self esteem, as well as practical, social and emotional skills.

1.7 Land Use, Accessibility to Green Areas and Health Effects

Although the general feeling is that nature is good for people's health, nature is not yet widely used for health promotion by public authorities. Green space nearby is often seen as a luxury rather than a necessity, especially in urban areas where the competition for land is intense. Current views on urban densification have led to even greater pressure on remaining open spaces.

Recent studies have looked into accessibility to and use of nature on (self-reported) human health and well-being (Photo 1.5). Studies that compared health indicators with access to green spaces in Denmark, The Netherlands and Sweden, for example, found that both health and well-being were better among people who regularly visited nearby nature and green spaces. A short distance to nearby green areas was associated with the number of visits, and subsequently with lower levels of stress. Moreover, people with a garden of their own were found to be less affected by stress.

Although links between green space and health are increasingly well established, little is known about whether nearby nature has an independent causal effect on

Photo 1.5 Accessibility for elderly and disabled people is an important factor in the design of green spaces (Photo: Kjell Nilsson) (*See Color Plates*)

Photo 1.6 Physical exercise is good for health, but does it make a difference if the activity is carried out in the open air or in a fitness centre? (Photo: Kjell Nilsson) (*See Color Plates*)

human health or not. Based on the available evidence such a causal effect is plausible. Suggested mechanisms are, amongst others, improving air quality, reducing stress, stimulating physical activity (Photos 1.6–1.8), and facilitating social cohesion within neighbourhoods. It is unclear which, if any, of the suggested mechanisms are the most important in terms of generating health benefits. However, it is already obvious that the way to optimise the health effects of local greenery depends strongly on the mechanism that is operative. Using natural elements to catch fine dust will lead to a different optimal green structure then using such elements to create a green oasis to relax and recover.

Past research mainly falls into one of two categories. The first is experimental research, especially on stress reduction and attention restoration. Many of these studies focus on short-term stress reduction, with stress being induced within the experimental setting. Furthermore, usually a crude distinction is made between a natural and a built-up environment, often represented by slides or videos.

Photo 1.7 The Common Park in Copenhagen is popular for jogging (Photo: Kjell Nilsson) (*See Color Plates*)

Photo 1.8 Volleyball is a perfect physical activity in the park as well as on the beach (Photo: Kjell Nilsson) (*See Color Plates*)

Based on this line of research it is difficult to say: (a) what the (size of) long-term health benefits of exposure to nearby nature in the residential or working environment will be, (b) what type of nature will work best, (c) how much of this type of nature is needed, and (d) whether there are additional requirements that should be fulfilled. With regard to the last aspect, the social safety of green areas comes to mind, especially in an urban setting. The second type of research is correlational in nature (surveys, epidemiological studies). It is better suited to give an impression of the size of long-term effects of nearby nature in a real-life situation. However, the causality of the observed relationships is usually difficult, if not impossible to establish. Furthermore, within this line of research there has been little theoretical development to date. Indicators for the local supply of green spaces tend to vary from study to study, without clear theoretical underpinning. A common quantification method is absent, not only in terms of local supply of greenery, but also regarding health outcomes, making comparisons between studies difficult.

As mentioned, more evidence is needed on (the size of) health-promoting and salutogenic effects of different natural outdoor settings in general. Only in this way can 'nature's health service' be properly understood and promoted, for example as part of new strategies for health promotion. The positive links between environment and health will provide a valuable addition to the rather extensive body of evidence of the harmful effects of the environment on human health. Obviously best possible use should be made of data that is already available.

1.8 Settlements and Localities: Health and Nature Where We Live

As mentioned in the previous section, nearby nature plays a very important role in the linkages between outdoor environments and human health and well-being (Photo 1.9). Nearby nature consists of the natural elements and features that people encounter in and around those settings of everyday life in which they spend much of their time, including residential settings, the workplace, and schools. Empirically we can see that people make most use of outdoor spaces that are nearby, in particular if they are close to home, engender a sense of security and ownership, and are attractive. Knowledge of the health benefits of nearby nature can support the design of interventions that serve multiple sustainability goals.

If we wish to deliver public benefit by encouraging activity in nearby natural settings and through contact with animals and greenery then we need to consider how to: compete with people's other interests and calls on their time; motivate and sustain particular behaviours; design and promote appropriate places; identify and target different groups (i.e. segmentation); and fit our activities into the context of wider health objectives.

There is considerable research to show that urban green space is frequently inaccessible. Reasons include physical barriers such as transport corridors, informational barriers where people do not know of areas or of the possibility of using them, disability,

Photo 1.9 During weekends people leave their apartments in St Petersburg, Russia, for an excursion to one of the state forests (Photo: Kjell Nilsson) (*See Color Plates*)

ownership issues, particular behavioural problems where the activities of one group exclude others, and barriers related to unattractive or inappropriate layout, location, design and infrastructure. Access requires infrastructure internally and also externally, leading into the area. Green spaces must be attractive to users and have facilities appropriate to the main objective. For example, if we wish to encourage socialising in towns, then small urban parks might be the best option. Differentiation applies both to spaces and activities and to the social groups for whom they are provided. We need research to understand the health benefits of different structures and infrastructures, to establish the scale and scope of benefits (including economic analysis when possible). There is a large body of social research from which it is possible to say that the distinction between rural and urban people is one of location, not of values. Nowadays, people in rural areas are likely to have very similar life-styles and attitudes to urban dwellers, at least in a European context.

Special attention in future research should be directed towards groups such as children, the elderly and ethnic minorities, who may have special needs that can be satisfied by nearby nature. Approaches need to be differentiated and tailored to the needs of these and other specific social groups. In the case of children, for example, there are concerns about the impact of a culture of safety and low risk that constrains children's access to outdoor environments, both urban and natural spaces. Across Europe there are considerable differences in the way that children are allowed to access the outdoors, in their 'mobility', and also cultural differences in the way that perceptions of danger and concerns about safety impact on children. Cultural diversity of Europe and the probability that immigrant groups are likely to have different perceptions and needs in respect to nature interactions also need study. More data is needed to take account of the needs of ethnic minority groups; this is related to issues of governance and social inclusion.

1.9 Health Policies and Economics

Public policies in many sectors have important health implications. These implications are not always properly assessed and considered. Given the importance of improving health and well-being and minimising adverse health effects, it is necessary that consequences are addressed when developing public policy. Gradually, the links between 'green' and 'health' are gaining more interest from international and national policy-makers. In several European countries, reviews have been carried out or are underway to describe the (research) state-of-art on nature and health, in order to provide a basis for policy. In these reviews, both the direct and indirect influences of nature on health and well-being are given attention.

Agriculture and forestry play important roles in linking outdoor environments and health. These roles have changed fundamentally in Europe in the last decades, and the multifunctional character of the agriculture and forestry sectors has become stressed. According to the Organization of Economic and Cooperation Development (OECD), multifunctionality refers to the fact that an economic activity may have multiple outputs, and, by virtue of this way, may contribute to several societal objectives at once. At present, however, mainstream discussions of multifunctionality in agriculture and forestry tend to neglect the health and sometimes also the social values of activities associated with nature. Yet, better opportunities for focusing on services such as those related to human health and well-being have emerged, for example due to increasing societal demands, higher awareness about alternative marketable outputs, and the 'crisis' of traditional agriculture. European policies in the framework of rural development have encouraged and supported diversification in agricultural enterprises. For example, the health and social services provided by care farms in The Netherlands and other countries are seen as a way to promote diversification and to escape from the impacts of globalisation on agricultural markets resulting in a constant demand for increased farm specialisation. Diversification refers to those situations in which, for example, an agricultural enterprise runs production activities in different economic sectors.

Another issue is how to assess the value of the benefits resulting from green care and other 'green-health' interactions. This requires the development of evaluative systems to quantify the costs and benefits of interventions. Presently public funds are still the main source of direct and indirect payments for green care services. As often in the case where non-market services are provided, payments which are made are mostly related to inputs rather than to outputs.

Decision-makers need to be supplied with sound evidence that provides further insight into the various effects, positive as well as negative, of nature on health. Most empirical research on positive linkages to date relates to the (short-term) effect on recovery from stress and attention fatigue. However, there has been very limited methodologically sound empirical research into links between nature and (generic) health indicators. More studies on these and other topics should be part of the development of a knowledge infrastructure which should consist of compilation research data and practical examples (good practices), a programme for further knowledge generation, as well as a coordination structure. The roles of the different actors involved should be made clear, for example in terms of responsibilities and financing.

As mentioned, there is a need for better evaluative frameworks for green care and other nature-health initiatives. Without an overview of the economic dimensions of these activities, it will be difficult to promote them in a policy setting. Better analysis of the economic dimensions should look at monetary as well as non-monetary aspects, issues of social responsibility, consider impacts on local level, and so forth. These assessments will need to be multidisciplinary and look at the relationship between nature and health in a wide range of contexts and under varying types of financing.

1.10 Future Research Needs

The Action found that nature-based approaches can contribute significantly to health objectives in Europe by ensuring that people have contact with nature in their everyday lives and that nature would be an integral feature of health care environments and approaches. More effective coordination and communication of existing knowledge and understanding, combined with increased investment in new research, is necessary to capitalise on the benefits of nature-based approaches.

The following key findings regarding future research needs have been identified:

1. There is suggestive evidence of *substantial economic benefits* arising from lower rates of illness and a reduced requirement for medical interventions. Because of the potential scale of the savings a concerted, Europe-wide effort to understand the costs and benefits is called for. The current scale of research is disproportionately small relative to the potential public benefit.
2. European *forests appear to be an important asset for health*, the economic value of which has not been understood in health policy or in forest policy. Forests are accessible to the public and can be used to benefit health at little or no cost to the individual or to the public purse.

3. Access to nature should be considered in *public health policy in Europe*. There are examples of national custom and national practice that could be adopted more widely.
4. There are strong, well recognized links between *social and environmental deprivation and poor health*. Urban forestry and urban green space is a means of rapid improvement to poor environments and thus is likely to improve health outcomes in deprived areas.
5. There are *highly positive differential benefits* where less mobile groups such as children, the elderly, disabled people and poor people are likely to gain particular benefit from policies that promote local green space and woodlands as a resource for health and fitness.
6. *Current policy* on health and the environment over-emphasizes environmental hazards and neglects the potential for natural environments to make very large positive contributions to health. In addition the emphasis on hazards creates behavioral barriers to public use of, and public benefit from green space.
7. Access to nature and natural places can be a central theme in promoting contemporary *lifestyle-based public health approaches*.
8. A more *persuasive evidence base* is needed on the links between natural outdoor environments and human health and wellbeing. Studies should investigate the mechanisms at work, and look at effects for different target groups.
9. Questions about health deriving from contact with nature should be incorporated into *national health surveys*.
10. Health should be a *central theme in urban and land-use planning*, for example, in debates about urban densification. Effort spent in developing tools and strategies that integrate healthy lifestyles into urban planning and green space management will be well repaid.
11. New research should be based on a more *comprehensive catalogue of existing studies*. Substantial research has been carried out, but it is widely dispersed. Findings need to be cross-referenced, for example, against other health care and epidemiological research.
12. Future research requires *common theoretical frameworks and more robust methodologies*. Some high quality studies now exist, but broader application of more rigorous methods will lead to greater acceptance in medical and related fields. Common frameworks, definitions and methodologies will enable cross-border comparisons.
13. More knowledge is needed about *health-related products and commodities from nature*. Multidisciplinary work should cover the process from identification of promising substances to their commercialization.
14. *Cross-sectoral, multidisciplinary research* is needed. Areas for future research include the health benefits of outdoor environments, as well as issues such as food security and quality, and environmental protection.
15. *European research* on nature and health is increasing rapidly but its multidisciplinary nature reduces its visibility and impact. It is reported in several different areas of scientific literature and there is a case for establishing a high-quality journal to bring such research together in one place.

1.11 Structure of the Book, and the Action: Five Themes

The Action and this book are organized in five themes. Part I, *Forest Products and Environmental Services*, consists of three chapters and deals with the direct and in-direct effects and contribution of the forest derived pharmaceuticals, herbs, fruits, fungi, organic certified products, and other wood and non-wood forest products on human health and well-being, economical and social development, alternative medicine and industry. Their preventive, nutraceutical, therapeutic and healing values and benefits in relation to forest environment will be addressed. Negative and hazardous aspects of forest environment substances on human health will also be a subject for discussion.

Part II, *Physical and Mental Health and the Experience of Nature*, consists of three chapters and addresses the question 'how do forests and trees contribute to health and well-being?' The question has three aspects. One aspect of the question concerns the effects or outcomes of transactions between people and trees or forests. Work related to this aspect involves specifying the physical and mental health benefits of trees and forests for individuals and populations. The second aspect of the question concerns processes. Work related to this aspect involves describing the physical, behavioral, psychological and social processes through which trees and forests have physical and mental health effects on individuals and populations, as well as the characteristics of individuals and the contextual factors which modify those processes. The third aspect of the question concerns identifying those forms of variation in trees and forests that are relevant for processes related to health and well-being.

Part III, *Promoting Physical Activity*, contains three chapters and deals with the contributions that forests and other natural areas may make towards human health and wellbeing, related to the physical activities that are undertaken within (or travelling to) this type of environment. The beneficial effects of physical activity on human health are well documented. Much less is known about to what extent offering attractive and nearby natural settings will lead to people becoming more physically active, especially during leisure time (higher frequency, longer duration and/or higher intensity). Also it is not clear whether the same physical activity, when undertaken in a natural setting, has a larger effect on human health and wellbeing than when undertaken in an indoor setting, e.g. a treadmill in fitness centre. Finally, even if offering natural settings does not lead to more activity, and performing the activity by itself is not healthier when done so in a natural setting, then it may still be the case that it leads to spending more time in a natural environment.

Part IV, *Therapeutical and Educational Aspects*, holds two chapters and discusses the healing power and therapeutic aspects of forests, trees and related green spaces for human health and wellbeing are gaining momentum in the post-industrial societies of Europe as in other developed economies of the world. Forests and trees as representations of the natural world have often proved to be counterbalancing the negative effects of stress ridden societies whose lifestyles are dominated by high technology and virtual worlds. Daily life is predominantly lived indoors and outdoor activities are performed in people's past time only. Outdoor recreation has become an important factor of a healthy living and a remedy against the deficiencies of a modern life world separated from nature.

And finally Part V, *Forest and Health Policies and Economics*, consists of one chapter that deals with the economic value of health benefits from forests and trees. Health issues are one of the largest expenditures in public budgets in any European country today. Thus there is a need to strive for the more efficient treatments, methods, etc. We need to know with certainty if costs and benefits in using the forest as basis for rehabilitation are favorable to the use of institutionalized procedures.

Finally, in a post script, the need for focus on a sixth theme, the cultural dimension in the landscape, is addressed.

Part I
Forest Products and Environmental Services

Chapter 2
Urban Forests and Their Ecosystem Services in Relation to Human Health

Giovanni Sanesi, Christos Gallis, and Hans Dieter Kasperidus

Abstract In this chapter we briefly discuss the concept of forest taking into account the provision of different goods and services. We provide some technical information on the forest classification systems adopted in Europe which are then reflected in the different roles and meanings that Europeans give to forests. We give a special emphasis to urban forests considering their origins, typologies and indicators. The importance of urban forests is analyzed including the role that forest areas and green spaces can play in contemporary (sustainable) cities. Different citizens' attitudes towards urban environment are also discussed considering the cultural differences existing at European level. The effects of urban forests on urban environments (i.e., hydrology climate, air quality, biodiversity) and human health are finally discussed. This chapter considers the social role of urban forest and the relationship existing between forests and communities through emerging approaches such as community forests.

2.1 Introduction

The concept of 'forest' has evolved considerably in the last few decades. Prior to the 1960s, it was seen principally as a productive land use, providing timber, wood and food. Other functions were seen as the protection of soils and to guard settlements

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against avalanches, rainfall, and torrents in mountain zones. Since then, the discourses on environment and environmentalism, the increasing role of urban culture as well as the critical assumption of degradation and huge loss of forested land (e.g., Amazon and Congo basins) drove towards the need of re-defining the concept of forest in use in contemporary societies. The forests currently are seen as an important source of non-wood products and of environmental, ecological, and social benefits. Several authors agree that in Western society the role of forests is changing rapidly from productive to consumptive (mainly recreation and landscape) and protective (biodiversity and erosion) functions (Glück and Weiss 1996; Koch and Rasmussen 1998; Eland and Wiersum 2001). These changing perceptions of forests mirror the wider perceptions of the rural environment typified in the changing European policy on rural development. More widely, the international forest policy process set in train by the United Nations Conference on Environment and Development (UNCED) in 1992 has established principles for sustainable forest management that emphasize social and economic factors as well as economics (Humphreys 1996). This different way of construing forests has led to changes in forest management in European countries. This is particularly valid for public owned forests where current management aims to conserve complex ecosystems and deliver social benefits at a landscape-scale. There is also a trend towards integration across different levels of administration (Kennedy et al. 2001). More difficult is the analysis of private forestry. The difficulty in generating income from non-timber products and from forest services is a major constraint for the owners and can require new knowledge and skills. It can also lead to conflicts where forest management impacts on scenic and recreational value, especially in forests near urban areas (Tahvanainen et al. 2001).

Forests not only are physical entities, they have strong symbolic and cultural value, and this leads to different perceptions of forests and woods within and between societies. This chapter has three main goals: (1) to illustrate the complexity of the term ‘forest’ within Europe; (2) to indicate current knowledge of the environmental functions and benefits of forest and trees especially at urban level; and (3) to introduce forests and trees as resources for human health.

2.2 Forest Classification Systems

Technically a forest can be classified on the basis of specific parameters such as frequency of forest cover on land use, tree canopy cover rate or species composition and forest structure. This approach belongs mainly to forestry inventory and statistics. But the way in which such data is applied varies, so that forests can be defined or classified in different ways in various European countries (European Commission 1997).

Recently, faced with a need for common definitions in international policy processes such as the Kyoto Protocol, organizations such as The Global Network for Forest Science Cooperation (IUFRO) and the Food and Agriculture Organization of the United Nations (FAO) have attempted to introduce an international standard to classify forest land. FAO now defines forests as '*Land extending to more than 0.5 ha, with trees higher than 5 m and a canopy cover of more than 10%*' (FAO 2004). However, EU members still use their own definitions to ensure consistent data and comparable time series at national level.

Another approach to classification is based on climatic, soil and cultural situations and the related vegetation conditions. Kuusela (1994) identified nine different ecological forest zones in Europe that usually have similar management regimes and exploitation techniques. In recent years, the focus in forest classification has moved from productive to more protective and service functions.

An ecological perspective takes account of the origin of forests, giving rise to a distinction between native, natural, and planted forests. Terms such as virgin forest, old growth forest, natural forest, semi-natural forest, secondary forest, are commonly used in different countries, but often with a different meaning. In planted forests, established by artificial means of regeneration, we can consider the method of regeneration and the 'human footprint' defined by shape, composition, species distribution, ecological characteristics. In terms of the Kyoto Protocol, this kind of forest can be included in the categories of afforestation and reforestation.

In respect of history and past management, we find terms such as unmanaged and managed forest. However, almost all European forests have undergone some sort of management in the (recent) past. The eighteenth century urbanization in Europe, linked to industrialization, led to changes in landscape and also in the relationship between people and the natural world (see e.g., Thomas 1983). A number of authors (see e.g., Trentmann 2004) have written on consumerism as a dominant paradigm that influences perceptions of nature.

2.3 Urban Forest and Green Spaces: Typologies and Indicators

In the 1960s, the term 'urban forest' was introduced in Europe from the United States. It focuses on woodland in and near urban areas (Konijnendijk 2003; Konijnendijk et al. 2006). Bell (1997) summarizes research that shows that open spaces need to be close to home before we can be confident that they will be used for recreation; over 400 m and the frequency of visits drops sharply. In respect of health, this has led to an interest in urban woodland, and urban forestry, as it is these woods that are likely to be accessed by large numbers of people. In a study in Rome, Bonnes et al. (2004) confirmed the roles of location, accessibility, and distance on the use that local people made of urban and peri-urban green areas.

In addition to natural and semi-natural forests and woodlands the most recognized elements of the urban forest are parks, gardens and green spaces with a significant amount of tree cover. However, urban forestry practitioners also include in the definition single trees, groups of trees and other woody vegetation located in green spaces near residential areas, schools, and hospitals.

Urban forest can have different origins. From the middle of the twentieth century new techniques were developed for establishing trees on previously industrial land at relatively low cost, leading to an expansion of woodland in towns. In the United Kingdom, the terminology of community forestry arose. Previously to do with communally owned forests in Europe, it was adapted to cover new landscape creation in peri-urban sites with an objective to provide social, economical and environmental benefits to local and urban communities (Colangelo et al. 2006).

Community forest and similar programs implement the concept of green infrastructure (Benedict and McMahon 2002), which is an interconnected network of green space that conserves natural ecosystem values and functions and provides associated benefits to human populations. Benedict and McMahon (2006) describe green infrastructure also as a process that '*promotes a systemic and strategic approach to land conservation encouraging land use planning and practices that are good for nature and for people*.'

Urban forests are key features in any region and can themselves be taken as expressions of culture, where different cultures see them in different ways. These differences persist and new understandings of forests arise as cultures change. Bonnes et al. (2004) identify ambivalent and opposing attitudes towards forests. One the one hand people see themselves as part of nature, with positive attitudes and an inclination towards natural spaces (Sanesi et al. 2006). On the other, there is a sense of people being in opposition to nature, including urban green spaces and urban forests, giving rise to perceptions of personal insecurity in the use of these areas. Personal experience of using natural spaces greatly influences attitudes and the research indicates that the quantity of urban forest available in their neighborhoods may positively affect people's attitude towards satisfaction and use of these areas.

Biennial visitor surveys by the British Forestry Commission (Slee et al. 2005) indicate that people visit forests for peace and quiet, wildlife, attractive scenery and a safe environment. People in the UK make perhaps 355 million visits to woodland and forests each year, with two thirds of UK population visiting woodland and forests in the 2 previous years.

Therefore, concepts of forest quality cannot be separated from the use to which the forests are put. As forests invariably have many functions, there is no single ideal, so that forest management is about finding a balance between complex objectives. For urban planning, the area of public open spaces and its accessibility are the two main indicators adopted (Roma et al. 2000). Access to green urban areas has been proposed as an important indicator of urban sustainability and quality of life. Urban areas differ very much from each other as to the proportion of open spaces of the total urban area, the size, the shape, sport and leisure facilities and their distribution in relationship to residential areas. Roma et al. (2000), in European urban audit, looked at differences in the provision of urban forest (green spaces) in the studied cities. Usually the amount of accessible green space is higher in northern, peripheral and capital cities. There is a trend towards increased areas of accessible green space in most European cities. Access to green areas (the European Common Indicator A4 relates to the percentage of people living within 300 m of a public open area greater than 5,000 m^2 (EC 2003) is an important indicator that nevertheless should

Photo 2.1 An overview of Stuttgart and its green space system with large, well-connected areas (Photo: Giovanni Sanesi) (*See Color Plates*)

not be taken only at face value. Taking Milan and Munich as examples we find that Milan is characterized by a large number of relatively small open public areas, which are spread across the city whilst Munich is characterized by much bigger areas that are more continuous, but concentrated in the outskirts of the city. An optimal situation can be found, on the contrary, in Stuttgart (Photo 2.1). The overview of this city gives an example of a large, well-connected green space system. In spite of these differences, which can be immediately seen on a map, the indicator gives a very similar value for the two cities (Kasanko et al. 2002).

2.4 The Forest and the City: Implication on Urban Environment

2.4.1 Urban Forests and the Sustainable City

At the end of the twentieth century a new narrative arose in city planning, centered on the concept of the sustainable city (Töpfer 1996), which is important to better understand the significance of forests for the ecological integrity of urban environments. Today this concept is commonplace in academic and policy papers (e.g., Kahn 2006; European Commission 1996) where a central aim of urban planning is to achieve development without deterioration in environmental quality and impacts on the quality of life for urban residents. Töpfer (1996) suggests that at the same time we have seen the emergence of holistic approaches that take account of the impact of urban development on the wider regional and even global environment. Thus, the perspectives of urban policy have perhaps shifted to take account of externalities, and our improved understanding of the complex relationships between urban and wider environments. An important milestone was UNCED 1992 from which emerged not only the current global policy process for sustainable forest management (Humphreys 1996) but also Agenda 21 with its mantra '*Think globally, act locally*' and emphasis on cooperation between local decision-makers, corporate and third-sector actors and the public.

Applying UNCED's three pillars of sustainability – economic, social, and environmental – to urban planning, Hancock (1996) stressed the relationships between health, social well-being, environmental quality, ecosystem health and economic activity in urban environments. For sustainable urban development, he proposes in his model to balance and integrate environmental viability, community sociability, and economic prosperity. Environmental viability means the quality of local ecosystems as well as healthy air, water, soil and food. In urban environments, these kinds of ecosystem goods and services (de Groot 1987) can be provided by urban forest ecosystems (e.g., Bernatzky 1983; Rowntree 1986, 1998). The term community sociability implies the web of social relations, social cohesion, civic community, and social solidarity. Economic prosperity involves a sufficient level of economic activity to ensure that communities can satisfy their basic needs. Any economic activity must be socially equitable and ecological sustainable. The latter means that economic activities do not waste natural resources, pollute the environment, and damage ecosystem health. In this respect, the existence of a vigorous and healthy urban forest ecosystem can serve as a significant indicator for such desired sustainability conditions.

How important are natural spaces to urban quality and to wellbeing? Black (1996) considers the environment in a city as a composition of the natural and cultural elements. Natural elements are climate, air, water, soil, plants, and animals. In urban environments, green spaces have proven to act as ameliorating factors of some climatic features related to heat stress, reducing their effects and providing comfortable outdoor settings for people (Lafortezza et al. 2009). The cultural environment can be defined as the complex of human activities, the built environment including parks and green spaces and the ways and styles we maintain and develop this environment. If we take the World Health Organization's (WHO-HFA 2002) understanding of health, which in addition to the absence of illness encompasses physical, social, and mental wellbeing then we can argue that urban forests can make an important contribution to achieve this vision of human health.

Tzoulas et al. (2007) argue, based on a synthesis of a wide body of interdisciplinary literature, that urban and peri-urban green spaces (i.e., green infrastructure) can provide healthy environments and physical and psychological health benefits to the people residing within them.

A further dimension to be considered towards social wellbeing is related to the governance issues and people's participation in decision-making concerning their immediate environment. Social well-being is associated with comfortable housing, green space, recreational and cultural activities and public transport. A healthy population implies equitable access to good local environments, hereby including a high level of communication, participation and people involvement in local decision-making process.

This outlines the framework within we have to rethink our relationship between cities and the urban forest. We know that the type and arrangement of urban trees not only determines many characteristics of the city's physical and biological conditions but also influences the socioeconomic environment.

Nowak and Dwyer (2007) argue that the benefits of green space in towns depend on appropriate management, so that we need a better understanding of these benefits and a better understanding of the costs that will be generated from the provision and maintenance of the urban forest. Since many of the benefits are intangible they argue for environmental economics that quantify and monetize the services from the urban forest so that decision makers can make comparisons.

Not only must we understand the economic value of these services, managers also require the skills to understand the likely outcomes from different management options. The aim is to deliver the benefits appropriate to any locality. Urban forestry sees the urban forest as an ecosystem (Rowntree 1986) within and extending beyond the urban system and aims to analyze the interactions between the natural and socio-economic system.

There are many aspects where the urban forest can have an impact on the quality of the urban environment and thus influence the quality of life in urban areas. We see this illustrated in the high proportion of Agenda 21 initiatives that focus on the urban forest and define goals, standards, and measures to improve the environmental quality of the city with help of urban forests (Healey 2004).

Based on a study if European cities awarded in the European Sustainable Cities and Town campaign, Beatley (2000) argues that '*many European cities show that human settlements can be green and ecological, at the same time that they are highly desirable places in which to live and work*'.

2.4.2 Impacts of Urban Forests on Natural Urban Environments

In this section, we consider which impacts urban forests and other green spaces have on the quality of the urban environment in terms of hydrology, climate, air quality and biodiversity.

2.4.2.1 Hydrology

Urban structures affect hydrology, especially through accelerated runoff during rainfall and also through contamination of water by substances washed off roads and other hard surfaces. The urban forest can reduce these impacts and help control the surface runoff. Tyrväinen et al. (2005) suggest that trees affect urban hydrology through:

- Interception of precipitation that can be stored and evaporated by tree foliage
- Reduction in the peak rates of run-off into drains and water systems
- Reduced impact from raindrops, reduced soil erosion, and pollutant wash-off

Several studies confirm that the hydrology of urbanized zones is far from being simple: the urban environment is highly heterogeneous in terms of land use, subsoil characteristics and other factors, which serve to influence all hydrological processes (Ragab et al. 2003; Göbel et al. 2004; Berthier et al. 2006).

In a case study in urban green areas, a model for estimating the evaporation of rainfall has been developed based on forest research (Gash et al. 2008). These authors concluded that the process of evaporation from an urban roof is sufficiently similar to that from a forest canopy, which means that forest evaporation models can be used to give a useful estimate of urban roof runoff.

Taking into account the evidences in forestry soil, the water cycle can be strongly affected by climatic conditions (Martínez-Zavala and Jordán-López 2009).

Natural areas also allow infiltration of water into the ground that can then become available as groundwater.

It is estimated that typical runoff volumes in highly impervious urban settings amount 60–70% of the average annual rainfall. In vegetated urban areas with permeable soil conditions, the typical runoff volumes amount between 10% and 20% of the average annual rainfall (MPCA 2000). Forestry resources can play also an important role in the protection of water bodies and in the management of groundwater supplies. Healthy urban forest stands protect soil from erosion into sewer systems and water bodies. More water can be stored in soil layers with high organic matter content from leaf litter and dead wood (Cappiella et al. 2005).

Whitford et al. (2001) studied the hydrological effect of urban forests in four urban areas of Merseyside, UK. As part of their study, they found that the greatest influence on the ecological value of urban areas was the percentage of green space, particularly of trees. In respect of hydrology, their results suggested the use of roof gardens and permeable paving as a means of improving rainfall management.

2.4.2.2 Climate: The Urban Heat Island Effect

One of the more important characteristic of urban climate is the urban heat island effect (UHI) (Oke 1995), in which the urban temperature is significantly higher than its rural (green) surroundings. The intensity of the UHI is measured by the temperature difference between the heat centre in the cities and its suburbs. Normally heat island intensity is proportional to the population size and density of a city (Oke 1973; Gyr and Rys 1995; Brazel et al. 2000). The UHI arises partly through the replacement of trees and vegetation with buildings and sealed surfaces that absorb short wave (solar) radiation and then release the energy as long wave radiation (heat). Energy release from vehicles and buildings also contributes.

Extreme heat waves in cities can cause considerable health problems for citizens, for example the sharply increased mortality during episodes of high temperature across Europe in 2003 (Michelozzi et al. 2005; Nogueira et al. 2005; Poumadere et al. 2005). Whether UHI is a factor in global warming is unknown. However, it seems likely that the quality of urban environments will be impacted by a rise in temperature (Alcoforado and Andrade 2008).

Trees evaporate water and cool leaf surfaces with the effect that neighborhoods with a well developed tree canopy are cooler in summer than other urban areas with lesser or no tree canopy. Another effect is that lower temperatures reduce ozone concentrations by lowering emission of hydrocarbons (McPherson and Simpson 2002).

The positive effect of urban trees in reducing UHI effects is through shading, cooling through evapotranspiration (the evaporation of water trough foliage) and a reduced demand for air-conditioning in summer. At city level positive effects of urban forestry on UHI and thermal profiles have been assessed in Germany and Sweden (Tyrväinen et al. 2005).

Probably the cool effect of green areas is related to a lot of variables, such as local urban morphology around the parks, land use around the parks, wind-flow, types of pavements, and types of trees, landscape design (Brown and Gillespie 1995).

2.4.2.3 Air Quality

Urban forests have been demonstrated to improve air quality, largely through their foliage that reduces particulates by a process of interception of gases such as ozone (O_3), nitrogen dioxide (NO_2), Carbon dioxide (CO_2), and sulfur dioxide (SO_2), but also through surface effects and also absorption into the leaves (Smith 1990). Bernatzky (1983) reported that up to 85% of air pollution in a park can be filtered out, and up to 70% in a street with trees. Donovan et al. (2005) in the UK explored the role of trees in removing air pollutants such as low-level ozone, nitrogen oxides, and carbon monoxide. The best-known demonstration of these effects is in the 'Chicago project' in the US, reported by (McPherson et al. 1994). McPherson et al. (1997) estimated that trees in Chicago remove some 5,500 of air pollutants annually.

Ozone (O_3), a normal component of the upper atmosphere, causes little risk to health at low and O_3 stable concentrations but becomes a threat to health as concentrations rise (Powe and Willis 2004). Additional ozone is produced in the troposphere, the lowest part of the atmosphere, and at ground level by a reaction with pollutants, mainly nitrogen oxides from vehicles and volatile organic compounds (VOCs). The effect is photochemical and is stronger in sunny areas. Trees can remove large quantities of ozone from the atmosphere (McPherson et al. 1994, 1998). In US, it has been suggested that a 20% loss of wooded area due to urbanization in Los Angeles would lead to a 14% increase in ozone concentrations (Taha 1996; McPherson et al. 1998; Nowak et al. 2000).

Several studies have demonstrated that trees can remove large quantities of sulfur dioxide (SO_2), a gas that is implicated in respiratory disease, from the atmosphere (McPherson et al. 1994; Nowak et al. 1998). McPherson et al. (1994) estimated that on average approximately 3.9 t/day of SO_2 had been removed by trees in the Chicago area, improving the average hourly air quality by 1.3%.

Trees also can remove CO_2 from the atmosphere through their normal growth process and sequester the carbon within their biomass. In the US it was estimated that the annual carbon storage from urban trees was in total US about 70,439,700 t

(Nowak and Crane 2002). Thus, urban forests can play a significant role in helping to reduce atmospheric carbon dioxide levels.

The impact of a green area (i.e., park) in the urban environment could be also negative. Oliver-Solà et al. (2007), in a study about the impact of Montjuïc Park at Barcellona (Spain), evaluated that the forest surface area required to absorb the CO_2-equivalent emissions produced by the life cycle of the energy consumed (i.e., services for citizens) at this urban green area represents 12.2 times the park's surface area.

Airborne particles can also be removed by urban forests. The effect is mostly through interception by foliage, though some particles can also be absorbed into the tree. Particles might be re-suspended to the atmosphere, washed off by the rain or drop to the ground with leaf and twig fall (Nowak et al. 2006). At the same time urban forest canopies can limit the mixing of upper air with ground level air, leading to significant below-canopy air quality. Estimates by Tolly (1988) and Bramryd and Frabsman (1993) suggest that 1 ha of mixed forest can remove 15 t of particulates from the air each year while a pure spruce forest may filter two or three times as much. In urban environments, Escobedo and Nowak (2009) estimate an average removal of PM10 of around 7.5 g/m^2 of tree cover. Other researches confirmed the attenuation of particulate concentrations within an urbanized forest patch (Cavanagh et al. 2009).

Particulate matter can cause breathing and respiratory symptoms, aggravate existing cardiovascular disease, damage lung tissue and constrain the body's defensive mechanisms (Du et al. 2007).Therefore, urban forests are an important factor in reducing particulate matter and improve local air quality. However, trees can themselves be a source of VOCs. These emissions have been related to species and vegetation status with zerophytic trees particularly implicated (Loreto et al. 1995; Loreto 2002; Rapparini et al. 2004). Whilst there is a link between VOC emissions and ozone formation, VOC emissions arising from urban vegetation are typically less than 10% of that from anthropogenic sources, and urban vegetation also reduces ozone formation and concentration (Taha 1996; Nowak et al. 2006).

Many people consider oxygen production as a significant benefit of trees and other terrestrial plants; but this benefit is very scanty if we consider the large oxygen content of the atmosphere and the other sources of production. Net oxygen production by trees is based on the amount of oxygen produced during photosynthesis minus the amount of oxygen consumed during plant respiration. The amount of oxygen produced is estimated from carbon sequestration based on atomic weights (Nowak et al. 2007): net O_2 release (kg/year) = net C sequestration (kg/year).

Based on the national estimate of the carbon sequestration in the coterminous United States of 22.8 million metric tons C per year (25.1 million tons C per year) (Nowak and Crane 2002), urban forests in the United States produce about 61 million metric tons (67 million tons) of oxygen annually, which is enough oxygen to offset human oxygen consumption for approximately two-thirds of the US population.

2.4.2.4 Biodiversity

Urban forests, trees and other green spaces contribute to the ecological and environmental functions of urban ecosystems. The importance of urban green areas for the conservation of biodiversity is well-documented (Gilbert 1989; Sukopp and Witting 1993; Fernández-Juricic 2000). However, this contribution is strongly influenced by the intrinsic structure of the area, as well the landscape surrounding it. Several authors have used the structure and composition of bird communities as biodiversity indicators to detail the relationships between urban forestry and biodiversity. Ferrara et al. (2008) analyzed three urban and peri-urban green areas of the city of Bari (Italy). From the urban fringe to the city centre, the biodiversity drops dramatically. The reduction seems to depend not only on the degree of fragmentation and connectivity of the green areas, but also on other large-scale factors (Lorusso et al. 2007).

In a comprehensive study, Sanesi et al. (2009), showed positive correlations between green spaces with a more diverse and mature forest vegetation and the number of specimens and species observed in different urban zones. A positive relation appeared also between distance to the city center and richness and abundance of bird species.

Several authors emphasized that at local and at regional scale, the presence of a functional network of green space is an important factor for the maintenance of the ecological dimension of a sustainable urban and peri-urban landscapes; at the same time it's important the protection of natural structures (i.e., complexity, dead wood) in urban green areas to maintain high ecological diversity (Sandström et al. 2006). But the maintenance of these structures often can determine a conflict in managing the functionality of urban green spaces (i.e., safety in accessibility).

In the last decade, attention has been drawn to the value of woodland areas arising on previously industrial land through a process of natural succession (Markussen et al. 2005).

2.5 Environment Quality and Human Health

The current population of Europe enjoys better health than any generation since the beginning of human kind. People today have a longer life expectancy than ever before (WHO-HFA 2002). However, longevity and quality of life is not the same thing and there is a continuing concern to improve the quality of life of people. This concept of balance is illustrated by the use in public health of 'Quality-adjusted life-years' (QALY) that take into account both quantity and the quality of life generated by healthcare interventions.

What constitutes a healthy environment and a high quality of life might seem self-evident, when you see it you recognize it. However, city planners and policy-makers need to codify the concepts, and this is not straightforward. An extensive Dutch study by Maas et al. (2006), looked at the relationships between public health and greenness of people's living environment. Their research indicated that people living in urban areas generally are less healthy than people living in areas that are more natural. They argued that green spaces are more than just a luxury, but are rather a requirement to maintain or improve the health of the urban population. Mitchell and Popham (2007) confirmed that a higher proportion of green space in an area is associated with better health but they were unable to say whether this was simply because people in these parts of the city were wealthier or because there was a causal relationship in play.

Nearly four out of five European citizens live in urban areas where the existing statutory environmental quality limits are breached. High volumes of traffic and noise, atmospheric pollution, and high-density built-up areas contribute to a lower quality of life, as well as a gradual weakening of the sense of human health and well-being (e.g., EEA 2006; Report No 10/2006).

The state of the environment in cities is consequently of great importance to most Europeans (e.g., EEA 2005: Report No 1/2005). On the other hand, environmental problems, from global to local, are often rooted in increasing urban activities and the pressure they put on natural resources (e.g., EEA 2006; Report No 10/2006). The level of environmental awareness expressed in planning, designing and managing cities is directly relevant to wider concerns for achieving sustainability at a European scale.

2.5.1 Urban Forests as a Social Resource

A simple but important reason as to why forests and green spaces in towns are important is that they are attractive places that people can use for formal or informal recreation and for socializing. However, the perception and use of these spaces has a cultural dimension and will differ from one location to the next. There is a growing body of research on the management and promotion of open spaces in towns to encourage the social integration of people in difficulties, ethnic minorities, and immigrants. Germann-Chiari and Seeland (2004) investigated the potential of urban green spaces to create opportunities to integrate youths, elderly people, foreigners, unemployed, and other social groups into the urban life of large Swiss agglomerations.

Tradition and personal experience also play a part in coloring people's expectations for green space. Gerhold (2007) reported a Canadian study that explored the different attitudes of Toronto's residents to urban trees according to their different cultural backgrounds. Residents with British background were most interested in having shade trees whereas Italian and Portuguese neighborhoods preferred fruit trees and vegetable gardens. People with Chinese roots were the least concerned to have trees in their neighborhood. Green space is a topic which has been emerging onto the wider policy agenda in recent years.

As open space is often in public ownership its management is affected by the growing body of equal rights legislation in Europe. Generally, it is unacceptable to manage public assets in a way that has a differential effect on local communities (Lafortezza et al. 2008). In the UK, for example, recent diversity and equality legislation has led the state forestry service to undertake a review of all its policies and management practices. It is required to assess their impact on the interests of people categorized according to ethnicity, gender, disability, sexual orientation, life-stage and faith. Where negative impacts are found it is required to take action. The legislation is leading to changes in recruitment practice and to regional approaches to the management of open space to reflect the needs of the local population. It has also generated a need for social research to explore the place of culture in informing people's use of open space and to inform managers of local needs.

2.6 Forest Dependent Communities

In some places, communities can be directly dependent on forests for their livelihood. This includes not only industrialized countries, for example the US, Canada and Finland, where a community might rely on sawmilling or papermaking but also developing countries where the forest is crucial for the daily subsistence of families and communities. Elsewhere, forests might have an important but indirect part in the local economy, for example as a background to outdoor tourism.

The term 'Community forestry' (CF) includes all the forest management types that provide both economic and social goals, under the control (or property) of a local community or larger social group. CF management is often set in a larger ecological landscape with other land uses. Normally it combines multiple objectives, including subsistence (cooking, heating, etc.), cultural functions, and market production. CF includes many groups who manage their forests for subsistence purposes, and have entered markets on a limited basis, often with agricultural products or with products collected from the forest. In a developing-countries context, CF can have an important role to improve family (i.e., rural communities) income. For this reason the local communities play an important role in the sustainable management of land and forest resources, including the management of the risk of fire (Pagdee et al. 2006; Moore et al. 2002).

In the European countries the term CF is often linked to a England's national program that '*is a successful model for community involvement, inclusion, environmental regeneration and green infrastructure creation*'. The Program of Community Forests was launched as an experimental initiative to develop and test the use of multipurpose forestry as a mechanism to revitalize and regenerate countryside and green space around 12 major towns and cities. The Program was seeking to respond to a number of key issues at the rural–urban fringe including the need to integrate forestry with recreational interests, problems of land management and despoiled land e.g., through waste management or mineral extraction. Together England's Community Forests cover over 450,000 ha, one of the largest environmental initiatives in Europe. Community Forests can be described as multi-purpose forestry close to people that deliver integrated environmental, social, and economic benefits, and involve local communities in the planning, design, management, and use of trees, woodland and associated green space (Matthews 1994; Land Use Consultants et al. 2005).

2.7 Conclusion

People in different countries and from different cultures see forests differently. Nevertheless, there is widespread acceptance that trees and forests make a positive contribution to contemporary urban life. There is compelling evidence that green spaces can help to reduce the negative effects of urbanization. By improving the quality of air, biodiversity, and climate, they make towns and cities more habitable and more suited as a human environment. However, this is only part of the picture.

Social research in forestry is directing us towards new models of forest management where social inclusion, cultural integration and wellbeing are being adopted as core objectives. Managing forests for health is one of these new directions. We believe that there is now enough evidence showing the importance of green environments for mental, physical health and wellbeing to make this a core objective for forest management in Europe.

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Chapter 3
Forest Products with Health-Promoting and Medicinal Properties

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Abstract Forests are a rich renewable source of health-promoting and medicinal products. Not only the trees but also berries, nuts and mushrooms in forests contain a multitude of natural bioactive compounds which can be used in health-promoting products and medicines. In addition to the main structural components that trees contain, namely cellulose, hemicelluloses and lignin, thousands of bioactive compounds have been identified. Forest products have always had a key role in traditional medicine which continues to be of great importance, especially in developing countries. In the industrialized countries, the pharmaceutical industry is again increasingly looking at

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plant-derived natural drugs. Plant-derived compounds help to build a bridge between the traditional medical drugs in developing countries and the modern pharmaceuticals in the developed countries. Plant-derived bioactive compounds serve especially as preventive agents helping to maintain health.

3.1 Introduction

This chapter looks at the health-promoting effects of forest products from both a historical and scientific perspective. The use of medicinal plants – ethnomedicine – is a tradition common to all civilizations and according to WHO (Gurib – Fakin 2006), over 80% of the world's population rely on plant-derived medication for their health-care needs. At the same time, Western scientific research has begun to show the value of many traditional approaches, so that pharmaceutical companies in the Western world have revived their interest in plant-derived drugs and traditional knowledge of health care. Forests, the most diverse of all habitats, can be seen as natural pharmacies and over the past 2 decades, there has been a gradual return to the study of medicinal plants. As a consequence, the national and global markets for a wide range of forest products are growing rapidly. According to the World Bank (2004) the international trade in medicinal plants is worth $60 billion per year and is increasing at a rate of 7% per year.

Today, tree-derived bioactive compounds are produced in Europe in large amounts and marketed world-wide as ingredients in dietary supplements and health foods. We describe three products of this kind: xylitol, sitosterol and sitostanol. We also consider the development of products from knots and bark, including HMR lignan.

Plants produce a great variety of chemicals with important biological and ecological roles, including substances that protect plants themselves. Most of these chemicals can be classified as secondary natural plant products or secondary metabolites, i.e. any natural chemical product of plants not normally involved in primary metabolic processes, such as photosynthesis and cell respiration. The largest group of secondary plant products is terpenoids, among which many are used in food and beverages, and some are used in folk medicine and in pharmaceuticals, such as the anticancer drug Taxol and the antimalarial drug artemisinin. In this chapter we discuss the health benefits of volatile and non-volatile terpenoids in some *Cupressaceae* species, showing their traditional use for treating body ailments and diseases in both humans and animals. Uses include disinfectants, parasiticides, antiseptics, stimulants and painkillers.

3.2 Historical Perspectives for Medicinal Plants and Their Current State in Europe

3.2.1 Medicinal Plants in the History of Mankind

As old as man, the use of medicinal plants to cure diseases is rooted in tradition, empiricism and symbolic meaning. Whilst the number of plant species that have been used for medicinal purposes can only be estimated, Lange (2004) suggests that at least every fourth flowering plant of the approximate total of 422,000 flowering plant species (Scotland and Worthley 2003) has been used in ethnobotany somewhere in the world.

Several authors have estimated the number of plant species used for medicinal purposes. WHO has listed 21,000 medicinal species (Groombridge 1992), Farnsworth and Soejarto (1991) estimate that about 70,000 species are used in folk medicine. According to Schippmann et al. (2002), the number of higher plant species used for medicinal purposes worldwide is more than 50,000. This equates to approximately 17% of the world's vascular flora and constitutes the biggest spectrum of biodiversity used by people for a specific purpose (Hamilton et al. 2006).

India, China, the United States, Indonesia, Malaysia and Thailand (Schippmann et al. 2002) are the main countries where plants are used for medicinal purposes. A few plant families, including *Apocynaceae, Araliaceae, Apiaceae, Asclepeiadaceae, Canellaceae, Guttiferae* and *Menispermaceae* have higher proportions of medicinal plants than others. In developing countries, medicinal plants and forest products have always been a resource for primary health care, as part of first-line and basic health services not only to people living in remote areas, where it might be the only available health remedy, but to also to poor people.

Even where modern medicine is available, the interest in medicinal plants has increased rapidly in recent years, and it is still the case that in developing countries most people rely on herbal compounds rather than pharmaceutical drugs. WHO expects their use to be increased further, not only because of population growth, but also because of the increasing importance being attached to traditional health care in public health policy. In the industrialized countries, the use of medicinal plants was progressively abandoned in the twentieth century. This is perhaps due to the development of modern pharmacology and the achievements of medicinal products in fighting diseases, but it can also be seen a post-enlightenment phenomenon where traditional approaches were disregarded in the new scientific doctrine of medicine.

However, since the 1970s the Western world is also looking more to plant-derived drugs in its search for novel pharmaceuticals. In part, this seems to stem from the increasing costs of discovering new drugs, a reducing success rate for traditional drug development (Mintzberg 2006) and problems with synthetic drugs that have not always met their expectations. Thus, the past 2 decades have seen a gradual return to the study of phytochemicals used in herbal medicine. Fabricant and Farnsworth (2001) studied 122 compounds, obtained from only 94 plant species that are used globally as drugs. They showed that 80% of these have had an ethno-medical use that was identical or related to the current use of the active elements of the plant. They reported that when evaluating plants for bioactive compounds an ethno-medical approach based on traditional knowledge has been more successful than the random collection of plants. Nevertheless, they reported that random testing was the model increasingly adopted.

This interest extends beyond drug companies to include governments, research institutions and the wider public. Governments are considering policies about the appropriate use of plant-derived products. They are also concerned about the legal and ethical questions involved in patenting traditional medicines or drugs developed from them (Mintzberg 2006). The search for new pharmaceuticals is not restricted to drug companies. There are many researchers looking for active principles able to cure modern diseases or decrease the side effects often connected to medicinal products. The role of traditional knowledge is being re-appraised, with some researchers arguing that experience built over many centuries can provide a substantial basis for safe and effective use of medicinal plants.

3.2.2 State of Plant-Derived Products in Europe

Global and domestic markets for medicinal plants and their derivatives are growing rapidly. It has been estimated that internationally the trade in medicinal plants is worth $60 billion per year (World Bank 2004) increasing at a rate of 7% a year (Koul and Wahab 2004). The international trade in medicinal and aromatic plants (MAP) probably involves between 2,500 and 3,000 species worldwide (Shippmann et al. 2006). The 12 countries that were most active in the trade of pharmaceutical plants, during 1991–2000, imported a total of 326,300 t with a value of $97.8 million and exported 344,400 t with a value of $8.74 million (UNCTAD COMTRADE database). In that period, Europe imported annually around 127,000 t of medicinal plants while the annual European export average amounts to 75,900 t. The principal European export countries are Bulgaria, Albania, Poland and Hungary (Lange 1998, 2001, 2002). Within the European Union, the cultivation of medicinal and aromatic plants occupies an area of about 70,000 ha (Verlet and Leclercq 1997), though 90% of the European native species used in medicine are harvested in the wild (Lange 1998). Of the 3,000 or so species known to be traded internationally, only about 900 are cultivated commercially (Mulliken and Inskipp 2006). We can see that 70–80% of the medicinal plants traded in the world's most important markets for medicinal plants are collected in the wild (WWF/TRAFFIC Germany 2002). In Europe, the products derived from medicinal plants are used both for therapeutic and dietary purposes, and they are currently regulated in three categories: (1) Food supplements, according to Directive 2002/46/EC; (2) Traditional herbal medicinal products, according to Directive 2004/24/EC; (3) Medicinal products, that should be prescribed by medical doctors and sold in pharmacies (Directive 2001/83/EC; Directive 2003/94/EC, Directive 2004/27/EC).

The distribution of sales of over-the-counter herbal medicines, amounting overall to just under $5 billion (at manufacturers' prices to wholesalers), is shown in Table 3.1.

A further $132 million in sales was divided among Portugal, Hungary, Ireland, Slovakia, Finland, and Norway. The spending per capita was $25.00 in Germany, $18.80 in France, $9.50 in Italy, $6.50 in Poland, $3.60 in the United Kingdom, $4.10 in Spain, $12.30 in Belgium, $13.00 in Switzerland, $10.90 in Austria, $5.00 in the Netherlands, and $7.40 in the Czech Republic (De Smet 2005).

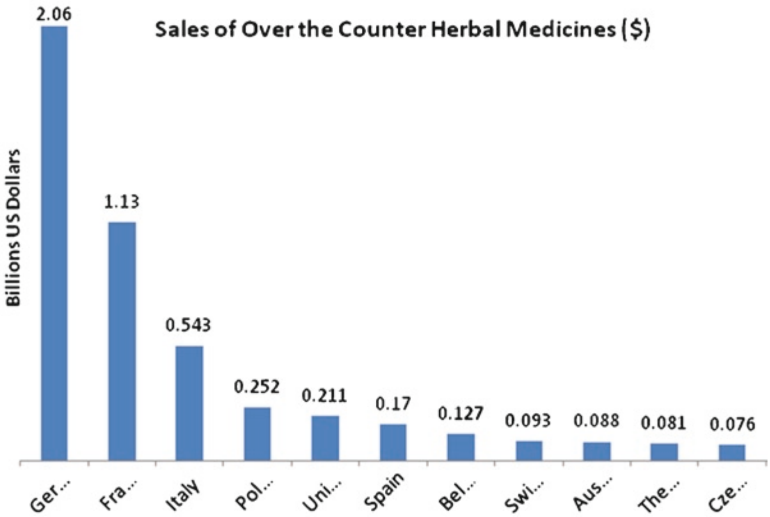


Table 3.1 Sales of OTC herbal medicines in Europe (De Smet 2005)

3.2.3 Potential Role of Medicinal Plants in Human Health and Critical Topics

Medicinal plants and forest products are already important sources for pharmaceutical manufacturing. As many as 50% of prescription drugs are based on a molecule that occurs naturally in a plant, with some 25% of prescription drugs derived directly or modeled on molecules from flowering plants (Foster and Johnson 2006). Plants and trees contain a large number of bioactive compounds such as polyphenols, flavonoids, phytoestrogens, terpenoids, phytosterols, fatty acids and vitamins which are known to exert beneficial health effects. Their use for the prevention and treatment of diseases ranges from traditional and popular medicines to the use of botanical extracts following the methodology of mainstream medicine. They embrace, among the other, therapeutic categories such as anticonceptives, steroids and muscle relaxants for anesthesia and abdominal surgery, quinine and artemisinin against malaria, digitalis derivatives for heart failure, and the anticancer drugs vinblastin/vincristin, etoposide and taxol. So far, scientific research has documented significant pharmacological activities of several medicinal plants that are used in association with medicinal products, and form the basis for a safe use of these products.

Collecting raw materials from natural habitats, however, can be damaging and potentially cause not only the extinction of rare species but also affect local economies on which communities depend. The number of endangered plant species is still unclear. In 1997, the World Conservation Union's (IUCN) Red List of Plants included some 34,000 threatened species out of 60,000 evaluated. Since then, the IUCN Red Listing criteria have changed, and around 11,000 species have been evaluated with the new system. Of those evaluated, some 8,000 species were found to be under threat. Both of these assessments indicate that well over half of all plants evaluated are at risk (Walter and Gillet 1998), implying that they should not be collected for medicinal purposes. WHO (2003) has compiled the Guidelines on Good Agricultural and Collection Practices (GACP) for medicinal plants.

Medicinal plants protected by national and international laws may be collected only with the appropriate permission. The provisions of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) constrains the trade in particularly endangered species.

Intellectual property rights for compounds derived from plants, and the traditional knowledge associated with them, is a contested topic. The debate centers on the protection provided under international and national patent laws and whether this can deliver equitable sharing of the benefits arising from the exploitation of traditional resources. Does bio-prospecting in forests disenfranchise traditional knowledge? What must be done if indigenous peoples are to benefit from the use of their resources? What say do indigenous people have in the decision-making process that deals with the use of their resources? Mintzberg (2006) is one of many authors who ask further questions about the ethics of restricting access to life-saving drugs through the use of patents and other intellectual property rights.

3.3 Evaluation of Forest Products

3.3.1 Introduction

Because of the limited supplies of some plant material from the wild and exhaustion of natural sources there is a need to cultivate analogues, both to conserve medicinal plants and to ensure adequate supply. Plants and trees contain a large number of bioactive compounds that can contribute to health (Kris-Etherton et al. 2002; Holmbom et al. 2007; Moutsatsou 2007). There are many variables, including climate, soil, the degree of ripeness, plant genetics and cultivation conditions that strongly influence the characteristics of the plants and the composition of chemical extractives (Ross and Kasum 2002). In many cases efforts to cultivate the same subspecies in other geographical areas have failed. The chemical content and relative concentration of compounds may vary even in the same species depending on their floral origin (Oddo et al. 2004; Terrab et al. 2004; Ruoff et al. 2006).

3.3.2 Extraction and Chemical Analysis

The main aim of this section is to describe the procedures typically used to isolate and analyze plant-derived bioactive compounds. Prospecting for plant-based pharmaceuticals can be done using high-throughput screening protocols on selected or

Table 3.2 Typical procedure for extraction, analysis and biotesting of forest and other plant products

Procedure	Aims – results
(a) Sampling	Well defined samples
(b) Extraction	Extracts of different polarity
(c) Fractionation and Purification	Compound groups or individual compounds
(d) Chemical Analysis	Identity and concentrations of compounds
(e) Biotesting (Clinical tests, In vitro, In vivo)	Bioactivity of extracts, compound groups and individual compounds

random samples, computational and molecular modeling and ethno-botanical studies. Whatever method is used to select a plant for analysis, the next step is to test for biological activity and potential health effects. The analytical procedure involves three basic steps: extraction from the sample, fractionation and purification and chemical analysis (Table 3.2). The extraction procedure is the first critical step since different solvents extract compounds with different chemical characteristics. The goal is to obtain a sample extract that has a high concentration of the components of interest, but is free from interfering substances.

Chemical analysis aims at distinguishing between already known compounds (dereplication) and new molecules in plant extracts. Techniques such as liquid chromatography/mass spectrometry (LC/MS), liquid chromatography/mass spectrometry/mass spectrometry (LC/MS/MS) and liquid chromatography/nuclear magnetic resonance (LC/NMR) are applied to plant extracts to identify new bioactive compounds or to quantify already known constituents. Mid-Infrared-Spectrometry (FT-MIR) and Near-Infrared Spectrometry (FT-NIR) are also valuable tools for confirming the botanical and geographical origin of plant-derived products (Ruoff et al. 2006). Further methods used to analyze bioactive compounds in plants are chromatographic methods including, thin-layer chromatography (TLC), gas chromatography (GC), high-pressure liquid chromatography (HPLC) and capillary electrophoresis (CE) (Wolfender et al. 2003). Gas chromatography/mass spectrometry is a very powerful tool for the simultaneous identification and quantification of individual compounds.

3.3.3 Biomedical Evaluation

Bioactive compounds found in tree and plant extracts include polyphenols (including flavonoids, phenolic acids, tannins, lignans and stilbenes), carotenoids (lycopene), sterols (sitosterol), polysaccharides, beta-glucans, and various terpenoids (Kris-Etherton et al. 2002; Holmbom et al. 2007). Numerous studies have shown that these phytochemicals can be biologically active with properties such as anticancer activity, antiatherogenic and antioxidant potential, neuroprotection effects, and bone-favoring effects (Kris-Etherton et al. 2002; Moutsatsou 2007).

To assess the biological activity of plant extracts and plant-derived compounds an array of in vitro test systems is used. There are high-throughput screening tests which set priorities for further assessment. A combination of several in vitro test systems is required in order to predict the effects in vivo. However, in vitro assays do not include metabolites of compounds and aspects of the absorption of compounds so they may give false negative or false positive results. Only in vivo studies are able to predict the action of a substance in the organism, since under these in vivo conditions the substance is exposed to both absorption processes and multiple metabolic transformations.

3.3.4 In Vitro Test Systems

To assess the estrogenic or anti-estrogenic potential of phytochemicals (an activity usually shown by certain polyphenols) several in vitro test systems are typically used: (1) a radiometric competitive receptor-binding assay, (2) reporter gene assays, (3) assays that measure the expression of endogenous estrogen receptor (ER) target genes (end point assays), and (4) a proliferation assay using an established cell line that is known to respond to estrogens (Diel et al. 1999; Gutendorf and Westendorf 2001; Mueller 2002).

Assessment of the anti-carcinogenic potential of phytochemicals usually includes: (1) a proliferation assay or a cell viability assay (MTT assay), and (2) investigation of apoptosis by using flow-cytometry techniques, measuring apoptotic or anti-apoptotic proteins and DNA fragmentation products (Kassi et al. 2007). Since cancer is a multi-factorial disease that requires modulation of multiple pathways and multiple targets, one may also assess the potential of phytochemicals on various other processes. This includes suppression of growth factor expression or signaling, inflammatory molecules and signaling (NF-kB, JNK and AP-1 signaling pathways), cell-cycle molecules (cylin-D1) as well as down-regulation of angiogenesis.

Atheromatosis is also a complex disease characterized by alterations in numerous cellular processes, among which the oxidative stress and inflammation play a key role. Thus, the anti-inflammatory and anti-atherogenic potential of phytochemicals may be assessed in cells of cardiovascular system (endothelial cells, smooth muscle cells) by determining inflammatory protein molecules such as adhesion molecules, cytokines, metalloproteinases and related signaling (NFkB, AP-1 signaling, Papoutsi et al. 2007a).

The effects of phytochemicals on bone health may be assessed by using the appropriate cells (osteoblasts, osteoclasts, monocytes) and tests such as mineralization of osteoblasts, measurement of proliferation or apoptosis of osteoclasts and osteoblasts, determination of cytokines, osteoprotegerin (OPG), osteocalcin and other bone parameters (Kassi et al. 2004; Papoutsi et al. 2007b).

3.3.5 In Vivo Test Systems

Various in vivo assays (animal models) are used to characterize the biological potency of phytochemicals and their mechanisms of action. The animals used are usually rats, mice or rabbits. In the tests the phytochemical is given orally or subcutaneously. Among the common animal models are several tumor models, which are mainly used to assess the potential chemopreventive properties of phytochemicals. There are several approaches, such as spontaneous carcinogenesis, chemical carcinogen-induced tumor models and tumor models by xenotransplantation of tumor cells. Spontaneous carcinogenesis may be applied for prostate and endometrial carcinogenesis. Chemical carcinogen-induced tumor models involve the exposure of rats to DMBA or NMU for the development of mammary carcinomas. Finally, some tumor cell lines, if xenotransplanted to immune-deficient nude mice or rats, grow tumors at the ectopic site and eventually metastasize through blood or lymphogenic pathways. This model is used for breast, prostate and endometrial tumors (Diel et al. 2002). Furthermore, there are more specific animal models to evaluate the estrogenic effects of phytochemicals. These animal models usually use immature, hypophysectomized or ovariectomized rats, mice or rabbits. In this case, the uterotrophic assay is combined with the analysis of estrogen-sensitive endpoints (such as morphological, histological, biochemical and molecular endpoints) in the uterus and other estrogen-sensitive target tissues, such as the vagina, the mammary gland, the liver, the bone, the cardiovascular system and the brain (Diel et al. 2002). The uterotrophic assay assesses the ability of phytoestrogens to stimulate uterine growth. However, this assay may not be very suitable for assessing estrogenicity, since there are compounds, like raloxifene, that exert tissue-specific estrogen-like activity, without effects in the uterus (Jefferson et al. 2002). The possible beneficial effects of phytoestrogens in osteoporosis, atherosclerosis and neurodegeneration are examined by using the ovariectomized adult rat model of osteoporosis, the rabbit model of high-cholesterol induced atheromatosis and several animal models of brain injury, respectively (Kalu 1991; Jee and Yao 2001; Picazo et al. 2003). In conclusion, the use of a suitable panel of different in vitro test systems combined with a final assessment in animal models will predict the real biological potential of phytochemicals.

3.4 Health-Promoting Effects of Honey and Walnuts

3.4.1 Introduction

Honey plays an important role in nutrition throughout Europe, with beekeeping deeply rooted in every European culture. Many European countries produce honey; Greece, Italy, Spain, France and Portugal being the main honey-producing countries.

Walnut trees are also important in Europe because of their fruits and decorative, valuable timber.

3.4.2 Honey

This natural product has been used for thousands of years in Greece. According to the philosopher Plato's concepts of health diet, a moderate and thus healthy diet consists of cereals, legumes, fruits, milk, honey and fish. Athenaeus, the Greek philosopher and author of 'The deipnosophists', reported that the Greek philosopher Democritus (500 BC) used honey in his daily diet for longevity and fertility. Democritus, along with Hippocrates and Dioscorides, considered honey as an important agent for strengthening the body and maintaining good health (Skiadas and Lascaratos 2001).

In Europe, more than 100 botanical species can give unifloral honeys (Oddo et al. 2004). Depending on flora and geographical origin, European honey is derived either from plant flowers, such as Danish honey or from conifers such as pine and fir trees. The conifer-derived honeys are marketed in central Europe as 'forest' honey. The quality of honey is judged by its botanical or floral origin and chemical composition. The floral source of a honey has been identified traditionally by the analysis of bee pollens present in the honey, while modern approaches rely on accurate chemical analysis of flavonoids and other phenolic compounds (Ruoff et al. 2006; Gómez-Caravaca et al. 2006).

Honey contains hundreds of substances and is considered as a traditional medicine. Among its important constituents are flavonoids, phenolic acids, certain enzymes, ascorbic acid, carotenoid substances, amino acids and proteins. The phenolic content and the antioxidant activity of honey vary greatly depending on the floral source and external factors such as the season and environment (Gheldof et al. 2002; Gómez-Caravaca et al. 2006). The total phenolic content of honeys derived from various flora sources ranges from 46 to 400 mg/kg honey (Gheldof et al. 2002). The high flavonoids content endows honey with antioxidant properties and an array of other biological properties, including antibacterial, antitumor, anti-inflammatory, anti-allergic, antithrombotic and vasodilatory actions (Ceyhan and Ugur 2001; Schramm et al. 2003; Swellam et al. 2003). Honey has shown wound-healing properties and also metabolic effects in diabetes (Katsilambros et al. 1988; Molan 2006).

3.4.3 Walnut

Walnut trees *Juglans regia* are important in Europe because of their fruits and decorative, valuable timber. They grow well on fertile, deep and well-drained soils in temperate climates. The main areas of its distribution in Europe are in flat regions in Germany, France, Italy and the eastern part of Austria. Walnut (*Juglans ssp.*) has a potential for use in agroforestry since it produces high-value products (e.g. good quality timber and nuts).

The naturalized European walnut tree is traditionally cultivated for fruit production, but it is also highly valued for its wood (Fady et al. 2003). Walnut (*Juglans regia*) is rich in substances such as ellagic acid, a known polyphenol, α-tocopherol (vitamin E), fiber, essential fatty acids, flavonoids and phenolic acids (Jurd 1956; Fukuda et al. 2003; Maguire et al. 2004; Colaric et al. 2005, Li et al. 2006).

The high content of polyunsaturated fatty acids (linoleic and linolenic acid) in walnuts has been suggested to reduce the risk of heart disease by decreasing total and low-density lipoprotein (LDL) cholesterol and increasing high-density lipoprotein (HDL) cholesterol. This favorable lipid profile of nuts has previously been proposed as the mechanism of walnuts' apparent anti-atherogenic effect in humans (Zambon et al. 2000; Almario et al. 2001). The cardiovascular protective effect of a walnut diet has also been related to its antioxidant effects as well as to modulation of endothelial functions (Anderson et al. 2001; Ros et al. 2004; Tsuda and Nishio 2004). The inflammatory process plays an important role in the pathogenesis of atherosclerosis through the interaction of the endothelium with the immune cells. The adhesion molecules, the vascular cell adhesion molecule (VCAM-1) and the intracellular cell adhesion molecule (ICAM-1) activated by inflammatory cytokines, such as tumor necrosis factor-α (TNF-α), participate in the initiation of this interaction. Recent data support that the methanol extract of walnut inhibits the inflammatory process in endothelial cells and that it also has favorable effects on bone cells (Papoutsi et al. 2007a, b). In conclusion, honey and walnuts are important, health-promoting forest products. A diet enriched with honey and walnuts may be beneficial for the prevention of many degenerative diseases.

3.5 Medicinal Properties of Pine Resin and Chios Mastic Gum

3.5.1 Pine Resin

Among the conifers in the northern hemisphere, the family *Pinaceae* is second only to the *Cupressaceae* in the extent of its range. Comprising about nine genera and 225 species it includes the economically important cedars, firs, hemlocks, larches, pines and spruces. Its members extend from deserts to rain forests and from the sea level to the mountain tree line (Scagel et al. 1965). The pine genus is the largest in the family, with around 120 species in two sub-genera.

The great success of pine trees rests partly on defense systems that have allowed them to withstand inter-specific competition and to deter pathogens, particularly saprophytic fungi but also other microbes, and attacks from herbivores, insects and other animals. Their principal defense mechanism is the production of resin (termed also oleoresin or pitch), which is a viscous, odoriferous secretion that appears at wound and infection sites (Philips and Croteau 1999). Pine resin is a complex mixture of terpenoids, consisting of roughly equal parts of volatile turpentine (monoterpenes, C_{10}, and sesquiterpenes, C_{15}, including oxygenated types) and rosin (diterpenes, (C_{20}) resin acids) (Croteau and Johnson 1985; Jonnessen and Stern 1978).

Pine resins have been used in traditional medicine since ancient times. Today, they are still used as the basic component of various medicinal preparations, often in ointments containing pine resin and beeswax. However, the pharmaceutical and medicinal properties of pine resin have not yet received extensive attention from the research community.

Simbirtsev et al. (2002a) reported that medical trials on animals have shown that **pine resin (PR)** and **pine resin ointments (PRO)** can be highly effective in the treatment of wounds and burns during phase I of the wound process, in cell regeneration at the wound surface and formation of early granulation tissue. They undertook in vitro studies of the antibacterial activities of PR and PRO on wounds and burns on standard test strains (gram-positive *St. aureus* and gram-negative E. coli and *Ps. aueroginosa*), and the effects of PRO on reparative processes studies in vivo on animals (Simbirtsev et al. 2002a). PR was characterized by pronounced bactericidal effects, while PRO had no effect on microorganism growth, which was perhaps caused by beeswax ester macromolecules that inhibited its diffusion. Their results showed that during the early stage of the inflammatory process, PRO modulated non-specific and inhibited specific immune response, normalized hemodynamics in the inflammation focus, activated regenerative processes in tissue, and was effective against anaerobes and bacilli. The same group of scientists also studied the immune-toxic properties of PRO during therapy of burns, wounds in phase I of the wound process, and of purulent and inflammatory diseases of the skin and subcutaneous fat testing, as well as the possible irritating and allergic effects of PRO (Simbirtsev et al. 2002b). The results of this study show that long-term treatment with PRO in clinical doses has no effect on non-specific immunity, but modulates specific immunity. The preparation of PRO inhibits humoral, but stimulates cell immunity. Neither local irritation nor allergic reactions were observed after long-term epicutaneous application of PRO. In particular, in the therapy of burns PRO stimulates non-specific immune response, normalizes hemodymanics in damaged regions, and stimulates proliferation of epithelial cells (Khmel'nitskii et al. 2002).

Inflammatory cells are mobilized over the first hours after burning or wound infection. In vitro experiments show that preparations containing PR activate phagocytosis and hold much promise for the therapy of burns, wounds, purulent and inflammatory diseases (Simbirtsev et al. 2002c). The same experiments show that PR and PRO contain various bioactive substances producing opposite and dose-dependent effects on phagocytosis (Simbirtsev et al. 2002d).

Rosin, formerly called **colophony** or **Greek pitch** (*Pix græca*), is the major product obtained from pine resin. It is a brittle, transparent, glassy solid produced by heating fresh liquid resin to vaporize the volatile liquid terpene components. Rosin and rosin derivatives have been pharmaceutically evaluated as microencapsulating materials and as anhydrous binding agents in tablets (Fulzele et al. 2002, 2007; Pathak and Dorle 1990; Sahu et al. 1999; Satturwar et al. 2004; Lee et al. 2005). Rosin biomaterias have excellent biocompatibility and degradation features, and film-forming ability (Fulzele et al. 2003). They show potential as components in film-based drug delivery systems and dosage technology (Satturwar et al. 2005; Fulzele et al. 2007).

3.5.2 Chios Mastic Gum

Pistacia lentiscus var. Chia of the *Anacardiaceae* family is grown almost exclusively in the southern part of Chios island, a Greek island in the Aegean. Chios mastic gum (CMG) is a white, semitransparent, natural resin that is obtained as a trunk exudate from mastic trees. Mastic gum and essential oils from *P. lenticus* are natural antimicrobial agents that have found extensive uses in Mediterranean and Middle Eastern countries since ancient times, both as a dietary supplement and as herbal remedy. Kolliaros (1997) suggests that they were used in Greek medicine in classical times by physicians such as Hippocrates, Dioscorides and Galenos, who mentioned their properties and recommended their use for various gastrointestinal disorders like gastralgia, dyspepsia and peptic ulcer. Nowadays, mastic gum is used in surgery for the production of special stitches that are absorbed by the human body. In dentistry it acts as an oral antiseptic and tightens the gums (Topitsoglou-Themeli et al. 1984), and for that reason it is used in toothpastes and chewing gums (Stauffer 2002). Mastic is used in Mediterranean cuisine as a seasoning, such as in biscuits and ice cream, or as a sweet additive in drinks. The essential oil is used in perfumery and in the cosmetic industry (Doukas 2003).

The biological activity of Chios mastic gum can be attributed to a variety of compounds. It mainly consists of triterpenes of the oleanane, euphane and lupane type (Andrikopoulos et al. 2003; Assimopoulou and Papageorgiou 2005). Koutsoudaki et al. (2005) reported that the major constituents of mastic oil and gum were α-pinene, β-myrcene, β-pinene, limonene and β-caryophyllene.

Medical trials have shown that mastic gum may have cyto-protective or anti-acid effects for the gastrointestinal system, such as relief of ulcers (administration of 1 g of CMG daily relieved the pain and healed the stomach and duodenal ulceration in the majority of the patients within 2 weeks (Al-Habbal et al. 1984) and reduction of the intensity of gastric mucosal damage caused by antiulcer drugs and aspirin, with little or no side effects. It has been reported that mastic gum possesses considerable in vitro antibacterial and antifungal activity (Magiatis et al. 1999; Tassou and Nychas 1995), for which verbenone, alpha-terpineol, and linalool seem to be responsible (Koutsoudaki et al. 2005). It has been specifically reported to be effective against *Helicobacter pylori* and peptic ulcer in vitro (Huwez et al. 1998; Bona et al. 2001; Marone et al. 2001). However, in a more recent in vivo study against of *H. pylori* infection, the activity of CMG was compared with antibiotic eradication schemes, and after a 7-day treatment no eradication of the bacterium from the stomachs of mice receiving mastic was observed (Loughlin et al. 2003). The same experiment was repeated in humans, where *H. pylori* positive patients were treated with mastic capsules for 7 days, and all remained *H. pylori* positive after the administration (Bebb et al. 2003). We have to take into consideration that the crude resin that was used in all previous studies contained a high percentage (30%) of an insoluble and sticky polymer (poly-β-myrcene) (Van den Berg et al. 1998) that obviously hinders its oral administration and reduces the bioavailability of the contained active compounds. To bypass this problem in subsequent studies, researchers used a total mastic extract without polymer.

Pistacia lentiscus has also been traditionally regarded as an anti-cancer agent, especially against tumors of the breast, liver, stomach, spleen, and uterus. These beliefs accord with recent studies demonstrating that CMG induces apoptosis (Balan et al. 2005) and possesses antiproliferative activity in human colon cancer cells (HCT116) in vitro (Balan et al. 2006). Furthermore, CMG has already been associated with cardiovascular protection. It inhibits human LDL oxidation in vitro (Andrikopoulos et al. 2003) and due to the triterpenes that are major constituents both of the neutral and the acid fraction, it acts on peripheral blood mononuclear cells to elicit an antioxidant and anti-atherogenic effect (Dedoussis et al. 2004). Although CMG's antioxidant effect is widely known, whether it can directly inhibit atherogenesis has not been clarified.

3.6 Edible Wild Forest Mushrooms as a Source of Health-Promoting Compounds

3.6.1 Introduction

Mushrooms comprise a large and yet mostly untapped source of new pharmaceutical products. Whilst the medicinal use of mushrooms has a very long tradition in Asian countries, their use in the Western hemisphere has been slightly increasing only since the last decades (Lakhanpal and Rana 2005; Lindequist et al. 2005).

Several reviews have been written lately on the medicinal properties of mushrooms, which give an overview of the pharmacological potential of many fungi. The most investigated mushrooms for medicinal value are cultivated species such as *Ganoderma lucidum* (Reishi), *Lentinus edodes* (Shiitake), *Grifola frondosa* (Maitake), *Agaricus blazei* (Hime-matsutake), *Cordyceps militaris* (Caterpillar fungus), *Pleurotus ostreatus* (Oyster mushroom) and *Hericium erinaceous* (Lion's mane) (e.g. Lakhanpal and Rana 2005). For a comprehensive review of this subject concerning cultivated fungi, the reader is referred to the works of Wasser and Weis (1999), Borchers et al. (1999), Wasser (2002), Lakhanpal and Rana (2005), Lindequist et al. (2005), and Zaidman et al. (2005).

Edible wild mushroom species have not been studied as extensively as those in cultivation although interest in wild mushrooms has been raised recently partly due to the abundance of wild mushroom harvests. The nutritional value of these mushrooms has been recognized for a long time, since they are high in protein and low in fat. Mushrooms also contain significant quantities of vitamins, such as thiamine, riboflavin, ascorbic acid, and vitamin D_2, as well as minerals (Mattila et al. 2000). As much as 10–50% of dried matter from mushrooms can be dietary fibers belonging to β-glucans, chitin, and heteropolysaccharides (Wasser and Weis 1999). Mushrooms are a good source of trace elements, such as copper, zinc, selenium, iron, and molybdenum. Especially selenium has emerged with the most anticancer effect among a number of micronutrients tested in animal experiments and clinical trials (Zaidman et al. 2005).

In this section, we focus on antimicrobial and anti-tumor properties of edible wild forest mushrooms commonly used, especially in northern European countries.

3.6.2 Antimicrobial Activity

Mushrooms need antibacterial and antifungal compounds to survive in their natural environment (Zak 1964; Kope and Fortin 1989). Extracellular antibiotics produced by ectomycorrhizal fungi have been suggested to be one form of protection for roots against infection of phytopathogenic fungi (Zak 1964). Antimicrobial compounds that could also be of benefit for humans have been isolated from many species (Lindequist et al. 2005). Macro-fungi have been found to have wide antimicrobial properties, tending to inhibit the growth of bacteria, fungi, protozoa and cancerous cells in mammals.

In the study of Dulger et al. (2002) methanol extracts from several *Lactarius* species (*L. deterrimus, L. sanguifluus, L. semisanguifluus, L. piperatus, L. deliciosus, L. salmonicolor*) revealed antimicrobial activity against some Gram (+) and Gram (−) bacteria, but showed no antagonistic effect against yeasts. A general characteristic of the genus *Lactarius*, is that the fruit bodies contain a latex which can be observed if they are cut or broken. The creation of sesquiterpenes in the injured fruit-bodies appears to be enzymatic and in the pungent *Lactarius* species clearly contribute to the fungus's defense system (Bergendorff and Sterner 1988; Clericuzio et al. 2002). *L. deliciosus* and *L. deterrimus*, which are not pungent species, also contain fatty acid esters of a single sesquiterpene, and these esters are transformed to sesquiterpene aldehydes and alcohols as a response to injury (Bergendorff and Sterner 1988). However, the sesquiterpenes of *L. deliciosus* and *L. deterrimus* have a quaiane skeleton, which is not formed the same way as in the pungent species. The class of protoilludane sesquiterpenes occurs rather widely in higher fungi in addition to *Lactarius* species (Clericuzio et al. 2002).

Ethyl acetate, chloroform and ethanol extracts of *Cantharellus ciparius* Fr. (*Cantharellaceae*) (Photo 3.1) were tested for antimicrobial activity by the disc diffusion method by Dulger et al. (2004). In that study, C. *ciparius* revealed antimicrobial activity against some Gram (+) and Gram (−) bacteria, yeasts, filamentous fungi and actinomycetes. All the extracts showed more antifungal than antibacterial activities.

Peptaibols are a family of peptides characterized by a short chain lengths (≤20 residues), C-terminal alcohol residues and high levels of non-standard amino acids, principally α-aminoisobutyric acid, isovaleric acid and the imino acid hydroxyproline (Whitmore and Wallace 2004). Peptaibols originate from fungal organisms, some of which exhibit antibiotic activity against phytopathogenic fungi and Gram-positive bacteria (Lee et al. 1999). The antibiotic functions of peptaibols arise from

Photo 3.1 *Cantharellus ciparius* Fr. (*Cantharellaceae*) extracts display antimicrobial activity against some bacteria, yeasts and fungi (Photo: Tytti Sarjala) (*See Color Plates*)

their membrane insertion and pore-forming abilities (Whitmore and Wallace 2004). A new peptaibol, boletusin, was isolated and sequenced by Lee et al. (1999) from an extract of fresh, fruiting bodies of *Boletus* spp. Boletusine was composed of 19 residue amino acids and it showed antimicrobial activity against several Gram-positive bacteria (Lee et al. 1999).

3.6.3 Anti-Tumor Activity

Over the past 2–3 decades, scientific and medical studies in Japan, China, Korea and the United States have increasingly demonstrated the potent and unique properties of mushroom-extracted compounds for the prevention and treatment of cancer (Zaidman et al. 2005). There are about 650 species of higher Basidiomycetes that have been found to possess antitumor activity (Wasser 2002).

High-molecular-weight polysaccharides or polysaccharide-protein complexes from mushrooms appear to enhance innate and cell-mediated immune responses, and exhibit antitumor activities in animals and humans (Zaidman et al. 2005). Although immunomodulators (agents that activate or suppress the body's immune system) isolated from many mushroom species have shown anticancer action in animals (Wasser and Weis 1999), only a few have been taken to the next step, that is, objective clinical assessment for anticancer potential in humans. Polysaccharides with antitumor action vary greatly in their chemical composition and configuration, as well as their physical properties, which have been summarized by Wasser (2002). Structural features such as β-(1→3) linkages in the main chain of the glucan and additional β-(1→6) branch points are needed for antitumor action

(Wasser 2002). All main taxonomic mushroom groups have been investigated for biologically active polysaccharides, and most of them possess such substances. According to Wasser (2002), quite commonly used fungal species in Europe for example in the following genus (number of species studied in parenthesis) *Boletus* (11), *Leccinum* (2), *Suillus* (5), *Cantharellus* (5), *Tricholoma* (1), *Rozites* (1), *Lactarius* (18), and *Russula* (23) have been reported to have antitumor or immunostimulating activity.

Tricholoma matsutake is quite common in Northern Europe and Asia and is recognized as a high-quality and expensive culinary mushroom in Japan. A novel α-glucan-protein complex with immunomodulatory activities has been isolated and characterized from the mycelium of *Tricholoma matsutake* by Hoshi et al. (2005). The immunomodulatory activity of a biological response modifier derived from the mycelia of the *Tricholoma matsutake* was proved by Ishihara et al. (2002) by demonstrating inhibition of stress-induced decrease in Natural Killer Cell activity in mice. Antitumor polysaccharides have been isolated also from other *Tricholoma* species (Mizuno et al. 1996).

Polyhydroxysteroids, which have been found to possess cytotoxic activity on hepatome cell line, were found by Lanzotti and Iorizzi (2000) in *Tuber borchii*, a valued culinary species in Europe.

It is interesting that a common constituent of fungal membranes, ergosterol, has been reported by Takaku et al. (2001) to have antitumor activity which may be due to direct inhibition of angiogenesis (a physiological process involving the growth of new blood vessels from pre-existing vessels).

Most of the studies on the efficacy of medicinal mushrooms that are available to the public are based on animal studies (usually in mice) or cultured cells. In these cases, the bioactivity of the mushroom extracts cannot always be correlated to their activity when ingested by humans – either orally or by injection. In future, more clinical assessment to investigate the immunomodulators would be needed to utilize the medicinal properties of fungi.

3.7 Nutritional and Medicinal Properties of Forest Berries

Berries, both cultivated and from the wild, are part of the traditional diet in many European countries. In Scandinavia the importance of berries is thought to be partly explained by the fact that they are generally low-growing and accessible. The geographical distribution of different wild berry species varies. For example, black currant species (*Ribes nigrum L.*) are found in Europe in Central Europe, Scandinavia and the British islands. Red and white currant species (*Ribes rubrum*) are found in alpine areas of West and Central Europe and in Northern Europe. Arctic bramble species (*Rubus arcticus*) are generally found between the 60th and 70th degrees of latitude and cloudberry (*Rubus chamaemorus L.*) is found extensively in Europe only in Norway, Sweden and Finland. Lingonberry (*Vaccinium vitis-idaea*), often called cowberry or mountain cranberry is widely found in

Europe whilst blueberry/bilberry (*Vaccinum myrtillus*), is common in northern Europe, as well as on mountains of southern Europe and is absent only from southern Italy and the Iberian Peninsula.

Gathering berries is a social activity and is part of the traditional culture of rural life, especially in Scandinavian countries where, since the thirteenth century people have had the so-called ‘everyman’s right’ to go into the forests and pick berries and mushrooms. Berries are a natural source of antioxidant vitamins (C and E), fiber (mostly insoluble; cellulose and minor quantities of soluble; pectin), beneficial fatty acids with a high portion of unsaturated fatty acids such as omega-3 and omega-6, no cholesterol and low sodium (Na) but high potassium (K) content. These affect human health in different ways. Insoluble fiber has an effect on gut health and prevents constipation. Soluble fiber lowers blood cholesterol and sugar levels. Low Na and high K contents have an effect on blood pressure. There is seasonal variation in the composition of berries, influenced by the weather conditions during the growth period and environmental stress on the plants. There is also a difference in the abundance of these health-promoting compounds between different genotypes of the same berry species.

In addition to being good sources of essential nutrients, berries contain phenolic compounds such as flavonoids, phenolic acids, procyanidins, lignans, stilbenes and polymeric tannins. Flavonols (see Fig. 3.1 for a chemical structure) in food are found to be an interesting subject since they owe several biological functions positive for human health. Among these can be mentioned antioxidative effects, binding of free radicals, inhibition of saturation of fat, inhibition of inflammation and allergy, inhibition of raise of blood pressure and antimicrobial activity (Puupponen-Pimiä et al. 2001). Lingonberry, blueberry, and bilberry, which are members of the *Vaccinium* (*Ericaceae*) family, are particularly known for their flavonoid content (flavonols, anthocyanins and proanthocyanidins) (see Fig. 3.2 for a chemical structure). These have anti-cancer characteristics and anti-carcinogenic activity. The full effect is still under investigation (Bomser et al. 1996). The highest concentration of flavonols is found in cranberry, lingonberry (cowberry), black currant and bog whortleberry (50–200 mg/kg fresh berries). The main group of flavonoids present in berries is the anthocyanins, which are dark in color and found in great concentrations in blueberry/bilberry and black currant (2,000–5,000 mg/kg fresh berries).

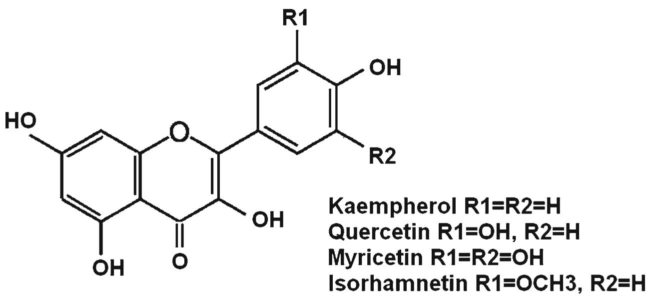


Fig. 3.1 Chemical structures of flavonols

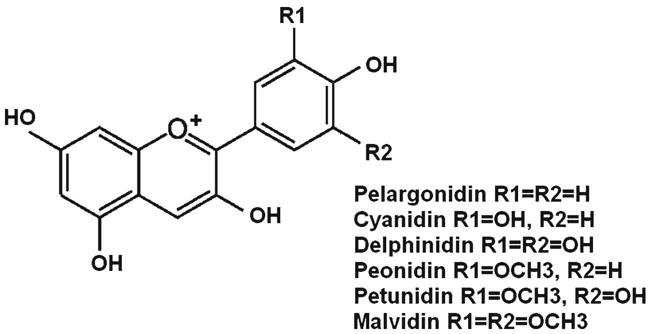


Fig. 3.2 Chemical structure of anthocyanidins

The most abundant flavonoids are kaempferol, quercetin and myricetin and among the phenolic acids p-coumaric acid, coffeic acid, ferulic acid, p-hydroxybenzoic acid, gallic acid and ellagic acid are the most common. In *Vaccinium* species (lingonberry, cranberry and bilberry/blueberry) and *Ribes* species (red currant, black currant) the most abundant flavonoid is quercetin. The most abundant phenolic compounds found in cranberry and lingonberry are hydroxycinnamon acid and flavonols which is also very abundant in red and black currant. Ellagic acid is the most abundant phenolic compound in cloudberry and red bramberry (Häkkinen et al. 1999). In red berries the major flavonol group present is the anthocyanins. A recent clinical study stated that the consumption of moderate amounts of berries resulted in favorable changes in platelet function, HDL cholesterol, and blood pressure (Erlund et al. 2008).

The antimicrobial activity of bilberry/blueberry, bramberry, lingonberry, black currant, cloudberry, cranberry and sea buckthorn was tested against gram-negative and gram-positive probiotics and other intestinal bacteria including some pathogenic species (*Salmonella enterica* and *E. coli*). In general berry extracts inhibited the growth of gram-negative bacteria, but not the growth of gram-positive ones. Extracts from cloudberry and bramberry (Puupponen-Pimiä et al. 2005a) seemed to be the especially effective against *Salmonella.*

Phenolic compounds present in berries have a varying effect in inhibition of the growth of pathogenic bacteria. The best inhibition effect has been found with cloudberry and bramberry. Ellagitannin compounds effectively inhibited the growth of *Staphylococcus* bacteria (Puupponen-Pimiä et al. 2005b).

Plant extracts containing phenolic compounds have strong antioxidant properties. The total amount of phenolics in berries is relatively high (12.4–50.8 mg/g GAE, gallic acid equivalent) (Kähkönen et al. 1999).

Storage of the berries in normal room temperature (RT) causes a loss of phenolics, but low-temperature storage only slightly reduces the amount of phenolics in the berries and does not seem to affect the antimicrobial activity. For some berries storage in a freezer increased the antimicrobial effect (Puupponen-Pimiä et al. 2005a).

Processing crushed blueberry/bilberry and cloudberry samples with enzymes increased the total phenolic content in the juice and also the antimicrobial activity against bacteria of *Salmonella* and *Staphylococcus* species (Puupponen-Pimiä et al. 2005b). Enzymatic treatment liberates the phenolic compounds bound to the cell walls and the treatment might also change their structure. Clinical studies have shown that urinary tract infections can be reduced by drinking cranberry-lingonberry juice (Kontiokari et al. 2001, 2003). One clinical study on cranberry juice's influence on risk factors for kidney stone formation concluded that cranberry juice has anti-lithogenic properties that warrant its consideration as part of a therapeutic protocol in managing calcium oxalate kidney stone formation (McHarg et al. 2003).

Cranberry has been shown to affect the balance and level of cholesterol. Wilson et al. (1998) found that cranberry extract inhibits low density lipoprotein oxidation. The cranberry juice had a polyphenolic content of 1.55 mg/l GAE and pH of 2.5. It was found to inhibit the electrophoretic movement of the LDL-cholesterol and thus the juice has the capability to inhibit the oxidation of LDL-particles in a similar manner to red wine. In vitro studies show that cranberry juice has antioxidative effects on the LDL oxidation processes. The effect is stronger with higher concentration of cranberries. The antioxidative effect of a cranberry sample of 100 g is similar to that of a 1 mg dose of Vitamin C or 3.7 mg dose of Vitamin E. The juice increased the expression of LDL-receptors in hepatocytes and increased the capability of the hepatocytes to intake cholesterol in correlation to juice sample size (Chu and Liu 2005). This indicates that cranberry juice can have a positive effect on the removal of extra cholesterol from blood plasma and can act as an inhibitor of heart and coronary diseases.

There are still other health effects found with berries. The long-chain carbohydrates extracted from the seeds of black currant can inhibit the attachment of ulcer bacteria (*Helicobacter pyroli*) to the walls of stomach. A number of epidemiological studies (Arts and Hollman 2005) show that there is a relationship between the intake of phenolic compounds from daily food, such as fruits and vegetables, and a reduced risk of cardiovascular diseases and lung cancer. These health effects seem to be related to the antioxidant activity of the phenolic compounds protecting the body tissues against oxidative stress (Prior 2003). The cancer-preventive properties can be attributed to mechanisms such as cell cycle arrest, apoptosis, altered cellular signaling, and induction of detoxifying enzymes (Chen and Kong 2004). A clinical study showed that high intake of certain flavonoids (flavonols and flavanones) could protect against coronary heart disease, stroke, lung cancer, prostate cancer, asthma and type-2 diabetes (Knekt et al. 2002).

3.8 Health-Promoting By-Products from Forest Industries

Of the various chemical products, including health-promoting compounds, produced from the sixteenth century to the middle of the nineteenth century in the area which now is Finland, wood tar was the most important commercial product.

Tar was used mainly for painting wooden ships but was also used as a health product. Other examples of health-promoting products from trees with ancient traditions are birch bark tar, birch sap juice and pine inner bark.

Today, bioactive compounds from trees are produced in Europe in large amounts. They include compounds that are marketed world-wide as ingredients in so-called dietary supplements and in functional foods. In this section, the development of three products, xylitol, sitosterol and sitostanol, and HMR lignan is described and the development of other products from knots and bark is discussed.

3.8.1 Xylitol – A Caries-Preventing Sugar

Xylitol (Fig. 3.3), produced by acid hydrolysis of xylans, the dominating hemicellulose in deciduous trees, followed by reduction of xylose, was developed as a health product in Finland in the 1970s when research at University of Turku found that xylitol can inhibit tooth decay (Sheinin and Mäkinen 1976). Commercial production of xylitol began in Kotka, Finland, by the Finnish Sugar Company. Xylitol-containing chewing gum was developed and marketed as a product promoting dental health. Since then, xylitol has been found also to inhibit ear infections in children (Uhari et al. 1996). After approval by the United States Food and Drug Administration (US FDA) in 1986, xylitol has spread world-wide, and is now used as a specialty sweetener in large variety of food products.

3.8.2 Sitosterol/Sitostanol for Reducing Blood Serum Cholesterol

Sitosterol (Fig. 3.4), the dominating sterol in plants, including trees, was known already in the 1950s to inhibit the absorption of cholesterol into the blood stream (Miettinen et al. 1995). By the early 1970s sitosterol was being produced in France from tall oil, a by-product from the pulp industry, when it was used mainly in the cosmetic industry. Sitosterol production from sulfate soap, a by-product from chemical pulping, was developed in Finland in the 1970s, and a production plant was built at a pulp mill in Lappeenranta. In 1995, the company Raisio in Finland announced a new margarine product, named Benecol®, containing sitostanol fatty

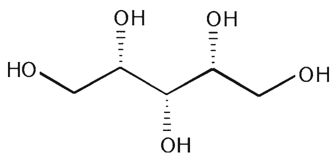
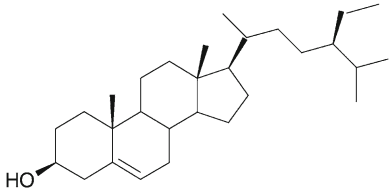


Fig. 3.3 Chemical structure of xylitol

Fig. 3.4 Chemical structure of sitosterol



acid ester as the active ingredient. Sitostanol is the saturated analogue to sitosterol and is produced by catalytic hydrogenation of sitosterol. The Benecol® margarine marketed as a cholesterol-lowering functional food, attracted large attention all over the world.

Today, there are a large variety of Benecol® products: cream cheese, pasta, yoghurts, sour milk, meat products, etc. Several competitors to Benecol® have arisen based on sitosterol fatty acid esters, or mere sitosterol, using the same cholesterol-lowering arguments in their marketing. The total annual production of sitosterol for use in functional foods now exceeds 10,000 t.

3.8.3 HMR Lignan – A New Anticarcinogen and Antioxidant from Spuce Knots

The lignan 7-hydroxymatairesinol (HMR) (Fig. 3.5) is the predominant lignan in spruce wood. It was first identified and its chemical properties described in 1957 (Freudenberg and Knof 1957). Already in the 1970s and 1980s HMR and other spruce lignans were studied at Åbo Akademi. In the early 1990s, researchers at University of Turku tested of HMR for its biomedical properties, initially for its possible estrogenic effects on fish (Mellanen et al. 1996). However, such effects were not found, but when the compound was studied in a breast cancer test, a positive response was obtained. This led Hormos Medical Ltd, a biotechnology company in Turku, to develop HMR as a health product. Further tests were made on rats and significant inhibition of breast cancer growth was documented (Saarinen et al. 2000).

A new and exceptionally rich source of HMR was discovered in 1998, when a knot from a spruce tree (Fig. 3.5) was analyzed at Åbo Akademi. The knot contained as much as 10% lignans and over 7% of HMR. Further research has shown that knots in spruce trees (*Picea abies*) contain on average about 10% of lignans, of which HMR makes up 70–85% (Willför et al. 2003). The variation between knots is large; values ranging from 6% to 29% have been found (Fig. 3.5). The lignan concentrations are 100–500 times higher in the knots than in the surrounding normal stem wood. Spruce trees in Northern Finland contain considerably larger amounts of lignans than trees in south Finland (Piispanen et al. 2008).

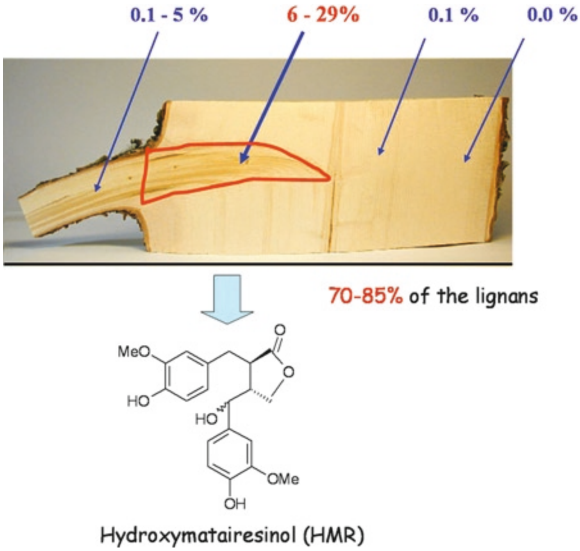


Fig. 3.5 Typical distribution of lignans in spruce wood (*Picea abies*)

The HMR research at University of Turku and Åbo Akademi, and further toxicological and clinical studies undertaken on behalf of Hormos Medical Ltd., provided the necessary data for an application to the U S Food and Drug Administration (FDA). HMR was approved by the FDA to be marketed as dietary supplement in 2004. Hormos Medical then sold a world-wide production and marketing license to Linnea S.A., a phyto-pharmaceutical manufacturing company based in Locarno, Switzerland.

The HMRlignan™ was launched as a dietary supplement on the market in 2006. HMR is a direct, effective precursor to the lignan enterolactone. There is good scientific support also for the statements that plant lignans have a positive influence on the development of breast, prostate and colon cancer which rely specifically on estrogens in order to progress. Lignans can also help to maintain good cardiovascular health and can moderate other estrogen-dependent health problems such as menopause symptoms and osteoporosis (see www.hmrlignan.com).

Production of HMR started in 2005. Spruce chips were taken from a paper mill in northern Finland and processed in southern Finland where clean knot material was separated according to a patented process. The knot material was then delivered to Switzerland where the knots were extracted and the HMR purified by precipitation.

The next stage in the HMR product development is to obtain clearance for using HMR as ingredient in health foods. Research at Åbo Akademi has recently uncovered that HMR exists naturally in cereals, where it is often the predominant lignan, and in oilseeds and nuts (Smeds et al. 2007). This new finding that HMR is a common lignan in foods validates that it is a good choice for inclusion in health foods.

3.8.4 Other Potential Bioactive Compounds from Knots and Bark

Research on polyphenols in knots started at Åbo Akademi in 1998 and has since become extensive (Holmbom et al. 2007). Knots in about 60 tree species other than spruce have been investigated. In almost all of the species the knots have been found to contain substantially higher concentrations of polyphenols than ordinary stem-wood, for many species 20–100 times more. Knots of softwood species commonly contain 5–15% (w/w) of polyphenols, with lignans as the dominating group. Some tree species also contain large amounts of flavonoids and stilbenes. These studies have documented that knots constitute a very rich source of a wide variety of polyphenols, maybe the richest source in all of nature.

Bark, the protective 'skin' of trees is also a rich source of bioactive compounds. Bioactive bark products are already on the market. Pycnogenol is the trade name for extract from bark of the maritime pine (*Pinus pinaster*) growing in the region near to Bordeaux in France. It contains a complex mixture of phenolic compounds, mainly procyanidins and bioflavonoids. It is a powerful antioxidant and is said to be good for cardiovascular health, skincare, diabetes health and inflammations, among others.

Spruce (*Picea* spp.) bark contains large amounts of stilbenes, such as piceatannol (also named astringenin), its methyl ether and resveratrol (Fig. 3.6). Resveratrol which is present also in red wine and other plant extracts is presently of great interest in research because it has been found to extend the lifespan of cells and even mammals and may be developed to an anti-aging drug (Bauer et al. 2006).

3.8.5 Concluding Remarks

Trees live much longer than almost all other organisms and cannot run or move away from threats. They can persist for centuries in a single, fixed location. It is not surprising that trees contain higher concentrations of protective and defensive substances than annual plants. These compounds have been created by natural

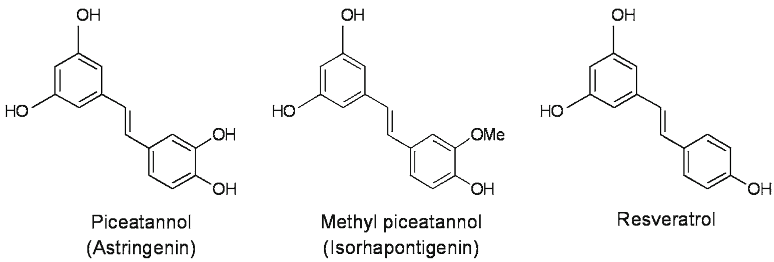


Fig. 3.6 Stilbenes that can be extracted from spruce bark

evolution during millions of years to protect the trees from micro-organisms, herbivores, insects and other dangers. The chances of finding more health-promoting compounds in trees seem good.

3.9 Health Benefits of Volatile and Non-Volatile Terpenoids in Some Cupressaceae

Plants produce an imposing variety of chemicals, called secondary products, which are not directly involved in metabolic pathways, but nonetheless have important biological and ecological functions and include substances that protect plants by various means (Harborne and Tomas-Barberan 1991). The terpenoids form by far the largest group. They are highly lipophilic, open chain to ring compounds built from multiples of the 5-carbon (C_5). About 35,000 terpenoids have been described to date, with the huge variation arising mainly from different combinations of isoprene units and stereoisomerism (Connolly and Hill 1991). Terpenoid compounds are ubiquitous in algae, lower plants and especially abundant in conifers and several aromatic angiosperm families. They occur as highly volatile, often pleasant-smelling compounds called essential oils (mostly C_{10} and C_{15} compounds), semi-solid oleoresins (mostly C_{10}, C_{15} and C_{20} compounds) and solid resins (mostly C_{20} compounds in conifers and C_{30} compounds in angiosperms) (Steele et al. 1995). Their main uses include additives to food and beverages in pure form, as herbs and spices which contain numerous essential oils, in folk medicine as well as pharmaceutical preparations including the commercially important anticancer drug Taxol and the antimalarial drug artemisinin (McGarvey and Croteau 1995). Effects of volatile essential oils that permeate the forest atmosphere on mental health have been recorded. Antimicrobial activity and immuno-modulation of terpenoids present in volatile essential oils and resins has also been shown in a number of scientific publications (Yatagai et al. 1995; Barrero et al. 2003). Throughout history, man has found different and varied health and well-being uses for volatile and non-volatile terpenoid extracts from plants in general and forest trees, especially conifers, in particular. Fragrant resins have been employed for thousands of years in making perfumes, unguents and disinfectants by virtually all advanced cultures that had access to these resources. Resin burnt as incense both for religious rites and in traditional medicine is again also frequently recorded in the literature (Claisse 1985; Buhagiar et al. 2000).

The Cypress family (*Cupressacea*e), one of seven in the *Gymnospermae*, is a large widespread family comprising seven subfamilies, 30 genera and over 130 species including recent grouping of members of the *Taxodiaceae* such as the redwoods *Sequoia*, *Sequoiadendron* and *Taiwania* within this family. The largest genera are *Juniperus* (60 spp.), *Cupressus* (15–22 spp.), *Callitris* (16 spp.), *Thuja* (5 spp.) and *Chamaecyparis* (7 spp.). Phylogenetic relationships between members of the Cypress family are useful tools in the search for bioactive principles since these usually occur in related genera (Farjon et al. 2002).

Since antiquity, cypress family members have been important sources of durable wood, as well as resin and essential oils since their wood resists fungal and insect attack. It is recorded that Cicero paid enormous sums of money for table tops made from the wood of one particular species. Their resins are very fragrant when burnt and indeed the resin of some family members was burnt as incense in ceremonial gathering, some of which may have served as mass healing sessions. It is evident that very early on in man's history someone had made the connection that this healing effect was due to something 'magical' present in the wood or resin, and burning them gave these extraordinary properties. A good few cypress family members are mentioned in ancient texts including Egyptian herbals, the Bible, Theophrastus' *Historia Plantarum* (Enquiry into Plants), Ayurvedic literature and Chinese herbals. The essential oil and resin-producing species of a number of cypress family genera such as *Thuja*, *Cupressus* and *Tetraclinis* are additionally given the name of Tree of Life (*Arbor Vitae* in Latin or *Shagjaret al. Hajat* in Arabic) attesting to the life-preserving importance attached to these species in the past. Some of the beneficial properties will now be reviewed.

3.9.1 Health Benefits Reported in the Literature

Volatile monoterpenoid constituents including those of conifer resins are now known to induce various physiological, emotional and behavioral responses. Yatagai et al. (1985, 1995) refer to the beneficial effects of terpenoid emissions in forest air even when present at extremely low concentration ranges of 10–1,000 ppb. Specifically, a low concentration of alpha-pinene reduces tension and mental stress, improves physical and mental health, and helps quick recovery from fatigue. Conversely, high concentrations of the same monoterpenoid result in increased fatigue and the accumulation of stress. Given that volatile terpenoids have an effect that relieves stress and depression; it is perhaps no coincidence that the Etruscans and the Romans buried their dead under Cypress trees, a tradition that carries on in Mediterranean cemeteries to this day.

The use of terpenoid additives in food as a flavor enhancer and long-term preservative to prevent spoilage in stored food also goes back in antiquity. Neolithic pottery dating back to 5000 BC has been shown to have contained resinated wine with a non-conifer resin added to prevent *Acetobacter* from turning wine into vinegar (McGovern et al. 1996). And to this day, resinated wines are still produced for exactly the same reason, but often employing resin from pines and other conifers including that from the sandarac tree *Tetraclinis articulata*. The flavoring of food and gin with berries from *Juniperus communis* can also be mentioned in this context, and it is now known that the monoterpenes such as alpha-pinene, beta-pinene and borneol present in juniper berry and leaf oils, are bactericidal. Conifer resins also contain a variety of diterpene resin acids such as communic acid, which has been shown to have antimicrobial properties (Merzouki et al. 1997; Muhammad et al. 1995).

The ethno-botanical repertoire of some cultures includes varied and sometimes ingenious applications of terpenoid-rich extracts for treating many body aliments and diseases both in humans and in veterinary care. They have been applied externally as disinfectants, parasiticides, antiseptics and stimulants as well as internally for intestinal parasites, diarrhea, flatulence and respiratory problems. Some have been used for thousands of years as perfume, incense and embalming fluid and medicinally as a pain killer, to reduce spasms and fever, to heal wounds and as an ointment for sores, as a sweating stimulant and as a local stimulant to mucous membranes and to neutralize bad breath in oral hygiene (Prendergast et al. 1998). The medicinal action and properties of different oils and resins derived from members of the cypress family are equally versatile. Thus *Cupressus sempervirens* essential oil is described as astringent, antiseptic, deodorant, diuretic, diaphoretic, tonic, expectorant and rubefacient. Sandarac resin derived from the cypress family genera *Tetraclinis* and *Callitris* is reportedly used in the treatment of acute diarrhea, roundworm and tapeworm infestations, hemorrhoids, respiratory ailments, against hemorrhage, in dental fillings, diabetes mellitus, hypertension and cardiac diseases, skin diseases and to treat nervous disorders including depression (Ait Igri et al. 1990; Merzouki et al. 1997; Ziyyat et al. 1997; Eddouks et al. 2002).

The cellular, sub-cellular and biochemical effects of monoterpenoid, sesquiterpenoid and diterpenoid components in the volatile and non-volatile fractions of conifer oleoresin are equally varied. The effect of monoterpenoids on pathogenic and non-pathogenic bacteria and fungi has also been extensively studied and demonstrated both for non-conifer and conifer extracts (Chanegriha et al. 1994). The diterpenoids present in a number of conifers have repeatedly been shown capable of controlling pathogenic fungi and various authors have attributed their use in nature as antifungal agents. Muhammad et al., (1995), report on the isolation of potent antibacterial diterpenes from bark and leaves of *Juniperus procera* namely (+)-E-communic acid, (+)-Z-communic acid (labdane diterpenes) and totarol (totarane diterpenes), amongst others. Totarol is a highly hydrophobic bacteriostatic diterpenoid originally isolated from *Podocarpus* species (Totara pine) that has been found to have potent activity on *Mycobacterium* species – the causative agent of tuberculosis. Evans et al. (2000), also report on the antibacterial activity of totarol, its chemical analogues and derivatives, on drug resistant gram-positive bacteria (lactamase-positive and gentamycin-resistant *Enterococcus faecalis*, penicillin-resistant *Streptococcus pneumoniae* and methicillin-resistant *Staphylococcus aureus* (MRSA)). Pimarane diterpenoids isolated from North American white cedar (*Thuja occidentalis, Cupressaceae*) have also been shown to possess a range of biological activity including anti-tuberculosis effect and inhibitory effects on growth of fungal mycelium (Chang et al. 2000).

Apart from antimicrobial activity, additional bioactive properties are reported for diterpenoid compounds isolated from cypress family tree species. Shimizu et al. (1988) report on the anti-inflammatory effect of topically applied crude extracts of the conifer *Cryptomeria japonica* containing several types of pimarane diterpenoids. Similar immunomodulatory effects are reported for a number of pimarane diterpenoids isolated from leaves and wood of *Tetraclinis articulata* (Barrero et al. 2003). Minami et al. (2002) report on the antitumor and antiviral potential of labdane-type diterpenes isolated from *Pinus luchensis* but known to be present also in several members of the *Cupressaceae*. Other diterpenoids present in cypress family members as well as angiosperms have been found to induce massive cell death by apoptosis in a range of cancer cells by causing G_0/G_1 or G_2/M cell cycle arrest, DNA fragmentation into nucleosomal fractions, accumulation of cells with sub-G_1 DNA content and appearance of nuclear condensation, all being features typical of apoptosis (Dimas et al. 2001).

Bioprospecting for drugs is attracting increasing interest from drug companies. Given the huge number of terpenoid chemicals produced by plants, the range of cellular targets that they affect and the fact that certain terpenoid constituents appear repeatedly in those extracts that have medicinal applications, the importance of this class of secondary products to human health and well being, is bound to increase.

3.10 Conclusions

Forests are a rich renewable source of health-promoting and medicinal products. Not only the trees but also berries, nuts and mushrooms in forests contain a multitude of natural bioactive compounds which can be used in health-promoting products and medicines. In addition to the main structural components that trees contain, namely cellulose, hemicelluloses and lignin, thousands of bioactive compounds have been identified.

Forest products have always had a key role in traditional medicine which continues to be of great importance, especially in developing countries. In the industrialized countries, the pharmaceutical industry is again increasingly looking at plant-derived natural drugs. Plant-derived compounds help to build a bridge between the traditional medical drugs in developing countries and the modern pharmaceuticals in the developed countries. Plant-derived bioactive compounds serve especially as preventive agents helping to maintain health.

Today bioactive compounds from forests have been developed and are produced in Europe in large amounts for worldwide markets. New health-promoting products could be produced in large quantities especially from knots and bark. The research tools necessary for exploring these possibilities have developed dramatically during the last 30–50 years and continue to improve. We are confident that there are good prospects for identifying and exploiting further chemicals and products from temperate forests.

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Chapter 4
Negative Aspects and Hazardous Effects of Forest Environment on Human Health

Marek Tomalak, Elio Rossi, Francesco Ferrini, and Paola A. Moro

Abstract Direct contacts with the nature can help people to improve their overall health and fitness. However, visits to forests and other open green spaces may also, occasionally, lead to health problems, or even threaten human life. Senescent and potentially unstable trees, fallen leaves and fruits which litter pavements and streets, possible encounters with wild animals, deteriorating tree quality by pests and pathogens or even plant protection activity directed at solving these problems may be perceived as negative aspects being unpleasant, detracting, scary, dangerous, or otherwise unattractive, although, objectively, in most cases they are not such. On the other hand, a number of allergic factors such as plant pollen and spores of moulds, toxic and poisonous mushrooms and plants, tick-borne pathogens, blood-feeding and stinging insects, as well as venomous snakes and predatory mammals can, occasionally, pose a real hazard to human health. In many cases these hazards are not even realized by visitors to open green spaces. The objective of this chapter is not to scare visitors to forests and urban parks, but make them aware of potential hazards related with their visits. It is to show potential threats and suggest periods, places and situations which should be avoided in order to keep these visits safe and rewarding for the health and well-being.

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4.1 Introduction

Data referred throughout this book clearly show that individual trees, parks, and forests can provide multiple benefits to the human living environment in general, and to human physical and mental health in particular. Direct contacts with the nature can help to improve overall fitness, accelerate restoration from psychological stress, and regulate functioning of cardio-circulatory system. However, visits to forests and other open green spaces may also, occasionally, lead to health problems, or even threaten human life. Although, usually, these are indirect effects of human contacts with nature, and not always limited to the forest, they should be treated seriously, as in some cases the probability of their occurrence in this environment is greater than anywhere else.

For the purpose of this chapter we have limited the definition of negative aspects to those characteristics or situations when a forest or other wooded areas are perceived negatively as unpleasant, detracting, scary, dangerous, or otherwise unattractive. Since these characteristics or situations often have mythological or historical roots and are judged subjectively, they do not have to be really present in a particular forest environment. Hazardous effects are those which objectively exist in a particular environment and can be really health-affecting or even life-threatening to humans. In many cases they are not even realized by visitors to parks and forests.

The main objective of this chapter is not to scare visitors to forests and urban parks, but make them aware of potential hazards related with their visits. It is to show potential threats and suggest periods, places and situations which should be avoided in order to keep these visits safe and rewarding for the present and future health and well-being. We have concentrated on threats which are particularly relevant to forests and presence of trees in Europe. Examples from other regions are provided only occasionally.

4.2 Negative Aspects

4.2.1 Tree, Park, and Forest Management-Related Effects

4.2.1.1 Planting of Proper Tree Species, Identification and Management of Hazardous Trees

Problematic Trees

Trees provide many benefits to the environment by contributing to better air and water quality, helping to reduce energy use, and indirectly, by creating a more friendly living habitat for citizens and contributing to the health of the whole biological ecosystem. However, in some cases, particularly in urban areas, their presence can make the sharing of space and coexistence difficult, and add to the expenditure of considerable economic resources for their management and maintenance. Frequently, the individual trees that make up the urban arboreal patrimony belong to different species. As a consequence, there is a great variability in their shape, size, and adaptation to local condition, which leads to various problems. The most frequently encountered problems are those linked to the normal cycle of growth and the plant seasonal phenology. For example, there can be negative consequences of flower formation and pollen production which, in addition to the release of allergens, include attraction of insects, production of fleshy fruits and, changes in structural stability of the tree.

Recurrent human health disturbances related with seasonal shedding of pollen are common results of improper selection of tree species for urban sites (Photo 4.1). As underlined by Sogni (2000), pollen responsible for the principal allergic reactions comes mostly from anemophilous species which, in general, produce large quantities of pollen and depend on poorly selective diffusion agents such as wind. Typically, grains of such pollen are very light and small with a smooth, dry surface. Their diameters usually range from 20–30 μm with a maximum of 150 μm for some coniferous species. In contrast, entomophilous, i.e. insect-pollinated species, produce pollen which is normally bigger and heavier. As poorly dispersed through the air, it is rarely present in the atmosphere at concentrations sufficient to trigger an allergic reaction. However, there are exceptions such as linden (*Tilia*), an entomophilous genus that can also cause an allergic response. In cases where air-borne spread of pollen is limited, violent allergic reactions are recorded mainly after direct contacts with the pollen producing plant.

Photo 4.1 Early flowering hazel (*Corylus avellana*) with potentially allergenic pollen (Photo: Marek Tomalak) (*See Color Plates*)

The spread of pollen grains in the environment depends also on climatic events during flowering (e.g. wind, rainfall, atmospheric humidity) and the presence of barriers for their diffusion (e.g. vegetation, buildings, etc.). Changes in the intensity of these factors can greatly modify the concentration of pollen in the air and frequency of allergy cases.

The potential of pollen for eliciting allergic reactions cannot be directly correlated with its amount and dispersibility. For example, conifers rank first for individual quantity of pollen produced, but, with the exception of *Cupressus sempervirens*, they are toward the bottom of a hypothetical ranking of species responsible for allergic reactions. Conversely, *Graminaceae* are at the top of the list in terms of allergenicity, but they are individually modest producers of pollen. However, they are wide-spread in nature, and often highly concentrated in large biophytic associations. It is interesting to note that there are some species able to trigger allergic reaction only when grown at greater concentrations of individuals. This is the case of *Phoenix dactylifera* and *Trachycarpus fortunei*, primary allergic agents in North African countries, but of little or no interest in countries at higher latitudes, due to their limited presence. Similarly, species such as *Fagus sylvatica*, *Aesculus hyppocastanum* and those belonging to the genus *Betula*, which are generally not found in urban landscapes, when introduced there, become important as allergen producers with increased diffusion.

Climate change will probably trigger some changes in the species distribution and might enhance pollen production. This could, in turn, increase the risk of allergies. Meteorological factors strongly influence the timing and duration of the pollination season as well as the total pollen count. Thus, the seasonality of pollen-related disorders, such as hay fever, may be affected by the climate.

Litter from urban trees is another widespread problem, although it varies in the magnitude among tree species. Fallen fruits can dirty the environment, produce unpleasant odors (e.g. *Ginkgo biloba*) or, in cases of large or particularly hard fruits (e.g. cones of the Italian stone pine – *Pinus pinea*), they can cause damage to contacted surfaces. Even normal falling of leaves can be hazardous, or at least cause troubles when pavements and asphalt become slippery. A good review of littering from urban trees was provided by Barker (1986). The author has closely examined the trees that produce the most litter in the urban environment. For example American sweetgum (*Liquidambar styraciflua*) is sometimes extensively planted along urban streets, yet its fruits are a vexing litter problem (Barker 1986). Lavalle hawthorn (*Crataegus x lavallei*) is frequently recommended for street planting (especially in narrow streets) because of its stress tolerance, but its fruits can increase the risk of slipping. Full-grown purple-leaf plums (*Prunus cerasifera*), are among the most appreciated ornamental trees, but their fruits are an intolerable nuisance, littering roads and sidewalks. In general, fleshy fruits are usually troublesome, but other types of fruit can also be annoying. Best examples for this group are pods of carob (*Ceratonia siliqua*), honeylocust (*Gleditsia triacanthos*), black locust (*Robinia pseudoacacia*), and Japanese pagoda tree (*Styphnolobium japonicum*), or ball-like fruits of plane trees (*Platanus x acerifolia*).

If little can be done to prevent or diminish the problem of fruit litter from existing trees, possibly the best solution for the future would be to use non fruiting species and cultivars in newly developed areas, where existing trees are replaced (Barker 1986). In dioecious species (i.e. *Ginkgo biloba*, *Gymnocladus dioicus*) propagation of only male individuals is the easiest way to obtain non fruiting trees.

In some cases, however, the tree-related problems are not linked to the seasonal cycle only, but rather to the plant growth in the environment that is not conducive to the tree's spatial needs. This results in damage to infrastructures such as sidewalks, or in interference with utility lines both above and below ground.

Tree roots can cause severe damage to sewer or septic pipes, storm water drains, water supply lines, building foundations, sidewalks, streets, parking lots, curbs, walls and swimming pools (Randrup et al. 2003). Each year the repair of such damage is a major cost to cities. There is a potential for a range of tree species to cause root-related problems. For example, Italian stone pine (*Pinus pinea*), sycamore maple (*Acer pseudoplatanus*), Siberian elm (*Ulmus pumila*), Dawn redwood (*Metasequoia glyptostroboides*), and some species of poplar (*Populus* spp.) are known to interfere with paving and sidewalks. However, it must be stressed that although tree roots are blamed for cracking concrete and invading sewer lines, it is equally valid to point out that these structures fail because they have not been properly engineered to function in a landscape that contains growing trees and their roots. Unfortunately, in too many cities the approach has been to remove trees rather than to find ways of redesigning structures to be compatible with trees.

Sometimes it is not the plant itself which can cause negative interaction with human health and its environment, but animals, such as insects and ticks which live on the trees. Occasional mass outbreaks of processionary or brown-tail moths, and their caterpillars covered with poisonous hairs, attacks of aphids on street trees and their production of honeydew that covers cars, sidewalks, and pavements with sticky dirt, or accidental dropping of ticks which potentially carry human pathogens are important factors. In the subsequent chapter these issues will be discussed in more detail.

Without a doubt, whenever possible, careful selection of species and proper placing of trees can help to avoid, or at least minimize, problems described above. The principle of 'the right plant in the right place with the right management' is always valid. Yet, frequently, the arboreal patrimony we find and must manage is a result of plantings which took place in time when attention to space and maintenance, in terms of plant dimensions, did not cause conflicts. It is also probable that the different context, in terms of resources, presented fewer problems.

Tree Stability Assessment

Trees in the urban environment often have to face very harsh conditions. They can easily acquire mechanical defects, which may cause hazards in areas where people and property are present. According to the existing definition a hazard is 'a disposition of a thing, condition, or situation to produce injury' (Health and Safety Executive 1995). In a more specific way, a tree is considered to be hazardous if it is structurally unsound and there are possible targets, like vehicles or people. An unsound tree in an area with no targets is not hazardous (Dujesiefken et al. 2005). Although all trees have a potential to fail and become hazardous in particular conditions, senescent trees are most prone to acquire these characteristics. In such trees all functions, including photosynthesis, production of roots, stem growth and branching, resistance to pathogens, and others are gradually reduced or disorganized. The limbs progressively break off and the tree dies. Both the uncontrolled breakage of dead branches and actual fall of the weakened or dead tree can be dramatic in its consequences. Therefore, reliable assessment of the hazard trees and undertaking appropriate actions is a must in publicly accessible roads, parks and forests.

The management of trees and evaluation of potential problems connected to their presence in the urban environment involves a series of actions linked not only to the knowledge of plant placement, but also to the analysis of health and stability of trees in such a way, that would allow the planning of necessary interventions for their care, and to limit the risk of their unexpected fall (Lonsdale 1999; Ellison 2005; Sterken and Coder 2005). In most cases the diagnosis of the health and, thus stability of a tree is carried out using the Visual Tree Assessment (VTA) method (Mattheck and Breloer 1998). This method employs a complex of rules and procedures in order to establish the true stability of the tree, mostly through visual analyses, which, if necessary, are integrated with instrumental analyses.

Application of VTA is based on a biomechanical approach based on a qualitative and/or quantitative analysis of numerous descriptors through which the tree is represented for its shape, spatial positioning, relationship with its surrounding environment, and its vegetative and health status. Processing and evaluating the acquired data make it possible to identify potential factors of instability, as well as to determine the degree and risk of the single noted 'defects'. These characteristics form the basis for decisions and, if necessary, the plan for a possible intervention is based on these results.

VTA is driven by the assumption that tree shape and aspect derive from the tree's capacity to absorb and adequately divide external stresses of mechanical origin and competition for light, as well as water and mineral elements amongst its macrocomponents (i.e. crown, branches, trunk, collar and roots). From a strictly mechanical point of view, the structural measurement of a tree is based on the principal known as the axiom of constant tension: the tree, depending on mechanical exogenous (i.e. atmospheric agents) and endogenous (i.e. weight of the crown) stresses, optimizes its structure in such a way that no single point is over-weighted (thus risking breakage), nor under-weighted (thus causing a waste of supporting material, or energy). Under equilibrium conditions, the tree tends to distribute stresses uniformly throughout the trunk.

When a plant is in a generalized stress condition, or one of its components is damaged, the distribution of stresses first takes place in correspondence with the structurally weak points. In these points, as there is less equilibrium between the effect of the external stress and the consequential response of the plant, the stresses can give rise to traumatic events, such as breakage or collapse. Structural defects, even internal ones, can be diagnosed considering the fact that, in correspondence with the structurally weak points, the tree tends to seek its original equilibrium condition by adding support tissues. Each internal defect is, therefore usually correlated with a specific, externally visible symptom (Mattheck and Breloer 1994).

Whenever there are significant symptoms of structural defects, it is necessary to confirm that they are actually present and, if possible, to quantify their extent and risk, with the aid of instruments capable of examining the internal characteristics of the wood. It is commonly believed that instrumental analysis can be a solution to all questions that arise regarding the mechanical resistance status of wood, roots and, above all, trunk and large branches. It is important to underline that this sort of investigation should be carried out only when there are serious doubts about the risk, which cannot be resolved by other means. It would be equally inappropriate to indiscriminately and continuously carry out 'invasive' investigations of a suspect tree. Indeed, invasive techniques can break the compartmentalization barrier and allow the spread of pathogens through the wound. In some situations, as in the case of internal decay, when the tree has managed to seal off the diseased region in well compartmentalized sector, such traumatic interruption can be deleterious. However, analysis with a dendrodensimeter is still an irreplaceable tool, even if non-invasive diagnostic instruments (e.g. sonic or ultrasonic tomography) have demonstrated their ability to provide useful information for biomechanical evaluation of trees, and they are an excellent analysis method to complement dendrodensimetry, which is surely more rapid and easy to interpret.

As a matter of fact, a number of products and techniques are now marketed for detecting and assessing decay in trees. Very useful equipment and techniques such as the Picus Sonic Tomograph (Argus Electronics GmbH, Rostock, Germany) have been developed as a non-invasive method to quantify and locate wood decay. Sonic tomography is a technique used to produce an image of the internal structure of a solid object by recording differences in the speed of sound wave transmission.

More recently also other approaches to the assessment of tree statics have been widely used. For example the Static Integrated Assessment (SIA) and the Static Integrated Method (SIM) which are based on research carried out at the University of Stuttgart and published by Sinn and Wessolly (1989). The assessment of tree statics has been selectively explored and applied with varying levels of understanding.

It is acknowledged that there is no perfect method that covers all possible cases. For this reason it is considered necessary to explore and study all current approaches in order to find an appropriate way to make professional decisions, while considering the stability and structural integrity of trees. The methods and tools described above can provide support for the technician in measuring and evaluating internal decay and other defects in wood and standing trees. However, it is necessary to emphasize that in hands of knowledgeable and experienced persons, they can provide important information about the necessary action to be taken. Contrary, in inexperienced hands there is the risk of abuse or poor interpretation of data which can result in erratic assessment.

Finally, it has to be emphasized that some species of trees are more hazardous than others. The group of more hazardous species includes: basswood (*Tilia americana*), black locust (*Robinia pseudoacacia*), willows (*Salix spp*.), boxelder (*Acer negundo*), silver maple and mountain maple (*Acer saccharinum* and *Acer pseudoplatanus*), cottonwood, quaking aspen, and other poplars (*Populus spp.*), and tree-of-heaven (*Ailanthus altissima*). When planning new plantings these species should be avoided or a management plan to hamper possible failures should be set up. Moreover, it should be stressed that when the available volume of soil to be explored by the root system is not sufficient and/or when roots are damaged by human activity, or by pathogens and pests, even the most stable species can fall, particularly during bad weather conditions.

4.2.1.2 Deterioration of Tree Quality by Pests and Pathogens – Plant Protection Activity

Aesthetic and health-supporting values are top priorities for publicly used parks and forests, particularly those in the urban environments. Therefore, the quality and health of trees and other plants are closely watched by both the visitors and management of the green space areas. Trees and shrubs are colonized by many living organisms. Some of them, such as phytophagous insects and mites, plant pathogenic fungi and bacteria, or even larger vertebrates, can occasionally reproduce in mass and cause extensive damage to the host plants (Photos 4.2–4.5). This may threaten the visual quality of a tree and/or its lasting in the environment. As a consequence, complains from citizens, who become aware of deteriorating health of 'their' trees, are addressed to green space administrators and forest managers. In such cases intervention against leaf-, or wood-damaging pests and diseases is occasionally necessary in order to maintain the highest possible quality of the green areas. However, plant protection activities are also controversial issue to many green space visitors. Any interventions, particularly those within the urban environment, may provoke negative

Photo 4.2 Mature larva of gypsy moth (*Lymantria dispar*). Mass feeding of this leads to complete defoliation of several tree species (Photo: Marek Tomalak) (*See Color Plates*)

Photo 4.3 Wooly tents produced by larvae of bird-cherry ermine moths (*Yponomeuta evonymella*) on twigs of bird cherry make the infested trees unattractive to park visitors (Photo: Marek Tomalak) (*See Color Plates*)

Photo 4.4 Premature dying of leaves caused by horse chestnut miner (*Cameraria ohridella*) (Photo: Marek Tomalak) (*See Color Plates*)

comments and complaints about potential hazards to human health. Therefore, it is essential not only to continue effective and safe management of public trees and green spaces, but also to find a credible and convincing way to inform visitors that the undertaken plant management activities are necessary for the trees and all measures are considered to make them safe to people and the environment.

Photo 4.5 Gregariously feeding larvae of duff-tip moth (*Phalera bucephala*). Numerous and hairy caterpillars are scary to park and urban forest visitors (Photo: Marek Tomalak) (*See Color Plates*)

Urban green spaces, such as alleys, parks, and forests, with mostly uncontrolled public access, impose special safety limitations on the plant protection activities. As human safety cannot be compromised, the only solution is to find a balance between the level of damage which can be tolerated by trees and the public, and the efficacy of plant protection measures which can be attained with particular methods. Although for most of citizens the plant protection is usually associated with application of toxic chemical pesticides, in reality it offers a wide range of methods and control agents which can be safely used in various environments, including recreational and urban green spaces. The methods available for effective and safe control of pests and diseases on urban trees include (a) cultural practices, (b) biological control, (c) chemical control, (d) planting of resistant or tolerant tree species or clones, and finally (e) plant quarantine, which, with the aid of proper legislation, prevents accidental introduction of pests and diseases from other geographical regions (Tello et al. 2005). All these methods allow for some flexibility in the choice of proper agents and tools, especially suited for particular situations. The most desirable effects are often obtained by integration of compatible elements of all these methods. Long-term forecasting of mass outbreaks and precise monitoring systems, which involve continuous analysis of the pest or pathogen population dynamics in relation to current meteorological situation, may aid in making correct decisions on the necessity of prevention or intervention measures.

In the pest and disease management programs conducted within public green areas, cultural practices are probably easiest to perform for services responsible for tree care. The techniques include sanitary pruning, removal of dead and infested branches or entire trees, use of pheromone and color sticky traps, management of irrigation and drainage, etc. Pruning and removal of dead or dying branches or entire trees can help to prevent the pest or pathogen from spreading around. It can stop the problem, or at least slow down its progress. It also improves safety of green space visitors by removing potentially dangerous dead branches, which otherwise could break away and fall to the ground at any time. Sanitary pruning is usually conducted on trees affected by bacterial or fungal wood pathogens, or infested in mass with wood-boring insects. It is always performed by professional crews with proper notification, and temporary closing of public access to the subjected area. Thus, potential hazards to visitors are minimized. The same is true for the use of pheromones, which applied in combination with sticky traps, may be effective in catching particular pest species for monitoring and control. In forest practice they are used to attract selected bark beetles and tortricid moths. Due to the high specificity these chemicals pose no hazard to people and non-target species. Other traps, such as color (white, blue, or yellow) sticky boards or bands and light traps with UV emitters are also occasionally used for attracting and catching of flying pest insects (e.g., moths, sawflies, mosquitoes, or bark beetles). In public parks and alleys they may occasionally provoke complaints about their negative visual impact on aesthetics of individual trees or the whole green area. Although not satisfactory for solving all problems, cultural methods, as easy to apply and safe preventive measures, are among the most widely used in the management of open green spaces.

Planting of proper tree and shrub species or clones is another way to reduce potential danger of pest, or disease-related damage. This is particularly true in harsh urban conditions, where trees poorly adapted for elevated levels of air and soil pollution, drought, extreme light conditions, etc. may continuously suffer and be more susceptible to pest and pathogen attacks than in natural forest conditions. The most advanced approach to this problem is the selection of tree species or clones which are resistant or tolerant to particular pests or pathogens present in the region. A classical example of such approach could be the research on genetic improvement of elms that resulted in a series of clones resistant to the fungi *Ophiostoma ulmi* and *O. novo-ulmi*, responsible for Dutch elm disease. These new clones have been successfully introduced throughout Europe and North America (Smalley and Guries 1993; Stipes 2000). A similar approach is presently suggested for control of the horse chestnut leaf miner, *Cameraria ohridella* in Europe. Red and yellow-flowering species of horse chestnuts (e.g. *Aesculus flava*, *A. pavia*, *A. x carnea*) are resistant or less susceptible to attacks of this moth, than the most common white horse chestnut, *A. hippocastanum*. Therefore, planting of the former species, or their interspecific hybrids could help to reduce the damage (Straw and Tilbury 2006).

One of the most important characteristics of urban green spaces is the great diversity of tree and shrub species growing within a relatively small area. This diversity is also a very effective control measure against mass outbreaks of many pest and pathogen species, which cause notorious problems in commercial forests. Monophagous sawflies (*Diprion spp.*, *Acantholyda spp.*, *Pristiphora spp.*, etc.), or moths (*Pannolis flammea*, *Lymantria monacha*, *Dendrolimus pini*, etc.), which are devastating to large forest monocultures of pine, spruce, or larch usually remain unimportant in mixed-species stands of urban trees. However, insects with the ability of feeding on several host species, such as winter moths (*Operophtera brumata*, *O. fagata*), gypsy moth (*Lymantria dispar*), or brown-tail moth (*Euproctis chrysorrhoea*) may still be troublesome in urban parks, alleys and forests. They may cause defoliation of trees annually, and thus seriously threaten their health and aesthetic values.

If the forecasted or actually observed damage requires immediate intervention, in public green spaces biological control methods have the priority over chemical control.

There are several groups of commercially available biological control agents which can be effectively used in the practice. They include preparations of entomopathogenic viruses which are effective against several species of sawflies and moths. Bacteria (mostly *Bacillus thuringiensis*) are effective against a wide range of tree leaf-feeding beetles and caterpillars of moths. Entomopathogenic fungi are useful against aphids and grubs, and entomopathogenic nematodes are effective against many tree sawflies, moths and beetles pupating in the soil. There are also records of successful introduction of parasitic and predatory insects and mites for control of various tree pests. All these biocontrol agents are absolutely safe to people and most non-target organisms. Therefore, there is no hazard related with their application in the field.

Although the highest possible aesthetic quality of trees and shrubs, as well as clean forest floors that are free from dead branches are widely accepted standards for urban parks and forests, one should remember the other functions of trees. Many birds and mammals use tree cavities for nesting, denning, resting, feeding and hibernation. Dead branches can serve as dwelling habitats for beneficial insects, lizards, toads, and small mammals. All these living components are important and should be protected since they help to keep balance in natural environments and prevent populations of individual, harmful species from uncontrolled outbreaks. Therefore, dead branches or trees with cavities, even those which are not aesthetically perfect, should be left on site, providing they will not serve as a source of pests and pathogens or be hazardous to visitors passing by. A similar approach should be taken to numerous species of living organisms, including insects, which are present in parks and urban forests. Some of them feed on plants. Others are predatory or parasitic and feed on plant-feeding species, effectively reducing their populations. If high biodiversity is preserved, in most cases we do not have to worry about the damage caused to trees and shrubs. With a huge number of entomopathogenic, parasitic and predatory organisms, such as bacteria, fungi, protozoa, nematodes mites and insects commonly present in a forest or park environment, nature looks after itself. Even most harmful species occurring in small numbers can only cause insignificant and transient damage. The real problem starts with excessively reduced diversity of plants and animals, and mass outbreaks of individual pest or pathogen species, which cannot be effectively controlled by their natural enemies. Only in such cases intervention with appropriate control programs seems justified. In most other situations we should just enjoy, try to understand, and appreciate the benefits from biodiversity with its multitude of forms and functions. This is probably the most effective biological method of pest and pathogen control in nature.

Within urban green space and peri-urban recreation forests, chemical control methods usually play a less important role, as chemical pesticides are not recommended in most European countries. However, occasionally, exceptions from this principle are made if the situation presses for, and no other effective pest or pathogen control methods are available. In such cases only a few chemical pesticides with lowest human toxicity, such as inhibitors of chitin synthesis (e.g. diflubenzuron, teflubenzuron), which selectively affect only plant-feeding insects, some pyrethroids (e.g. deltamethrin, cypermethrin) with a very short environmental life, or selected systemic compounds, which remain active only inside the plant (e.g. imidacloprid, abamectin) are accepted under special conditions. In publicly accessible environments it is also essential to use application methods which minimize or completely eliminate any potential hazard to visitors in the subjected area. Such methods include direct injection or infusion of the chemical into the tree trunk, drenching or spraying with large droplets which prevent wind-mediated drifting of the working solution to the neighborhood, closing of public access to regions subjected to chemical treatments during the pesticide application and its prevention period, etc. In public green spaces pest and disease management with chemical pesticides can only be performed by experienced, licensed crews with certified equipment. This should minimize the potential hazard to visitors. Nevertheless, further improvement of the information system available to citizens and close watching of all notifications posted in the public green areas are necessary in order to avoid any potential problems.

Another area of potential insecticide application in urban parks and playgrounds is the control of blood feeding insects, such as mosquitoes, black flies, and tabanids, which can occur in masses during late spring and summer. A decision for an intervention is usually based not only on people's discomfort related to insect bites, but on the potential or real threat to human health, due to transmission of dangerous pathogens, such as viruses, protozoans or nematodes. Although such insecticide treatments only have limited effects on the pest population, it is difficult to argue against such actions, particularly in regions with endemic presence of viral encephalitis, sleeping sickness, or onchocerciasis – river blindness caused by filarid nematodes. Details of these phenomena will be discussed in later on in this chapter.

To conclude this section we can reason that although both the damage caused to trees by pests and pathogens, as well as plant protection practices conducted in public green spaces increase worries about deterioration of tree quality or/and potential hazards to human health, in most situation these worries are not fully justified. With existing methods both problems can be managed with high safety for humans, and excellent or reasonably good protection for the trees. All precautions of good plant protection practice must however, be respected by both the open green space and forest management services and visitors to the green areas.

4.2.2 Wild Animal-Related Effects

The fear of potential encounters with wild animals prevents many people from visiting forests and wooded areas. Not only large predators or venomous vipers, but also small insects, spiders and slugs can cause fear for various groups of people. In most cases such a priori fear is not rationally justified, and its roots should be traced somewhere in the life experience or education level of these people.

People often have an emotionally negative attitude towards wild venomous and predacious animals, such as toads, serpents, snakes, wolves, or bears. Such attitude led many species to local extinction. In the nineteenth and twentieth century populations of big predators, including wolf, lynx and raccoon have been greatly reduced or completely eliminated from many European forests. Fortunately, the positive value of these species for the forest ecosystem has been finally realized. By the selective predation they keep control of fast reproducing populations of rodents, eliminate weak and unhealthy individuals of ruminants, and reduce their tendency to periodic overpopulation in particularly advantageous environmental conditions. Predators play a significant role in the forest ecosystem by reducing the spread of pathogens and diseases among rodents and ruminants and by protecting young forest trees from damage caused by excessive feeding of these animals. Therefore, in most European countries all these animals are protected by law and numerous scientific programs have been initiated to partially or completely restore extinct populations at their original sites.

Nevertheless, large predators are still rare in European forests. The chances for seeing them in the wild are very low as they usually prefer to avoid contacts with people, unless they, their offspring, or territory are directly threatened. The exception could be when a wild bear, wolf, badger, fox, or raccoon learns that farms, human dwellings, or camp sites can be a source of easily accessible food. Bears' or wolves' visits to garbage dumps are occasionally reporter on the news worldwide. Although rarely observed, potential aggression of such animals may be expected, and all precautions, including proper protection of the garbage sites by fencing and careful approaching of persons to the affected area should be taken. Local increase of the big predator population and/or its habituation to human dwellings can periodically change the community opinion about the animals and potential threats related with their presence in the environment. Recent reports on wolves approaching human settlements in some regions of Finland frighten parents who consider this situation potentially dangerous for children playing outside, and rise serious questions about the strict wolf protection in Europe, which could hamper the human and livestock safety in some areas. In these cases detailed research on the original causes of such situation is needed in order to avoid making any biased decisions based on an over-emotional discussion. A recent study conducted on authentic records of wolf attacks on humans revealed that, at present, despite increasing numbers of wolves, the risk of wolf attacks in Europe appears to be very low. When compared with attacks of other wild animals, the number of fatal cases is also very low. There are records of nine people being killed in Europe, eight in Russia and none in North America during the last 50 years (Linnell et al. 2002). Most of the attacks were associated with wolves infected with rabies, their habituation and loss of fear of humans, provocation, or/and highly modified environment with scarce potential pray. According to Linnell et al. (2002) the recorded low rates of attacks are probably due to the fact that factors most often associated with wolf attacks are no longer common. Management of wolf populations with regulated hunting aimed at removal of animals that appear to loose their natural fear for humans or act in aggressive manner, as well as reduction of rabies in domestic dogs and wildlife in order to decrease the risk of attacks by rabid wolves could further improve the situation. There are only a few other predacious and venomous species in Europe which could be dangerous to humans upon direct contact. They are usually rare and tend do avoid contacts with people. Therefore, the great fear of wild animals is not justified in Europe and it should not limit human visits to forests or other wooded areas.

4.3 Hazardous Effects

4.3.1 Allergic Factors

4.3.1.1 The Allergy

The term allergy literally means 'another way to (re)act', as *allos* means other or different, whereas *ergos* means action. Allergies are due to an abnormal, excessive hypersensitivity to one or many specific substances, called allergens, which are common and non toxic components of the environment. We speak of hypersensitivity because the reaction is stirred up by contact also with relatively small quantities of the allergens. Allergies generally develop on a familial tendency and predisposition, with pathological conditions such as asthma, congiuntivitis, rhinitis, dermatitis, urticaria, alone or in different combinations. However, also without atopic allergic familial tendency, people can develop hypersensitity reactions associated with a class of antibody immunoglobulin E (IgE), and the mast cells are the main cell effectors of the immune response in allergic reactions.

4.3.1.2 Environmental Causes and Epidemiology

The numbers of allergies recorded within human populations are continuously growing. Allergic diseases and asthma represent one of the most common chronic pathological conditions throughout the world (Bousquet et al. 2003b). They usually start early in infancy or childhood and often persist throughout lifetime (Crane et al. 2002). They are extremely common in developed countries. It is estimated that 2–15% of the European population suffer from asthma, and in some countries, allergy may affect over 50% of children. In the European region, the countries with the highest prevalence of asthma and symptoms of allergy include Finland, Germany, Ireland, the United Kingdom and, recently, Romania. Lower asthma prevalence was found in Albania, Belgium, Estonia, Georgia, Italy, Lithuania, Spain and Sweden. In some countries with multiple study centers, variations in prevalence were seen, particularly in Italy. Poland reported a high rate of allergic rhinoconjunctivitis symptoms but low asthma rates.

In most of the Western countries this pathology affects up to 20% of population (World Health Organization 2003). In France and Italy during the last 20 years, the number of asthmatic patients has doubled, due to a complex of factors such as a greater environmental pollution, increased temperature, climate variation, and possibly, sanitary interventions. The prevalence of allergic diseases and asthma has increased during the past 3–4 decades. More recently a similar increase has been noted in developing countries, and these diseases now represent an important problem (Bousquet et al. 2003a). In the European Union the prevalence and severity of allergic diseases including asthma present a serious challenge both to health care systems and to society as a whole. Asthma is arguably the most serious of the allergic diseases in that it is disabling (e.g., annually causing more than 100,000 hospital admissions in England and Wales), and occasionally fatal (Jarvis and Burney 1998).

A possible explanation is the 'hygiene hypothesis'. This suggests that increased hygiene and the resulting lack of exposure to various microorganisms in early life affect the immune system so that an individuals' ability to fight off certain diseases is weakened and they are more susceptible to autoimmune diseases (Nicolau et al. 2005). First proposed by David Strachan in the 1980s, although there is no consensus on the reasons for the increased prevalence of allergies, the 'hygiene hypothesis' has solid support. In other words, squeaky-clean modern life could be a contributing factor, and may indeed be harmful to children. Another contributing factor is the environmental pollution.

According to a recently published Editorial of The Lancet (2008), allergy is a great social problem, and very difficult to solve. Whatever the reason, there is no doubt that allergy symptoms are increasing, can be debilitating, and often cause much misery and suffering. Societal costs are also substantial because of negative effects on educational attainment and loss of productivity at work. Furthermore, the medical profession has little idea about how to manage allergy-prone patients. Specific problems also include the continuing increase in the prevalence of food allergy, which is of a particular concern because of its major impact on the quality of peoples' life, and actually it may be life-threatening (Munoz-Furlong 2003). This problem mainly affects children (Sicherer 2002; Crespo and Rodriguez 2003). Another important allergenic factor, particularly related with open green spaces and trees is pollen abundantly released by plants during their flowering period. Pollen-induced allergy can annually cause annoying and recurrent health problems for a large part of the human populations.

4.3.1.3 Immunological Mechanisms in Allergic Response

When the organism comes into contact with a food protein or pollen (allergens) that is recognized as a foreign invader, blood plasma cells produce immunoglobulin E (IgE). Then the next step is the fixation of IgE to mast cells, and basophiles prepare these cells for the antigen-specific activation; this process is termed sensitization. Mast cells are present on the cutaneous and mucosal surfaces and in deeper tissues, so they can regulate the passage of foreign substances into the organism. The allergy antibody (IgE) becomes attached to mast cells, which are immune system cells. When the next time the same allergen enters the body, its proteins become attached to the IgE waiting at the mast cells. The IgE causes the mast cells to release chemicals (histamine, leukotrienes) that initiate reactions like sneezing, itchy eyes, and post nasal drip.

4.3.1.4 Clinical Symptoms

The allergic reaction can be initiated in several different ways. Allergens can be inhaled (e.g. pollen), injected (e.g. medications and inoculations), ingested (e.g. food and beverages), or they can enter the body directly through the skin (e.g. various chemicals). Allergic reactions can be of various types, mostly respiratory and cutaneous. They can also affect the digestive system, eyes, head, and vary from symptoms of eczema, or rhinitis and asthma-related to the anaphylactic shock.

Allergic rhinitis is characterized by symptoms of sneezing, rhinorrea, nasal obstruction, conjuntivitis, itching of mucous membranes, occurring in a temporal relation with the allergens.

Asthma is a chronic inflammation of respiratory track characterized by an increased responsiveness of the respiratory mucosa to a multiplicity of stimuli. More than a disease, asthma is a syndrome with different risk factors, different prognoses, and different responses to treatment.

Eczematous dermatitis can be atopic, which implies a familial tendency, or from contact with natural or chemical allergens.

Food allergy is manifested as a mere annoyance, such as indigestion or it can cause a life-threatening condition know as anaphylaxis.

4.3.1.5 The Most Common Allergens

The most common allergenic factor in nature is pollen of flowering plants (D'Amato et al. 1992; Negrini and Arobba 1992). Among those, the pollen from grasses is the most important allergen. Pollen of many trees, such as olives, cypresses, birch, alder and others can also provoke allergy. Other potent allergenic factors include various spores of fungi and moulds, and dust mites (e.g. *Dermatophagoides pteronyssinus* or *Dermatophagoides farinae*), which may be present alone or together in dust. Animal hair, saliva or scurf can also cause allergic reactions. Because such a broad range of potential allergens exists, we will only discuss a few examples which are most common and representative for the forest environment.

Grasses

Pollen of timothy (*Phleum* spp.), orchard grass (*Dactylis* spp.), oat grass (*Arrhenaterum* spp.), ryegrass (*Lolium* spp.) and other grasses are known to show high allergenicity. Their flowering period starts in March/April in the south of Europe, in May in central Europe, and during June and July it moves toward the northern areas of the continent. In general, the pollination period lasts about 2 months or even longer. Nearly all grass species are very closely related and cross react frequently. Grasses of minor importance include reed (*Phragmites* spp.), oats (*Avena* spp.), and Bermuda grass (*Cynodon* spp.). Cross reactions with food are not frequent, although they are known to beans, soy, peanuts and other leguminoses.

Mugwort (*Artemisia* spp.)

Mugwort shows high allergenicity. In central Europe, the start of the season is late July, and the peak days usually in mid-August. The flowering season may last until September. Mugwort pollen cross reacts with almost all other composites, especially with ragweed pollen. Further cross reactions are known with dandelion, goldenrod, sunflower, chamomile, and all the daisy-like flowers. Very important cross reactions are known in the frame of food-allergies with celery.

Sorrel, Dock (*Rumex* spp.)

The season stretches from April to September, in the Mediterranean it may last throughout the year. No cross reactions are commonly known so far.

Ragweed (*Ambrosia* spp.)

The main flowering season starts in mid August, peak days are mostly in early September. The season ends between late September and the end of October. High pollen loads in Vienna occur with winds coming from Hungary (south-eastern directions). The worst time of the day for hay fewer patients is late afternoon and evening. Ragweed pollen cross reacts with almost all other composites, especially with mugwort pollen. Further cross reactions are known with dandelion, goldenrod, sunflower, chamomile, and all the daisy-like flowers.

Several genera of trees, widely distributed in Europe, are well known for their moderate to high allergenicity. In various regions their particular species can annually be responsible for periodic increases in human allergy. The most allergenic tree genera include:

Alder (*Alnus glutinosa, A. incana, A. viridis*) and Hazel (*Corylus avellana, C. colurna*)

These trees are among the earliest flowering in the season. In Europe flowering time is whenever temperatures rise above 5°C, and in some regions this may start as early as at the end of December. Alders require slightly higher temperatures than hazel.

The pollen of alder and hazel cross react with pollen of birch. Very sensitive birch pollen-allergic persons will also suffer when hazel and alder pollen is in the atmosphere.

Ash (*Fraxinus excelsior, F. angustifolia, F. ornus*)

Ashes have a comparatively short flowering period of approximately 2 weeks, which peaks usually once a season, together with the first peak of birch. The season starts in March (in the sub-Mediterranean) to April, depending on the latitude. There is a strong cross reaction known between ash and olive tree. Both olive tree and ash cross react with forsythia (*Forsythia*), privet (*Ligustrum*), jasmine (*Jasminum*) and lilac (*Syringa*). Cross reactions with food are not proven.

Birch (*Betula verrucosa, B. alba*)

Depending on the weather, the flowering season might start earliest in mid of March, mostly in early April. However, due to lower temperatures mass flowering starts much later in the mountains and in the North of Europe. The pollen of birch is highly allergenic. Cross reactions are common with all genera of the order *Fagales*, e.g. alder, hazel, hornbeam, hop-beam, beech, oak, and sweet chestnut. Very common are cross reactions with green (raw) apples.

Members of the Family *Cupressaceae*

The family *Cupressaceae*, embracing the genera cypress (*Cupressus* spp. *Chamaecyparis* spp.), juniper (*Juniperus* spp.), and thuja (*Thuja* spp.) are known for moderate to high allergenicity, depending on the exposition. There are cross reactions reported with Japanese cedar (*Cryptomeria japonica*), which belongs to a different family of conifers (*Taxodiaceae*), and recently with true cedars (*Cedrus libani, C. atlantica*), which belong to the family *Pinaceae*.

Olive Tree (*Olea europaea*)

Olive trees flowers from April to June. The olive tree pollen shows high allergenicity. There is a strong cross reaction known between olive tree and ash tree. Both olive tree and ash tree cross-react with lilac (*Syringa*), forsythia, privet (*Ligustrum*), and jasmine (*Jasminum*). Cross reactions with food are not certified.

Plane Tree (*Platanus x acerifolia, P. acerifolia, P. orientalis, P. occidentalis*)

The flowering season ranges from March to May, depending on the geographical latitude. The pollen of this tree is moderate to highly allergenic. Cross reactions are known mainly with birch, but also alder, hazel, hornbeam, oak, beech, sweet chestnut, and to some extent with grass pollen.

Oak (*Quercus spp.*)

Usually, oaks show only moderate allergenicity. The season starts mainly in April and May (sometimes already in March), depending on the species and the geographical latitude. There is a strong cross reaction known between olive tree and ash tree. Both olive tree and ash tree cross-react with lilac (*Syringa*), forsythia, privet (*Ligustrum*), and jasmine (*Jasminum*). Cross reactions with food are not certified.

Among other common European tree genera and species the beach (*Fagus silvatica*), elder (*Sambucus* spp.), hornbeam (*Carpinus betulus*), horse chestnut (*Aesculus* spp.), maple (*Acer* spp.) and willow (*Salix* spp.) present only low or moderate allergenicity.

4.3.1.6 Diagnosis and Treatment of Allergies

The usual forms of allergy testing includes: in vitro antibody-, delayed hypersensitivity-, percutaneous-, and intradermal testing. All these methods are based on evaluation of direct reactions of the allergen with a patients' skin or blood samples. The scope of this chapter does not allow for detailed descriptions of these tests, but it should be mentioned that all individual tests have some shortcomings related to the precision of the results. To make a correct diagnosis it is therefore necessary to conduct a combination of the allergy tests. In the treatment of allergies the conventional medicine relies on three primary methods of treatment: avoidance, medication, and immunotherapy.

Avoidance

This strategy is based on reduced exposure of patients to allergens. The symptoms are minimized by avoiding contacts with the allergic substances. Even though this approach has a limited effectiveness, as it does not eliminate the allergy, it can be helpful in reducing negative effects of some environmental factors. During flowering periods avoiding visits to locations with high concentration of plants producing allergenic pollen could be effective. However, in regions with common presence of such plants this method would be impractical. The same is true for dust, which simply cannot be avoided in any common environment

Medication

Anti-allergy drugs are considered to be some of the most common drugs that are presently prescribed by medical doctors. The primary allergy medications include:

oral antihistamines, nasal antihistamines, oral and nasal decongestants, steroidal and nonsteroidal nasal sprays, anticholinergics, and leukotriene modifiers. There are however, side effects to be aware of and it is wise to consult a doctor before this type of long term treatment is started.

Immunotherapy

Immunotherapy is more commonly known as allergy shots. The patients are injected with weak versions of the substances that cause the allergy symptoms. Over time, the concentration of these injections is increased in order to build up the tolerance to the offending allergen. The theory is that the body will create antibodies that block the allergic antibodies causing the symptoms. However, this method does have limitations. For example, it can take years of injections before you build the immunity to the effective level. Moreover, this method is not known to work effectively with food allergens.

Allergy Treatment with Phytotherapy and Homeopathy

In many cases the same plants which can cause allergy, can also be used for prevention and treatment of allergic symptoms. For instance species like *Ribes nigrum* or *Rosa canina* are commonly used in natural antihistaminic treatment against allergic rhinitis or asthma. From a homeopathic point of view, allergy is considered a defense reaction of the organism, which is not able to produce the specific immune response to the allergenic stimulus. Lacking the appropriate response to the allergen, an organism is forced to produce a compensatory reaction with the aim of keeping allergens outside of the body. Allergy treatment in homeopathy and phytotherapy is based on plant products from such plants as *Pulsatilla, Sabadilla, Allium coepa.* Many of these species, such as *Arundo* and *Ambrosia* are allergenic at higher doses.

Adverse Reactions to Herbal Medicinal Products

'Natural' doesn't mean necessarily safe and without any risk, especially if we speak about natural pharmaceutical products. It is well known that a growing number of Europeans is using herbal products for preventive and therapeutic purposes and, until now, the adverse effects and drug interactions associated with herbal remedies are largely unknown. A *Ginkgo biloba* extract, advertised as improving cognitive functioning, has been reported to cause spontaneous bleeding, and it may interact with anticoagulants and antiplatelet agents. St. John's wort, promoted as a treatment against depression, may have monoamine oxidase-inhibiting effects or may cause increased levels of serotonin, dopamine and norepinephrine. Ephedrine-containing herbal products have been associated with adverse cardiovascular events, seizures and even death. Ginseng, widely used for its purported physical and mental effects, is generally well tolerated, but it has been implicated as a cause of decreased response to warfarin. Citizens and health workers must be alert for adverse effects and drug interactions associated with herbal remedies and physicians should ask all patients about the use of these products.

4.3.2 Toxic and Poisonous Mushrooms and Plants

European flora is characterized by a great variety and richness of endemic species, some of which have been used for feeding and medical purposes since ancient times. Nowadays, food comes mainly from farming and the relationship between people and nature has changed. The widespread belief that a positive attitude towards nature can improve health and well-being leads people to explore parks and forests, not being aware of the hidden hazards. Many species of mushrooms and plants are poisonous (Photos 4.6–4.8). The risk of picking up a toxic species is very high as botanical identification of edible species is often difficult. It cannot be

Photo 4.6 *Amanita muscaria*, a mushroom containing ibotenic acid and muscimol, neurotoxic toxins (Photo: Stefano Vianello) (*See Color Plates*)

Photo 4.7 *Boletus satanas,* a gastrointestinal irritant species (Photo: Riccardo Mazza) (*See Color Plates*)

Photo 4.8 *Amanita phalloides,* a mushroom containing hepatotoxic cyclopeptides (Photo: Stefano Vianello) (*See Color Plates*)

based on pictures in popular books or on self-acquired competency alone. Clinical manifestations of poisonings will vary with the type of 'natural' toxins involved. Specific actions of particular toxins can injure individual organs or cause generalized poisoning with potential fatality for the patient.

4.3.2.1 Mushrooms

Many wild mushrooms are toxic, while only few species are edible. Popular methods for identification of edible mushrooms and elimination of their potential toxicity (i.e. evaluation of color changes, feeding to small animals, boiling, freezing, drying, pickling it, etc.) are not reliable and usually misleading. The range of potential symptoms related with ingestion of poisonous mushrooms is wide and often characteristic to the mushroom species. They include vomiting, diarrhea, liver or renal injury, hallucinations, seizures, and cardiac arrhythmia. They can occur within a few hours after ingestion or be delayed for several hours or even days, particularly when deadly species are involved (Brent 1998; Diaz 2005a; Ellenhorn 1997; Goldfrank 1998; Olson 2004a).

Hepatotoxic Species

These are mushrooms containing amatoxins and other cyclopetides, such as *Amanita phalloides* (death cap), *A. verna, A. virosa* (destroying angel), *Galerina autumnales* (deadly galerina), *G. marginata, G. venenata, Lepiota josserandii, L. subinearnata*, and others. Symptoms: After a long time of latency (6–12 h after ingestion), there is a sudden onset of nausea, vomiting and diarrhea lasting for about 24 h. After an apparent recovery, the symptoms of acute hepatitis appear 2–4 days after ingestion. The mortality rate is very high despite intensive medical treatment (Giannini et al. 2007; Olesen 1990). Dried mushrooms contain 5–15 mg of amatoxins per gram and the lethal dose of amatoxins for adults is 0.1 mg/kg. Therefore, one Amanita cap, 15–20 Galerina caps, or about 30 Lepiotas can be a lethal dose for an adult (Haines et al. 1985).

Nephrotoxic Species

These mushrooms contain orellanine. Best known species are *Cortinarius orellanus, C. speciosissimus* and *C. gentilis* (deadly cort). Symptoms: Initial symptoms occur within 36 h to 11 days and they can seem flu-like (nausea, lumbar pain, muscle aching) before the onset of oliguria, and acute renal failure. Kidney injury is almost irreversible and patients need permanent dialysis or transplantation (Bouget et al. 1990; Calvino et al. 1998).

Neurotoxic Species

Mushrooms Containing Psilocybin – Psilocin

This group includes such species as *Conocybe cyanopus, C. smithii* (blue-stemmed galera), *Gymnopilus aeruginosa* (green pholiota), *Panaeolus campanulatus* (bell-shaped panaeolus), *Psilocybe spp.*, and others. Symptoms: Within 30–60 min signs of neurologic impairment, manifested by dysphoria, poor performance ability, unintentional movements, mydriasis, vertigo, paresthesias, muscle weakness, and drowsiness can be observed. Tonic-clonic seizures and hyperthermia may also develop (Benjamin 1979).

Mushrooms Containing Muscimol – Ibotenic Acid

Best known species are *Amanita citrina* (false death cap), *A. cothurnata* (booted amanita), *A. frostiana* (Frost's amanita), *A. gemmata, A. muscaria* (fly agaric), and *A. pantherina* (panther amanita). Symptoms: Onset is usually within 30 min–3 h post ingestion. The patient becomes dysphoric and drowsy. Confusion delirium, hallucinations, hyperkinetic activity, muscle spasms seizures are followed by lethargy, stupor and coma (Satora et al. 2005).

Mushrooms Containing Muscarine – Histamine

This group includes *Clitocybe dealbata*, *Inocybe fastigiata*, *I. lacera*, *Omphalotus olearius* (Jack-O-Lantern mushroom), and related species. Symptoms: Signs of poisoning occur early (within 30–120 min) after ingestion, in a characteristic combination named PSL, i.e. excessive (P)erspiration, (S)alivation, and (L)acrimation, accompanied by bradycardia, meiosis, abdominal pain, diarrhea, hypotension, and difficulties in respiration (Pauli and Foot 2005).

Gastrointestinal Irritant Species

This group comprises many species from various genera, namely: *Agaricus arvensis* (horse mushroom), *A. silvaticus* (woods psalliota), *Armillariella mellea* (honey mushroom), *Boletus erythropus* (red-footed), *B. luridus* (lurid boletus) *B. pulcherrimus* (red-pored boletus) *B. satanus* (Satan's boletus), *B. sensibilis* (sensitive boletus), *Clitocybe nebularis* (gray cap), *Collybia drophila* (nut-brown collybia), *Gomphus floccosus* (wolly chenterelle), *Hebeloma crustuliniforme* (poison pie), *H. sinapizans* (giant hebeloma), *Helvella acunose* (Elfin saddle), *Lactarius chrysorheus* (yellow-juiced lactarius) *L. deceptivus* (deceptive lactarius), *L. piperatus* (pepper cap), *L. rufus* (red milky cap), *L. scrobiculatus* (spotted-stemmed lactarius), *L. tormenosis* (woolly milky cap), *Lepiota molybdites* (green-spored lepiota), *L. naucina* (smooth lepiota) and many other species. Symptoms: Gastrointestinal symptoms appear early after ingestion (30 min–2 h) and include: nausea, vomiting, abdominal cramps, diarrhea. If fluid losses are restored, recovery is usually complete within 24–48 h.

Other Toxic Species

Mushrooms containing coprine, such as *Coprinus atramentarius* (inky cap), *Clitocybe clavipes* and others. Symptoms: If alcohol is ingested within 48–72 h after eating the mushrooms, there is a rapid onset of flushing, paresthesias, palpitations, chest pain, weakness, vertigo, confusion, nausea and vomiting. Respiratory failure and coma may occur. Coprine metabolites inhibit aldehyde dehydrogenase, producing a disulfiram-like reaction (Reynolds and Lowe 1965).

Mushrooms containing monomethylhydrazine (MMH), such as *Gyromitra esculenta* (false morel), *G. infula* (hooded false morel), *G. gigas* (snow morel), and *G. fastigiata* (brown false morel). Symptoms: After a long latent period of 6–12 h after ingestion, there is the onset of nausea, vomiting, abdominal pain and diarrhea lasting for about 2 days. Headache, intense pain in the region of liver and stomach are followed by jaundice, seizures and coma in most severe cases. Acute poisoning with early onset of symptoms may occur after inhalation of vapors from cooking of Gyromitra (Karlson-Stiber and Persson 2003; Michelot and Toth 1991).

4.3.2.2 Plants

There are thousands of potentially dangerous plant species that can cause serious illness. The habit of picking up wild berries or herbs may lead to acute poisoning, if toxic species are mistaken for edible ones or, if they are misused (Moro 2007; Nelson et al. 2006; Norton 1996). Species containing cardiac and/or neuroactive toxins are the most likely to cause death, though species containing gastrointestinal or irritant toxins may also cause severe clinical problems due to fluid loss, electrolyte imbalance, or difficult respiration caused by swelling of tongue and throat, if a supportive treatment is not performed.

Due to the limited space, a complete list of poisonous and otherwise dangerous plant species present in Europe can not be provided in this chapter. Only a few of the most dangerous and common species are listed below to illustrate the hidden hazards related with some plants (Ellenhorn 1997; Frohne 2004; Kunkel 1998; Olson 2004b; Shih 1998).

Aconitum – *Aconitum napellus, A. vulparia* (*Ranunculaceae*)

These plants can be found growing wildly in many parts of Europe. Toxic part: All parts are toxic and contain diterpene and norditerpene alkaloids. One gram of fresh *A. napellus* may contain 2–20 mg of aconitine and may be a lethal dose. Symptoms: Within 30 min after ingestion there is the onset of tingling of tongue and mouth extending to the arms, skin paresthesias, numbness, anxiety, nausea, dizziness, and chest pain. Cardiac rhythm disturbances and paralysis frequently occur, often causing death. This species can be mistaken for alpine-blue-sow-thistle (*Cicerbita alpina*).

Horse Chestnut – *Aesculus hippocastanum* (*Hippocastanaceae*)

It is a large deciduous tree, producing brown shiny seeds in an often spiny, valved capsule. Toxic parts: All parts are toxic – the young leaves, flowers and the bark contain aesculin, while the seeds contain variable amount of aescin and a mixture of saponins. Symptoms: Vomiting and diarrhea are often the only symptoms seen. CNS depression, stupor, coma, muscle uncoordination, paralysis, and headache are also reported. Its seeds are mistaken for edible chestnuts.

Anemone – *Anemone alpina* (*Ranunculaceae*), Buttercup-*Ranunculus bulbosus* (*Ranunculaceae*)

They are easily found in the mountains of Europe above 1,000 m altitude. Toxic parts: All the parts contain protoanemonin which has an irritant and vesicant action. This compound is unstable and is readily converted to the inactive dimer anemonin upon drying or heating. Thus, dried plants containing protoanemonin are less toxic.

Symptoms: Contact dermatitis, local pain, swelling and blistering of skin and mucous membranes are often reported.

Belladonna, or Deadly Nightshade – *Atropa belladonna* (*Solanaceae*)

It is a perennial herb growing in western and south Europe. Its berries are purple to black when ripe.

Bittersweet – *Solanum dulcamara* (*Solanaceae*)

It is a woody – herbaceous perennial vine with violet-purple flowers and small flashy red berries. Toxic parts: All parts are toxic. They contain variable concentrations of tropane alkaloids (atropine, hyscyamine, scopolamine). Symptoms: Dilated pupils, red hot skin, tachycardia, hallucinations, stupor, coma, convulsions (anticholinergic syndrome) are common symptoms. Berries are mistaken for the fruits of blueberry (*Vaccinium myrtillus*).

Meadow Saffron – *Colchicum autumnale* (*Liliaceae*)

This plant can be found growing wildly in many parts of Europe. Toxic parts: All parts of this plant contain the alkaloid colchicine, which has an antimitotic effect resulting in arrest of cell division in the metaphase stage. Symptoms: The early symptoms include severe vomiting. Diarrhea and abdominal pain are starting within a few hours after eating. They last for about 12–24 h. After an apparent recovery there is the onset of haematological alterations and multiorgan failure, frequently leading to death. This plant can be easily mistaken for edible wild garlic *Allium ursinum*

Helleborus, or Christmas Rose – *Helleborus niger, H. viridis* (*Ranunulaceae*)

These are perennial herbaceous plants growing wildly in the south and central parts of Europe. The flowers of *H. niger* are white, those of *H. viridis* are yellow- green. Toxic parts: All parts are toxic. They contain a mixture of protoanemonin, saponins, and digitalis-like glycosides. Symptoms: Saponins and protoanemonin cause oral, gastrointestinal, and dermal irritation. Digitalis-like glycosides produce cardiac toxicity.

European Holly – *Ilex aquifolium* (*Aquifoliaceae*)

It is an evergreen tree, native to Europe. Leaves have spiny teeth and fruits are bright red berries. Toxic parts: Leaves are minimally or non-toxic, but their spines can produce mechanical damage; fruits are supposed to contain saponins.

Symptoms: Ingestion of berries produces vomiting and diarrhea. Severity of symptoms is related with the amount ingested.

Lily-of-the-Valley – *Convallaria majalis* (*Lilaceae*)

It is an herbaceous perennial with white scent little flowers blooming in May. The fruits are red-orange berries. Toxic parts: The whole plant contains convallarin and convallamarin – cardiac glycosides like those found in Oleander and Digitalis species. Symptoms: Nausea, vomiting, slow heart pulse, hypotension, cardiac arrest are observed symptoms. This plant can be easily mistaken for edible wild garlic (*Allium ursinum*)

Mezereon – *Daphne mezereum* (*Thymelaeaceae*)

It's a woody shrub native to Europe; flowers are purplish and the fruits are small red drupe. Toxic parts: All parts of the plant are toxic. Symptoms: Ingestion causes burning, swelling and ulceration of the throat, mouth, and stomach, severe gastrointestinal complaints with bloody diarrhea, weakness, coma, and death.

Golden Chain Tree – *Laburnum anagyroides, Cytisus laburnum* (*Leguminosae*)

It's a small tree native to southern Europe characterized by pendulous yellow flowers; fruits are long, flat pods containing up to three seeds. Toxic parts: All parts contain cytisine and other quinolizidine alkaloids. Symptoms: Within 15–60 min there is the onset of profuse and persistent vomiting, abdominal pain, hypotension, tachycardia. Neurological symptoms (confusion, agitation, lethargy) and muscle weakness can also occur.

Common Yew – *Taxus baccata* (*Taxaceae*)

It is a tall branched tree native to Europe. Fruits are composed of a little hard stony berry surrounded by a red, globose, and fleshy aril. Toxic parts: All parts with the exception of the red aril contain taxine. Symptoms: Within 1–4 h there is an occurrence of vomit, abdominal pain, dilated pupils, lethargy, coma, seizures and cardiac arrhythmia. Most ingestions of berries cause no effects because they are swallowed without crunching the seed that is resistant to digestive enzymes.

Veratrum – *Veratrum album* (*Liliaceae*)

It is a perennial herb growing in Europe. Toxic parts: All parts are toxic, especially roots. This plant contains cardiac-active alkaloids. Symptoms: The principal effects are nausea and vomiting, followed by bradycardia, syncope, paresthesias, weakness, hypotension and ECG changes. The plant is mistaken for *Gentiana lutea*.

4.3.3 Arthropod-Related Effects

Human contacts with some arthropods commonly present in parks and forests can result in direct body injury and/or allergic response due to biting or stinging behaviors of the animals themselves, contacts with their stinging hairs, and/or in infection with pathogenic microorganisms transmitted in their alimentary track. Although in Europe the group of health-threatening arthropods is not very large, the potential hazard can be considerable, and visitors to green spaces should be aware of it. The most dangerous arthropods include ticks, stinging bees and wasps, biting mosquitoes and flies, and moths covered with stinging hairs or spines. Although their presence is not confined to parks and forests only, due to greater availability of their natural hosts, these arthropods are more frequent in these, than in other environments.

4.3.3.1 Ticks and Tick-Borne Pathogens

Ticks are arthropods that belong to a large class of *Arachnida*, a taxonomic group which includes also mites, spiders and scorpions. Besides the unpleasant biting into the skin and sucking of blood, many tick species are capable of transmitting a variety of bacterial, protozoan, and viral pathogens to humans, and some of them can induce allergic reactions. Transmission of human diseases has been proven to representatives of two families, commonly known as hard and soft ticks. The hard ticks or *Ixodidae* have a sclerotized dorsal shield. They usually pass through a 2-year life cycle with an egg, larva, nymph and adult stages. They suck a blood meal once during each developmental stage and for the feeding they attach to their hosts for extended period of several hours or days. The soft ticks or *Argasidae* have no distinct sclerotized dorsal shield. They have several nymphal stages in their developmental cycle. In each stage soft ticks can take a blood meal several times, and in contrast to hard ticks their feeding usually lasts for less than half an hour. Surprisingly, they can also survive without any food for several months or even years. During feeding on a series of animal hosts, ticks can acquire various microbial or virus pathogens, and during subsequent biting, accidentally transfer them to humans. Field study conducted in the St. Petersburg region (Russia) revealed that of 1,606 examined passerine birds, 110 (6.8%) proved to be infected by attached larvae and/or nymphs of *Ixodes ricinus*. Of these 110, 51.8% contained one or more human-pathogenic agent, such as tick-borne encephalitis virus, *Borellia spp.*, *Ehrlichia spp.*, *Anaplasma sp.*, or *Babesia sp.* These pathogens were also found in 32.5% of adult *Ixodes persulcatus* collected from plants (Alekseev and Dubinina 2003). Similarly high incidence of 40% infection of adult *I. ricinus* with *Borellia spp.* and 35% with *Ehrlichia sp.* and *Anaplasma sp.* was reported from Bulgaria (Christova et al. 2003).

Among the most important tick-borne diseases at least six are reported from Europe. These are Mediterranean spotted fever, human granulocytic ehrlichiosis, Lyme disease, tularemia, babesiosis, and tick-borne encephalitis.

Mediterranean Spotted Fever

The Mediterranean spotted fever is caused by *Rickettsia conorii*. The disease occurs throughout southern Europe, Africa, and in western to central Asia. Its onset is observed some 6–10 days after biting by the infected tick. The identified vector of this pathogen is the brown dog tick (*Rhipicephalus sanguineus*). This suggests that the potential area of contact for humans is not limited to forest or wooded regions only. Main symptoms of the disease include fever accompanied by headache, myalgia and/or arthralgis. It is followed by maculopapular rash, usually 3 days later. The rash is most prominent on the trunk, palms and soles. Occasionally, patients may become confused and develop pneumonia.

Human Granulocytic Ehrlichiosis

This disease is caused by *Anaplasma phagocytophila*. In Europe the pathogen is wide-spread in many species of wild and domesticated birds and mammals, including rodents, carnivores, equids and ruminants. It is transmitted by the European sheep tick (*Ixodes ricinus*). The onset of symptoms of the disease is observed 5–10 days after biting by the infected tick. The affected people present fever, have a headache, myalgia and anorexia or nausea. Five days later in a proportion of them a macular, maculopapular or petechial rash is present on the upper body and/or palms and soles. Occasionally, other symptoms like diarrhea, lymphadoneopathy and changes in mental status can occur. The severity of disease ranges from mild to life-threatening.

Lyme Disease or Borreliosis

At least three species, namely *Borellia burgdorferi sensu stricto*, *B. afzelii* and *B. garinii* are pathogenic to humans and they have been identified as causative agents of the Lyme disese. The disease has been reported from North America, Europe and Asia with different tick vectors. In Europe it is *I. ricinus*. In most regions small murine rodents serve as the main natural reservoirs of the bacteria, although other vertebrates, such as birds and lizards can also play a role. Within the rodent – tick cycle humans are only accidental hosts. However, the number of reported infections can be large, e.g. in Croatia 3,317 cases were reported between 1987 and 2003 (Mulićet al. 2006), but according to these authors this might be only a part of the affected population. Similar records of the disease are also available from other European countries. In most of the cases reported worldwide, the pathogen is transmitted by tick nymphs, which are small and frequently unnoticed. The first symptoms are observed 3–30 days after the tick bite and are shown by erythema migrans, i.e. erythematous macule or papule at the site of the bite that gradually enlarges to erythematous annular plaque. This may be accompanied by other disorders like fever and regional lymphadenopathy. These symptoms gradually disappear over 3–4 weeks. In the second, early stage of the disease the symptoms include multiple, secondary annular skin lesions, conjunctivitis, myalgia, severe headache and nerve (particularly facial nerve) palsies. The third stage of the disease is manifested by recurrent attacks of arthritis affecting knees and other large joints, and other neurological disorders, such as encephalopathy, peripheral neuropathy or dementia. Even in medically treated patients persistent or recurrent nonspecific symptoms can be observed.

The tick vector, *I. ricinus* requires high humidity for its development. Therefore, the number of recorded human infection cases is always greatest in forest environments, mainly between May and September. A series of serological studies revealed that markers of infection were always more frequently observed in forest workers than in the general population (Burek et al. 1992).

Tularemia

The disease is caused by a gramm-negative bacterium *Francisella tularensis*. Of three main biogroups recorded in the world *F. tularensis* biogrup *holartica* is predominantly present in Europe and Asia, while *F. tularensis* biogrup *novicida* and the most virulent *F. tularensis* biogrup *tularensis* are found in North America. The tick vector in Europe is *I. ricinus*. In Europe, the number of reported tularemia cases differs between countries, regions of the country, years, and seasons of the year. A detailed study on endemic tularemia in Sweden revealed that in the central counties considered as endemic, the number of reported cases was greater than in the more northern and southern counties. The incidence of infection was much greater in some years (i.e. 1967 – 2,729 cases) than in others (i.e. early 1990s – less than 20), and much greater in August and September than in December till June (Payne et al. 2005). Incubation period of tularemia takes 3–5 days on average. The disease severity ranges from mild to fatal. Disease onset is abrupt with fever, chills, myalgia, vomiting, fatigue and headache. There are several forms of tularemia, such as ulceroglandular, glandular, oculoglandular, oropharyngeal, intestinal typhoidal, and pneumonic. The disease can be dangerous or even life-threatening to humans. Most fatalities are associated with the last two syndromes.

Babesiosis

Babesiosis is caused by a protozoan *Babesia divergens*. The pathogen is transmitted by *I. ricinus*. In endemic areas infections are common. The incubation period ranges from one to several weeks. Disease onset is gradual, and common symptoms include fever, chills, sweats, malaise, headache, anorexia and fatigue.

Splenomegaly and/or hepatomegaly may be present. The illness can last for weeks to months and recovering patients may experience prolonged malaise. Children have a milder form of the disease than adults. Severe disease with fatal consequences occurs in some 5% of patients. The greatest risk for severe symptoms occurs in patients over 50 years old (Buckingham 2005).

Tick-Borne Encephalitis

The tick-borne encephalitis flavivirus (TBEV) is a single-stranded RNA virus. It causes several 1,000 cases of infection in humans annually. Depending on the geographical region the thick-borne encephalitis can be caused by one of three viral subtypes. These are: Far East (formerly called Russian spring-summer) encephalitis, Siberia (formerly west-Siberian encephalitis) virus, and Western Europe (formerly central European encephalitis) virus. The Far Eastern subtype causes the most dangerous illness with fatality rates ranging from 20% to 60% (Buckingham 2005). The thick vector depends on the geographical region and in Europe it is *I. ricinus*.

Prevention of Contacts with Ticks and Their Removal

Pathogens and the related diseases are not evenly distributed throughout Europe. It strongly depends on climatic conditions, and availability of proper vectors and their natural hosts. Nevertheless, any potential contact with ticks should be avoided. Avoiding of humid forest regions with heavy tick infestation, wearing proper cloths and shoes, and using repellents are among the most effective preventive measures. In the case of biting, it seems that the earliest removal of ticks attached to the skin may significantly reduce the chance of successful transmission of the tick-borne pathogens. The easiest way to do this is to grasp the tick with a fine-pointed tweezers as close to the skin as possible. Then, it should be pulled gently, but steadily. It is important to avoid squeezing the body of the tick, which may cause it to regurgitate its stomach contents into the skin, increasing the possibility of infection. After the tick is removed, the site of the bite, hands and tweezers should be treated with a disinfectant. Other methods, such as using fine needles, petroleum jelly, or nail polish to remove ticks are ineffective, can cause irritation of the tick, and regurgitation of the intestine contents into the wound.

4.3.3.2 Insects

Several biological and ecological groups can be distinguished among insects potentially dangerous to human health. They include: (a) *biting species* which, for the purpose of feeding on vertebrate blood, pierce the human skin (mostly dipterans, such as mosquitoes, black flies, louse flies and tabanids); (b) *stinging species* which as a defending response use a stinger to introduce a venom to the intruders' body (mostly hymenopterans, such as bees and wasps); (c) *species covered with protective, venomous hairs* which can be easily broken, inserted into the skin, or inhaled and ingested by the intruder, or even indifferent victim (mainly lepidopterans, such as hairy moths and caterpillars), and (d) *species which produce disturbing poisonous fluids* in their body, which irritates or poisons the enemy (mainly cantharid and some rove beetles). As the type of action and potential consequences may differ significantly, all these groups will be discussed separately.

Biting Blood Feeders

In open green space mosquitoes, black flies and tabanids are among the most important blood feeding insects, which not only annoy people with their biting, but also occasionally transmit human pathogens and can cause serious health problems. Fortunately, in contrast to Africa, Asia, and both Americas, Europe is relatively safe region for the mosquito-, and black fly-borne pathogens. Mass breeding of these insects usually takes place in moist environments, such as water pools, lakes, streams, rivers, etc. However, adults can fly many kilometers from their breeding sites to find a necessary blood meal. In urban areas they are attracted to chemical cues released by human skin.

In most geographical regions mosquitoes are the most frequent blood feeding insects. Males feed on flower nectar and water, while females require blood meals to produce mature, healthy eggs. They 'bite' with a complex stylet. Its functions include piercing of the skin, sucking of the blood, and releasing of saliva into the wound to prevent the blood from clotting. Most people are allergic to this saliva. People exposed for the first time to the bites of a particular mosquito species are first nonreactive, but after repeated bites they become sensitized. At present, it is well documented that whealing is mediated by antisaliva IgE antibodies. Typical local cutaneous reactions to mosquito bites consist of immediate wheals and flares peaking at 20 min, and delayed pruritic papules peaking within 24–36 h. They diminish over several days or weeks. Less frequent large local reactions consist of itchy, red swellings appearing within minutes of mosquito bites, and itchy papules, ecchymotic, vesiculated, blistering, bullous reactions, appearing 2–6 h after the bites. They can persist for days or weeks. The term 'mosquito allergy' is only applied to large local reactions or to systemic reactions such as anaphylaxis, angio-oedema, generalized urticaria, or wheezing. Large local inflammatory reaction, occasionally accompanied by low fever is called 'Skeeter syndrome'. The increased risk of severe reactions to mosquito bites are usually related with (a) a high level of exposure, (b) low or absent natural immunity, like in infants and young children, (c) lack of previous exposure to indigenous mosquitoes, and (d) various types of immune deficiency such as AIDS and malignancies.

The second, most numerous group of blood feeding insects are black flies. During spring and summer their mass emergence can be annoying not only in the forest and other natural areas, but also inside the city, far from the insects' breeding sites. Morphologically, black flies clearly differ form mosquitoes. They are smaller, and stouter than mosquitoes, with shorter antennae and legs. Nevertheless, they walk and fly faster, usually in large numbers. Their larvae live in relatively clean water of streams and rivers, filtrating water plankton. Adult flies swarm near streams or rivers, and fly to other regions with a high concentration of potential hosts, like chicken farms, pastures, camping sites, and urbanized areas. Similar to mosquitoes, fertilized females need blood proteins to complete the development of eggs. They bite and suck blood from various birds and mammals, including people. Their biting is usually more painful to the host, with all other symptoms and consequences similar to those of mosquitoes. Fortunately, in Europe black flies are not as dangerous to human health as in Africa, where several species can transmit human pathogens, including filarid nematodes, responsible for onchocerciasis (i.e. river blindness).

Both groups of these insects can fly many kilometers from their breeding sites to find a necessary blood meal. Therefore, control of their populations would require systematic actions over a large area. This is technically difficult or impossible. As local fogging with chemical insecticides can be effective for only a short time – usually a few hours, personal protection with proper cloths and repellents applied directly to the skin, or cloths should be considered during long walks in mosquito-, or black fly-invaded areas.

Another group of blood feeding insects are louse flies (family *Hippoboscidae*) typically associated with wild forest ruminants, such as deer, elk and other bovine animals or birds. A number of louse fly species can be found in the forest environment throughout the world. Their contacts with humans are usually rare, however, in some regions, such as recently Scandinavia, they can be annoying to forest visitors. The most common species is the deer ked (*Lipoptena cervi*), a common louse fly of red deer, roe deer, elk and sitka deer in Europe, Siberia and China (Dehio et al. 2004). This species has been also accidentally introduced to North America. Adult flies are 5–7 mm long, light brownish in color. Their flat body and special claws help them to move through, and adhere to the hair of their hosts. The insect can fly for only a short distance. After invading the target host, they break off wings and burrow through the fur. Both male and female flies feed on the host's blood. Most of the larval development takes place inside the female body. Mature larvae pupate in the soil or in debris of the hosts' nests. Adult flies can incidentally infest humans and suck their blood (Ivanov 1975). They will not reproduce on any other host than selected ruminants. Occasional bites to humans initially leave little trace. However, within 3 days the site can develop into a hard welt. The accompanying itch and occasionally pruritic papule may last for 2–3 weeks or even longer. Although the direct causative agent for the deer ked dermatitis is not clearly known it is suggested in the literature that some bacteria, such as *Bartonella schoenbuchensis* may be responsible for initiation of this reaction (Dehio et al. 2004).

Stinging Insects

The most important insects in this group, bees and wasps, belong to the order *Hymenoptera*. Morphologically, they are similar to better known flies (order *Diptera*), but can be easily distinguished from them by having two pairs of membranous wings, while flies have only one pair. The ability to sting mainly occurs with social honey-, and bumble bees from the family *Apidae*, and social wasps, such as hornets and yellowjackets from the family *Vespidae*. The stinger present at the abdomen terminus is connected with glands producing venom. Upon contact with the victim's skin the insect inserts the stinger and releases venom into the wound. The composition of chemical substances in the hymenopterous venom, such as active amines, pain-inducing kinins, histamine-releasing peptides, and others can produce a wide spectrum of reactions, ranging from a mild swelling to occasional death of the victim within less than an hour.

Stinging by a single insect usually happens when the bee or wasp is disturbed during its search for food. This can happen throughout the warm season, but most frequently takes place in late summer or fall, when hundreds of yellowjackets are attracted to gardens with maturing tree fruits and to people eating outside. Such a single stinging usually does not inflict any significant health problems. The pain and swelling of the affected skin disappear within a day or two, with no further consequences. However, anaphylaxis resulted from stings to head or neck can, occasionally, be very dangerous, and even fatal within a short time, due to hypotension, laryngal edema, or bronchial constrictions.

Less frequent, however, posing greater threat to human health, are mass envenomations caused by hundreds of insects aggressively responding to intruders disturbing their colony. This can happen by accidental damage to the bee or wasp nests resulted from cutting or breaking trees with nests, or touching nests, which hang on trees. Depending on the colony size the number of stings in massive attacks can reach hundreds. Such attacks may cause systemic toxic reactions and renal failure, occasionally leading to death of the victim. In general, attacks of wasps involve lower number of insects, but they are more dangerous than those of bees. Renal failure or death have been reported in patients, who received 20–200 stings from wasps or 150 to over 1,000 stings from honey bees.

In both groups of insects effects of mass envenomations are similar. Initial symptoms include edema, fatigue, dizziness, nausea, vomiting, fever, and unconsciousness. Systemic damage may develop within 24 h or, occasionally, up to a few days. The systemic effects include changes in levels of various body enzymes, breakdown of blood and muscle cells, renal failure, aberrations of nervous system with symptoms such as muscular aches, cramps, hyperkalemia, hyperglycemia, and hypertension. These effects are reversible, if patients are medically treated (e.g. with dialysis) shortly after the attack.

Visitors to wooded areas should remember that stinging by social insects is usually a defensive response to contacts with an intruder, which accidentally physically disturbed them, or invaded their territory. This reaction is not essential to the insect's development or reproduction. Therefore, it can be avoided or reduced in numbers, if necessary precautions are followed. Any touching, breaking, destroying or even staying close to the bee or wasp nests must be avoided. As mass attacks can only occur near the colony of stinging insects, the best defense is to run away from the colony as quickly as possible. The insects will not continue to pursuit outside their territory. In the case of massive stinging immediate contact with medical personnel is necessary for pharmacological treatment. Patients should remain under observation in the hospital as serious symptoms may appear with a delay of a few days after mass stinging.

Insects Covered with Venomous Hairs

Worldwide, caterpillars, and occasionally adults, of over 150 species, representing 12 families, of moths and butterflies can provoke serious human health problems due to direct or airborne contacts of their poisonous hairs with the skin or mucous membranes. The injuries can range from urtical dermatitis and atopic asthma to osteochondritis, consumption coagulopathy, renal failure, and intracerebral hemorrhage. Although these insects do not posses a stinger, they bear specialized external nettling or urticating hairs, spines or setae to defend against attacks from predators and other enemies.

In the classification of diseases associated with moths or butterflies several categories, such as erucism, lepidopterism, dendrolimiasis, ophtalmia nodosa, and consumptive coagulopathy are distinguished. **Erucism** is a caterpillar-induced dermatitis characterized by localized, pruritic macupapular to bullous contact dermatitis and urticaria caused by contacts with or airborne exposure to caterpillar urticating hairs, spines, or toxic hemolymph (Goddard 2003). **Lepidopterism** is a systemic illness caused by a complex of adverse effects resulting from direct or aerosol contact with caterpillars, cocoons, or moth urticating hairs, spines, or body fluids, and is characterized by generalized urticaria, headache, conjunctivitis, pharyngitis, nausea, vomiting, bronchospasm, wheezing, and rarely, dyspnea (Lamy and Werno 1989). **Dendrolimiasis** is a chronic form of lepidopterism caused by direct contact with urticating hairs, spines, or hemolymph of living or dead pine-tree lappet caterpillars (*Dendrolimus pini*) or their cocoons (Dezhou 1991). It is characterized by urticating maculopapular dermatitis, migratory inflammatory polyarthritis, migratory inflammatory polychondritis, chronic osteoarthritis, and rarely scleritis. **Ophthalmia nodosa** is a chronic ocular condition characterized by initial conjunctivitis with subsequent penuveititis caused by corneal penetration and subsequent intraocular migration of urticating hairs from lymantrid caterpillars and moths, and tarantulas (Cadera et al. 1984).

Many 'hairy' caterpillars feed on forest and urban trees. When present individually they usually do not pose any significant hazard. However, most species with stinging hairs are gregarious feeders and their mass reproduction periodically leads to outbreaks which can expand over thousands of hectares of forest stands, posing real health threat to local dwellers and woodland visitors. In Europe, there are only a few species with potentially dangerous venom hairs. These are moths belonging to families *Thaumetopoeidae* (e.g. *Thaumetopoea* spp.), *Lymantridae* (e.g. *Lymantria* spp., E*uproctis* spp., *Orgyia* spp.), and *Lasciocampidae* (e.g. *Dendrolimus pini*).

*Processionary Moths (*Thaumetopoea *spp.)*

Within the geographical range of Europe, at least three species of processionary moths can be found on trees. The name 'processionary' originates from the specific procession-like way in which caterpillars migrate from the communal nests, where they hide during the day, to feeding places in tree crowns. The insects prefer solitary trees or trees growing at the edge of the forest or park. Therefore, contacts with the park or forest visitors seem very likely. Of the three species two, *Thaumetopoea pityocampa* and *T. pinivora,* live on pines. The third species, *T. processionea* is associated with oaks. Geographical distribution of *T. ptyocampa* is confined to southern parts of Europe, with greatest abundance in the Mediterranean regions. The two other species are also present in central and more northern Europe, but they are less frequent than the previous one. Depending on the species, adult moths fly in late spring or summer. They are relatively large with the wingspan of 30–40 mm, brownish-yellow or grayish-yellow with fine strips on their fore wings. Caterpillars are grayish-green or brownish-green with darker spots. The mass feeding of processionary moths' caterpillars can cause economic and/or aesthetic damage to the infested trees. However, more important and alarming in densely populated urban and recreational areas is the potential threat to human health.

Caterpillars of these insects are covered with poisonous hairs (setae) which upon direct contact with the skin or respiratory tracks cause severe allergic reactions in humans – contact urticaria and, in sensitized individuals, anaphylaxis. The hairs can prick the skin and ocular conjunctiva. When broken away from the insect cuticle they release a fluid containing thaumetopoein, a histamine-liberating toxin which plays a leading role in producing the clinical symptoms of lepidopterism. Although the group of the most often affected individuals includes foresters, cone pickers, and other persons occupationally connected with the forest environment, any individual can develop characteristic symptoms of the allergy. For example in Spain, in a rural area with pine forests, 9.2% out of 653 examined children reported a cutaneous reaction from exposure to processionary moth (*T. pityocampa*) caterpillars (Vega et al. 2003).

Brown-Tail Moth (Euproctis chrysorrhoea)

The insects are usually present on blackthorn and hawthorn, but occasionally they can occur in large populations on oaks and many other tree and shrub species. White moths with a brown or orange-brown tail fly in summer. Females lay eggs on the bark of host trees and cover the egg batches with orange-brown hairs from the abdomen. Young larvae hatch from mid-August on and start feeding together in large groups. They construct silk tents in which they shelter during unfavorable weather and during winter. The feeding is resumed next spring, when new foliage develops on host plants. Older caterpillars are solitary. Gregarious feeding of the brown-tail moth caterpillars can cause substantial defoliation of infested trees. However, frequent presence of this species on trees close to human dwelling creates a direct threat to human health as the poisonous hair of both the adult moths and caterpillars can evoke severe allergy, similar in symptoms to that described for processionary moths. Direct contacts with the hairs of brown-tailed moth caterpillars produced dermatidis in about 70% of tested persons. It is suggested that both the toxic and mechanical actions of the nettling hairs are responsible for the human skin pathology (de Jong et al. 1975).

Gypsy Moth (Lymantria dispar)

This moth (Photo 4.2) is considered an important and often destructive pest for forests. Mass feeding of caterpillars can also frequently damage foliage of a wide range of tree species in the urban environment. The insect is present throughout Europe and has been introduced to North America. It overwinters in the stage of eggs deposited in large clusters on tree bark, wood fences, garage doors, etc. and covered with female body hairs. The larvae hatch in late April and May. They develop for 2–3-months feeding on newly developing buds and leaves. Adult moths start to fly from late July on. The insect's caterpillars are covered with long hairs which break easily and can stick to the skin or fly in the air. Usually no direct negative effects of gypsy moths on human health are observed. However, during mass outbreaks of this insect in various regions of the United States, frequent dermatitis (itchy skin rash) has been recorded in a large proportion of the population, reaching up to 42% among school children (Tuthill et al. 1984). Tiny first-instar larvae showed to be particularly allergenic (Anderson and Furniss 1983). Although skin rash was the predominant effect in such reactions, other allergic-like symptoms including rhinitis, irritation of the eyes, and shortness of breath were also reported.

Pine-Tree Lappet Moth (Dendrolimus pini)

This species is widely distributed and very common in Europe and northern regions of Africa and Asia. It is frequently recorded as a dangerous pest of pine with the ability to produce mass outbreaks. Moths fly from June till August. The larvae feed on needles from September till November and then again from early spring till June. Mature caterpillars are up to 8 cm long, gray to dark brown with distinct markings on segments. They are covered with long brown and silver hairs, which can break. This insect can occasionally cause dendrolimiasis, which is a chronic form of lepidopterism. The symptoms include urticating, maculopapular dermatitis with joint swellings and pain, fever and chills, migratory inflammatory polyarthrits and polychondritis (Dezhou 1991). In general, contacts with dead caterpillars were more dangerous than those with living insects. Surprisingly, outbreaks of dendrolimiasis have been reported only from several locations in central and southern China, so far. As this insect has a wide geographical range, such outbreaks can potentially happen in other locations, including Europe, as well.

General Recommendations for Management of Caterpillar Envenomation

Most caterpillar exposures can be prevented by simple personal protective and domestic measures. In general, one should refrain from directly touching any hairy caterpillars met in the garden, park or forest. Particularly, children should be warned not to do this. During peak larval-instar season visits to the infested sites should be avoided or reduced as the first-instar larvae, and hairs or shed skins of older caterpillars, are blown around by the wind. If human dwellings are located close to the infested trees, the windows should be kept shut, and drying of clothing outside avoided. Any pruning of trees and shrubs, if necessary, should be carried out in protective cloths with long sleeves, using gloves, and hat. After the contact, management of most caterpillar stings includes: (a) immediate soap-and water washing of the sting site to remove toxic hemolymph and any loose urticating hairs; (b) 'no touch' drying of the sting site with a hair dryer, not a towel; (c) gentle stripping of the contact site with cellophane or adhesive dust tape; (d) application of ice packs with cooling enhanced by initial swabbing with isopropyl alcohol or ammonia; (e) topical and oral antihistamines; (f) topical and oral corticosteroids; and (g) oral or intramuscular antihistamines and corticosteroids, if indicated for prolonged, allergic reactions (Diaz 2005b).

Blister and Oil Beetles

Blister beetles, which include some species of *Meloidae*, *Oedemeridae* and *Staphilinidae*, are another group of arthropods that can cause dermatitis in humans. The adult insects are approximately 1–3 cm long, and can be of various colors, frequently metallic blue, green or coppery. When disturbed, brushed, pressed, or crushed they excrete a fluid which can irritate the skin. The symptoms include extensive skin lesions with erythema, slight oedema and confluence of flaccid bullae and pustules. The eruption occurs within hours after the contact and lasts for 3–6 days. These reactions are caused by cantharidin, a toxic substance produced by blister beetles from families *Meloidae* and *Oedemeridae*. Cantharidin can be taken up through the skin and mucous membranes, but it is also highly toxic by ingestion. The poisoning is called cantharidism. The toxin is absorbed through the intestine. Symptoms range from mild depression or discomfort, sweating, anorexia to severe pain, gastroenteritis, nephritis, shock and death. Massive doses of cantharidin cause shock and death within 6 h (Helman and Edwards 1997).

In Europe, the most common blister beetles are *Lytta vesicatoria*, which feed on leaves of ash and olive trees, and *Meloe proscarabaeus*, frequently found in the forest litter. In southern regions of the continent, such as Turkey and northern Italy, periodic human dermatitis is caused by a blister rove beetle, *Paederus fuscipes* (Brazzelli et al. 2002). This is predacious and scavenger species which feeds on debris and dead larvae of other insects in sandy soil near water. *P. fuscipes* is specific because the beetles produce a toxic chemical substance called paederin. The dermatitis caused by *P. fuscipes* is characterized by a more violent cutaneous reaction, with prominent urtication and a burning sensation prior to blistering.

4.3.4 Snake-Related Effects

Among almost 40 species of snakes inhabiting Europe only a few vipers (family *Viperidae*) are venomous, and contacts with them can be dangerous to people, or pets walking in the open green space. Most of these animals live in southern and central parts of the continent, while only one species, i.e. the common adder (*Vipera berus*) expands its geographical range to northern regions. Bites of European vipers usually are not as frequent and dangerous as those of their relatives from other continents, however, many cases from European countries are reported. If not quickly and properly treated, they can be life-threatening or even fatal. Therefore, snake bites always must be considered serious, as the probability of misidentification of venomous vipers with other non poisonous snakes is always great. Moreover, injured people are unaware of the cause of the bite or of the sting. Particularly, if they are children, they rarely can identify the snake.

The main differences between vipers and other nonpoisonous snakes include a triangular head, vertical pupils and one or two fang marks at the bitten area. Sometimes venomous snakes bite without venom, (dry bites), so not all bites result in envenomation. The popular habit of using tourniquets or sucking or making incisions at the bitten area is useless and dangerous. Therefore, it is not recommended. Bites caused by venomous snakes always are an emergency and require fast examination and appropriate medical treatment. The medical action is usually based on signs or symptoms actually present; antivenom is used only in more serious cases.

Vipers prefer wooded terrain, grassy fields, or rocky slopes. They frequently hide under stones and dead trees, or rest on the surface of warm stones during sunny weather. Bite incidences usually result from touching or accidental stepping on the animal. All vipers prey on small animals, such as insects, frogs, lizards, birds and small mammals, mostly rodents. Major functions of the highly toxic venom produced by a pair of special oral glands, and injected into the wound through the viper's fangs, are to immobilize the prey, and in some cases to initiate the process of digestion by breaking down the prey's tissues. The venom is also used in the animal's defense and, in fact, attacks against people are usually just a defense response. It should be mentioned, that most of the snake species present in Europe are not aggressive, and they prefer to retreat into nearby vegetation instead of attacking.

Besides the immediate pain, snake bits can be dangerous because of both the envenomation of the victim's body, and potential contamination of the wound with pathogenic microorganisms present in the snake's mouth. Each species of venomous snakes has a unique composition of the venom with a range of enzymes, including proteolytic enzymes, phospholipases, and hyaluronidases, as well as polypeptide toxins, glycoproteins, and other toxic compounds, which disrupt normal functions of the envenomated organism and break down its tissues. In general terms, venoms are classified as either neurotic, which affect nervous system, or hemotoxic, which affect the victim's circulatory system. However, in many snakes compounds from both groups are present in the venom. Viper bites trigger a series of symptoms in the victim, such as pain, swelling and discoloration of the skin around the bite region. There are also reports of dizziness and tingling. Although with European species fatalities are rare with proper treatment, envenomation may result in a wide spectrum of other clinical manifestations including local tissue destruction, cardiovascular collapse, and coagulopathy.

Among venomous snakes the common adder (*V. berus*), long-nosed adder (*V. ammodytes*), and Orsini's viper (*V. ursinii*) are probably the best known species in Europe. The most dangerous species is the long-nosed adder which lives mostly in south-eastern regions of the continent. It has a characteristic, single 'horn' on the snout. This species can pose a significant medical risk (Jackson 1980) with fatalities recorded in regions with its high populations, such as Balkans (Street 1979).

Although not as dangerous as the previous species, because of its wide geographical range and frequent presence in densely populated areas, the common adder is responsible for relatively high numbers of bitings in central and northern parts of Europe. For example, in Sweden there are estimates of some 1,300 bites annually with about 12% that require hospital treatment (Mallow et al. 2003). The envenomation symptoms include immediate and intense pain, followed by swelling and a tingling sensation. The swelling may spread to the whole limb, or trunk, and particularly for children, to the entire body. Other systemic symptoms resulting from anaphylaxis, such as nausea, vomiting, abdominal colic and diarrhea, sweating, fever, and loss of consciousness can also occur. Fatalities are rare.

Venom activity differs between viper species. In some of them, like in the Orsini's viper, it is not particularly dangerous to humans. Nevertheless, all snakes should be treated with caution, and direct contacts with them possibly avoided. In order to avoid snake bites it is advisable not to touch or play with them. It is better to remain at a safe distance – at least two lengths of the snake body. Boots and coarse, long trousers should be worn during trips to wild woodlands. As most snake bites concern hands and legs, it should be recommended not to put them into hidden places, which were not visually inspected before.

4.3.5 Predatory Mammals-Related Effects

Historically, the big predators, such as wolves and bears were probably the most feared animals in Europe. However, at the present their populations have been significantly reduced in numbers and their presence is limited to very restricted areas, usually of nature reserves and national parks. Therefore, potential encounters of these animals in wild are extremely rare. However, in cases where an area of human activity overlaps with the territory of a predator, occasional conflicts can occur.

The largest predator in Europe is the brown bear (*Ursus arctos*). This species is native to Asia, Europe, North Africa, and North America. In Europe, there are some 14,000 brown bears in several separate populations, from Spain in the west, to Russia in the east, and from Scandinavia in the north to Romania and Bulgaria in the south (Zedrosser et al. 2001). Bears are extinct on the British Isles and threatened with extinction in France, Spain and most of Central Europe. The largest population of brown bears in Europe, outside Russia, is the Carpathian population estimated at 4,500–5,000 individuals. Brown bears are omnivores feeding on a variety of food. Their diet is based mainly on vegetable components (berries, nuts, roots, fungi) which can constitute up to 90% of the food taken. Frackowiak and Gula (1992) found that in spring beech nuts may constitute up to 78% of a bear diet. The rest is covered mostly by insects, fish and small animals. Despite the general opinion bears are not frequent carnivores. Brown bears can occasionally prey on red and roe deer, and moose. In such cases they usually attack young and weakened animals since they are easier to catch.

It should be remembered that bears are very powerful. Large individuals can break a spine of a fully grown animal such as deer or elk. Moreover, in spite of their big size brown bears can run at speeds of over 50 km/h. Therefore, the attempts to escape from attacking bear may give a very limited protection. Although, in general not aggressive, when provoked bears can be really dangerous to people. However, worldwide records of human fatalities caused by bears are not frequent. In North America, on average two cases of fatal bear attacks on people are recorded annually. In Europe, human fatalities are even less frequent. For example, in Scandinavia there were only four such attacks reported during the last 100 years. According to results of the Scandinavian Bear Research project the following situations are potentially dangerous: (1) meeting of an injured bear, (2) a sudden appearing in front of the bear, (3) meeting a bear in its cave, (4) meeting a bear who has been provoked. There are also some special situations where human and bear encounters are possible. Bears are attracted to human settlings in a search for potential food sources. They dig in garbage dumps and trash cans, or venture into farmers dwellings or barns. If they are successful in finding the food within the range of human settling, they can associate these signals and continue returning. Occasionally, they can also kill and eat farm animals, mainly sheep.

The second largest predator after the brown bear is the gray wolf, *Canis lupus*. It lives in communities of family packs within clearly defined territory. Wolves are intelligent and usually prefer to avoid confrontations with people. However, in the past their prey frequently included farm animals, and therefore during nineteenth century wolves were persecuted in central and northern European countries. This led to significant reduction of their populations. After the introduction of partial or full protection of this animal, the wolf is recovering naturally in several countries. There are estimates of between 10,000 and 20,000 wolves in Europe. At the present, the biggest populations are found in eastern European countries.

Packs of wolves hunt on various large herbivores within their territories. Although they are well organized in such hunting packs, success of attacks is usually low and they have to hunt continuously to sustain their populations. Depending on the region, the wolves' diet includes deer, moos and other large ungulates (Smietana and Klimek 1993; Okarma 1995). Solitary individuals depend more on smaller animals, mainly rodents.

Although wolves rarely attack humans, the causes of wolf attacks may vary greatly. Habitat loss for example may result in diminishing of the wolf's natural prey. Subsequently, it may cause the local populations to turn to attacking livestock, or on some rare occasions, even people. Close proximity to humans may also cause habituation. In this case, wolves lose their fear of humans and consequently approach too close. Habituation also happens when people encourage wolves to come up to them, usually by offering them food. Habituation can also occur accidentally. Unrestricted hunting, forest clearing and intensive livestock grazing reduce availability of natural pray. Such situation forces the wolves to feed on domestic animals and garbage, then bringing them in close proximity to humans. However, wild wolves are usually scared of adult humans, and they try to avoid contact with them. Most of historical and present-day data on attacks by healthy wolves indicate that victims were mainly (90%) children under the age of 18, and especially under the age of ten (Linnell et al. 2002). In the few cases when an adult was killed, it was almost always a woman. In contrast, rabid wolves attacked mostly adults, and mainly man.

Fortunately, due to numerous changes in the environment and management of wolves' populations, attacks on humans by gray wolves are very rare at the present. Only 17 fatal cases have been recorded in Europe and Russia during the recent 50 year period (Linnell et al. 2002). As the main factors associated with wolf attacks on humans are rabies, habituation, provocation, and highly modified environment with a reduced availability of pray. Avoiding such situations in wolf management programs seems to be the best solution for organizations responsible for human safety. For individuals living in or visiting areas inhabited by wolves avoiding of direct contacts with any 'friendly-tempered' animals, which could be rabid, feeding them, provoking or entering their den with pups are probably the most important rules of personal safety.

4.3.6 Human Diseases Induced by Pathogens and Transmitted by Forest Mammals

Although wild mammals and birds can carry a large number of human pathogens from various taxonomic groups, including viruses, bacteria, protozoa, flatworms, and nematodes, in most cases transmission of these factors to humans is impossible through simple contacts. They usually require additional vectors, such as the earlier mentioned ticks (e.g. tularemia, borreliosis) and insects (i.e. viral encephalitis, filariasis), or direct consumption of the infected meat (e.g. trichinosis caused by a nematode *Trichnella spiralis*). However, some of the pathogens transmitted by mammals and birds can be acquired by humans as a result of neglected hygiene (like in the cases of a flatworm *Fasciola hepatica*, and tapeworms *Echinococcus spp.*) and bites or other direct contacts (e.g. rabies virus). Such situations can occasionally happen during visits to the forest or other open green spaces. Rabies and alveolar echinococcosis are discussed her to illustrate the problem.

4.3.6.1 Rabies

Rabies occurs in all continents except Antarctica and some islands (Rupprecht et al. 2002). In recent years it has been eradicated from many western European countries. However, WHO reports indicate that the number of rabies cases in wildlife has increased recently in Europe, particularly in eastern and northern areas.

The number of 4,269 cases reported in 1999 has increased to 7,095 in 2003 (WHO 2004). This is partially attributed to the dynamic growth of the populations of rabies vectors. In Europe the most important vectors are red foxes (*Vulpes vulpes*) and raccoon dogs (*Nyctereutes procyonoides*) (Holmala and Kauhala 2006). The later species was once limited to Russia, but it has recently spread to eastern and central European countries.

Rabies can infect all species of mammals, although their susceptibility varies significantly. Domestic dogs constitute the largest group of infected mammals. In European wildlife, besides red foxes and raccoon dogs, rabies also occurs in wolves (*Canis lupus*), arctic foxes (*Alopex lagopus*), badgers (*Males males*), pine martens (*Martes martes*) and polecants (*Mustela putorius*). Other species are infected only occasionally. Birds, reptiles, amphibians, and fish do not acquire this disease. Rabies is caused by a virus that attacks the brain. The virus enters the body through the saliva of infected animals, usually by a bite. It can also be transmitted, if infected saliva gets into an open wound or splashes into mucous membranes, such as those in the eyes, nose, or mouth. After the entry, the virus travels along nerve cells to the brain. It replicates there and moves to the salivary glands. The cycle is repeated when the animal bites a person or another animal. Rabid animals may be aggressive and vicious, or lethargic and weak. In people, early rabies symptoms of fever, headache, and fatigue are followed by confusion, agitation, hallucination, and paralysis. Once symptoms begin, the disease is almost always fatal.

Most healthy wild animals will try to avoid contacts with humans and escape even upon sight contact. If they are infected with rabies, they become more sluggish and 'friendly', however, they can bite at any time, when close enough or touched by another animal or a person. This can happen in the forest, urban park or even in the backyard where both domesticated and wild animals have access. Therefore, direct contacts with mammals, particularly those of the dog family, should be avoided in open space. If any biting took place, it is necessary to rush for a medical examination and appropriate treatment.

4.3.6.2 Alveolar echinococcosis

Alveolar echinococcosis caused by a tapeworm *Echinococcus multilocularis* is one of the most important emerging zoonoses in Europe. The fatality rate is greater than 90% in untreated patients. Over the last few decades, the distribution range of the tapeworm *E. multilocularis* in Europe has expanded from mostly eastern and central regions (Czech Republic, Slovak Republic, Belarus, Hungary, Poland, Romania and Estonia) to the west (Germany, Denmark, Belgium, The Netherlands, and Luxemburg). In the tapeworm's lifecycle the definitive hosts, which are canids, acquire adult worms in their intestines, but are relatively unaffected by the infection. In intermediate small mammal hosts, however, the larvae develop in the liver, leading to the host mortality. Transmission of the tapeworm larvae into the human population is accidental, as the human host is not an essential part of the lifecycle of the tapeworm (McCarthy and Moore 2000). In Europe, the list of definitive and intermediate hosts includes the red fox, arctic fox, wolf, raccoon dog, wildcat, vole, water vole, earth vole, house mouse, and musk rat. The red fox seems to be the most frequent definitive host. Examination of intestinal tracks of red foxes shot in eastern and western regions of Estonia revealed the presence of adult stages of *E. multilocularis* in 29% of the shot animals (Moks et al. 2005). After maturation in the definitive host the terminal proglottids filled with eggs are released to the environment with feces. The eggs ingested by small herbivorous mammals feeding on contaminated vegetation hatch into larvae, which enter the bloodstream. In subsequently infected organs (e.g., in liver) the larvae develop into cysts. The lifecycle is completed, when the infected small mammal is consumed by the canid definitive host, and develops into the adult tapeworm in its intestine. Humans can be accidentally infected through contacts with the parasite eggs present on unwashed berries of forest fruits, or through the pet dog, that could have acquired the parasite larvae by eating small rodents. Therefore, strict hygienic precautions are essential during visits to the forest and before eating any wild fruits collected there.

4.4 Conclusions

Although trees, parks and forests provide many benefits to human health and well-being, there are also a number of factors which can occasionally play a negative role, and make visits to these environments unpleasant, health-affecting, or even life-threatening to humans.

These factors can be directly or indirectly related with the presence of trees, and, therefore, their management requires specific approach from both the green space administration and the visitors.

A wrong selection of tree species for planting in specific (e.g. urban) environments, and their unsuitability for these environments' biological and physical characteristics, can result in spreading of allergenic factors, increase of susceptibility to pests and pathogens, lowering of resistance to air pollution, wind and excessive snow load, and increased probability of unexpected breaking or premature death and falling of individual branches or whole trees.

The lack or poor quality of a strategy for plant protection undertaken by the green space administration can lead to reduction of vitality and premature loss of the affected trees. It may also directly threaten the health of visitors, if an improper choice of pest and/or pathogen control methods has been made.

Green spaces are living environments for many plants and animals. Some of them can directly (e.g., poisonous plants and fungi, mosquitoes, bees and wasps, venomous vipers) or indirectly (i.e. ticks, insects, birds, and mammals transmitting human pathogens, caterpillars covered with venomous hairs) affect human health. Since complete elimination of these factors by the means of tree and forest management techniques is practically impossible and unreasonable, it is necessary to develop an effective warning system for green space visitors to inform them about necessary precautions, and recommend personal solutions to be considered, if their visits are to be pleasant and rewarding to their physical and mental health.

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Part II
Physical and Mental Health and the Experience of Nature

Chapter 5
Health Benefits of Nature Experience: Psychological, Social and Cultural Processes

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Abstract In this chapter we consider how experiences of nature can affect human health and well-being. We first address the matter of 'what has been'; that is, we sketch the development of theory and research concerned with health benefits

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of natural environments, from ancient times to the current situation. This shows the current research to be a recent expression of a number of long-running, intertwined, social and cultural processes. We then discuss ‘where we are now’; that is, we overview current theories and related research concerning processes through which nature experience might provide health benefits. These processes concern environmental preferences, psychological restoration, and learning and personal development. Finally, we consider ‘where we are going’; that is, we consider some additional directions for research and we identify some issues that research will have to address in the foreseeable future.

5.1 Introduction

Trees and forests affect human health in a variety of ways. They help to preserve people’s health by maintaining air quality, by providing nutritious foods and medicinal substances, and by protecting homes, crops and vital infrastructure from intense sunlight, high winds, and flooding. They also challenge health by discharging pollen, harboring disease-bearing insects, and posing hazards from fire and falling objects. In addition to such physical and biochemical influences, discussed in Chapters 2, 3 and 4 of this book, trees and forests affect health in ways that primarily have to do with people’s behavior and experiences. For example, surveys in numerous countries have found that many people like to visit natural areas such as forests, and that they do so to relax and ease feelings of tension. Behavioral and social scientists have taken interest in these common activities and valued experiences, and they have offered various explanations regarding their implications for health. These explanations have focused on phenomena such as environmental preferences, attention restoration, stress recovery, and personal development. The purpose of this chapter is to overview some of the most widely used of these theories and related empirical research.

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The ideas and theories discussed in this chapter differ in important respects from the explanations for benefits of trees and forests that are presented elsewhere in this book. For one, they do not focus only on trees and forests but also consider benefits for health related to the natural environment in general. Also, they consider other aspects of health; in addition to physical illness and wellness, they address various psychological and social aspects of health, such as emotional well-being and connectedness. Further, in explaining how the natural environment can benefit health, they invoke variables that have an abstract character. Much as ‘intelligence’ cannot be observed directly but is instead studied using tests on which people demonstrate their personal levels of intelligence, the phenomena discussed here, such as ‘stress’ and ‘restoration’, are studied indirectly with measures of cardiovascular activity, performance on standardized tests, statements about current feelings, and other indicators of psychological and physiological states.

In the following, we set the stage by providing some fundamental definitions. We then address the matter of ‘what has been’; that is, we sketch the development of theory and research concerned with health benefits of natural environments, from ancient times to the current situation. We then discuss “where we are now”; that is, we overview current theories and related research concerning psychological processes through which natural environments might provide health benefits. In doing so, our aim is not to exhaustively review the literature but to give readers a sense of the field of inquiry as it looks today and some points of entry into the literature. Finally, we consider ‘where we are going’; that is, we consider some additional directions for research and we identify some issues that research will have to address in the foreseeable future. Some of those issues are salient in policy, planning, and health care contexts in which ideas about health benefits of natural environments are put into practice. Our discussion of those issues will open for the discussion of relations between theory and practice in Chapters 6 and 7 of this book.

5.2 Fundamental Definitions

5.2.1 From Trees and Forests to the Experience of Nature

Most if not all of the theories covered here realistically assign importance to the objective physical environment, but they focus primarily on subjective aspects of the experience of the environment. People are continuously engaged in perceiving, evaluating, and assigning meaning to the events and conditions in the world around them. Their perceptions and evaluations, the meanings that they assign, and their actions can all be seen as contributors to processes through which the environment becomes linked with health. Without denying the importance of objective environmental features, we thus focus here on environments as people experience them. In particular, we focus here on the experience of ‘nature’.

The concept of nature has a broad range of meanings, from the intrinsic character of things to the whole of the physical universe (Gurthrie 1965; Naddaf 2006).

In line with the ideas, theories and research that we will come to discuss, the focus here is on a relatively narrow band of meanings assigned to nature. We are particularly concerned with nature as the seemingly natural features and processes that people ordinarily can perceive without the use of specialized instruments or sensory aids. This is the nature of trees and forests, other kinds of vegetation, animals and their creations, wind, sunlight, clouds and rain, changes in the landscape with the seasons, the flow of water in rivers and streams, tidal and wave action at shorelines, and so on.

This meaning of 'nature' overlaps substantially but not exactly with the meaning of 'natural environment', which is commonly used to refer to a large outdoor area with little or no apparent evidence of human presence or intervention (Pitt and Zube 1987). The natural environment is commonly contrasted with the built environment, as comprised of houses, streets, squares and other artifacts. In the literature that we will discuss, the terms 'nature' and 'natural environment' get used somewhat interchangeably, although, in a seeming contradiction, the nature of interest here is not only found in natural environments, but also in otherwise built environments. In addition to the experience of a person walking along a path through an otherwise untouched forest, we also take interest here in the experiences of people who might see potted plants indoors, or who might look through a window at trees along the street outside. This is not the only seeming contradiction. Some environments that people might consider to be natural are in fact as thoroughly designed, shaped, and organized as any urban centre; however, because they consist of trees, other vegetation, and perhaps other natural-appearing features, and so appear distinct from the built environment of buildings, roadways, and other constructed features, they may be perceived as natural. People may enjoy urban parks, botanical gardens, and golf courses as representations of natural environments, while still knowing of their artificial character.

Despite the wide range of variation in the environments and environmental features of interest here, most of the research that we will discuss has concerned places that most people can ordinarily experience. Some kinds of natural environments are seldom visited. The experiences of people who venture into polar regions, deserts, high mountains, high seas, jungles, and other wild, little populated places are relevant here, but much of the literature that we will discuss concerns natural environments and features of nature that are benign, familiar, close to home, and shared with other people. At the same time, most if not all of the literature concerns the experiences of people in urbanized societies who may be less sensitive to subtle differences between the natural and artifactual than, for example, indigenous people who live continuously in 'natural' environments.

Finally, the terms 'natural environment' and 'natural landscape' or simply 'landscape', also get used interchangeably in some of the literature we will cover. The word 'landscape' typically refers to a view over or into an area of land, or the area and landforms encompassed by a view (Daniel 2001). Unlike the definition of natural environment, which typically excludes apparent human artifacts, the definition of landscape is open to human involvement; this is reflected in designations such as 'cultural' and 'pastoral' that are often attached to landscape. Research and practical efforts do however often focus on the visual aspect of a natural environment (i.e., the natural landscape) and in doing so they treat people as viewers who might appreciate natural scenery. In line with this emphasis on visual experience, we also take interest here in representations of natural environments and features in a wide range of visual media, including landscape paintings, photographs, films, video and virtual nature. With these representations, a person might have the sense of being within a natural environment or recall an experience in a natural environment, while in some objective sense being situated in a completely artificial environment.

This is hardly an exhaustive treatment of the complexities involved with the definition of nature, natural environment and landscape. Those who want to read further on these matters can turn to, for example, Wohlwill (1983), Evernden (1992), Mausner (1996), and Eder and Ritter (1996) For present purposes, it should be clear that we are concerned with environmental entities as they are perceived, evaluated, and invested with meaning by individuals who are embedded within a socio-cultural context.

5.2.2 Health and Well-Being

The World Health Organization (WHO) has defined health as 'a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity'. This definition has been disseminated widely, and it has had the support of the WHO since its publication in the organization's Constitution in 1948. It has, however, also been criticized as utopic and unrealistic. For present purposes, this definition of health has several heuristic advantages. First, in that it calls attention to a person's physical, mental, and social condition, it affirms a view of health as multi-dimensional. This implies that people can enjoy relatively good health or suffer relatively poor health in different ways at the same time (cf. Antonovsky 1979). For example, a person who is physically and mentally fit may still have relatively poor health because he or she is socially isolated or the target of discrimination. A view of health as multi-dimensional invites consideration of how it arises from the interplay of physical, psychological, social and environmental factors.

Second, the WHO definition calls attention to subjective aspects of health, since well-being has a crucial subjective aspect. The level of subjective well-being can be seen as an aggregate of psychological sentiments and evaluations of one's own life (Kahneman et al. 1999). As such it has emotional and cognitive components that relate to affective features and evaluations of the person's circumstances (Diener 2000; Diener and Lucas 2000). Some of these components may be trait-like in that they remain steady over time and situations, while other components of subjective well-being may change as the immediate situation changes (Becker 1994). Attention to subjective aspects of health helps one to appreciate how psychological, social and cultural factors can come to work in chronic ill health as well as the maintenance of good health under trying circumstances.

Third, by defining health with regard to well-being rather than an absence of symptoms, the WHO definition affirms the importance of preventive as well as curative measures. This, together with its acknowledgement of the multi-dimensional character and subjective aspects of health, implies the need for a greater variety of actors in the health enterprise than does a definition that frames health in terms of symptoms in need of treatment. Medical professionals will continue to play a key role in caring for the sick, but additional actors can come to share with them responsibility for preventing illness and promoting well-being in individuals and populations. The preventive work can aim at positive as well as negative aspects of human-environment relations. For example, environmental health professionals can promote health not only by identifying and removing toxic agents, but also by identifying salutogenic features of environments, including possibilities for experiences of nature (Frumkin 2001). This said, disease prevention and health promotion should not only be delegated to professionals. A definition of health that acknowledges its subjective aspects implicitly places some responsibility on the individual (see WHO 1986). Individuals are expected to do more than simply turn up at the doctor's office in the hope of a cure when things turn bad. Aside from acquiring knowledge about endogenous determinants of health such as personal genetic attributes, the individual assumes some responsibility for exogenous determinants such as life-style (e.g., diet, smoking, exercise), social environment (e.g., friends and family ties), and physical environment (e.g., housing, proximity to natural areas) (de Hollander and Staatsen 2003). Not all of these things are under the control of the individual, of course, and different professionals working on disease prevention and health promotion will continue in their effort to establish and maintain social and environmental preconditions for mental, social and physical well-being. These issues will be addressed at greater length in Chapters 6 and 7 of this book.

5.2.3 On Processes that Link Nature with Health and Theories About Them

People commonly are not satisfied with the simple fact of a relationship among things; they want to know how that relationship became established. A theory offers an explanation. Most if not all of the theories of interest here describe some process, which we take to mean a sequence of changes in the attributes of a system. At the same time, a theory offers a basis for predictions that relate causes and consequences; if in the future one should change some attribute of the system, then one has a basis for expecting that another change will follow in a prescribed manner. Because knowledge of the causes and consequences may have practical value, a theory may come to have practical value if predictions based on it are accurate.

The theories of primary interest in this chapter concern psychological processes. For example, we will overview theories that concern processes through which a person restores a resource that is needed to meet the demands of everyday life, such as the ability to direct attention. Such theories may stand on less solid ground than physical or biochemical explanations for health effects of trees and forests because the variables thought to mediate or transmit environmental effects must be inferred from observations of people's behavior. Nonetheless, the further development and use of such theories is justified by their potential practical value, not to mention satisfaction of the desire to understand the phenomena.

The processes of interest here engender benefits that can be described as preventive or therapeutic, depending on whether the people who realize those benefits already enjoy relatively good health or are recovering from some illness. The preventive benefits are typically intermediate to later outcomes; that is, when a person realizes those benefits repeatedly over time, those benefits may cumulatively come to decrease the likelihood that a person will suffer some form of ill health. For example, if psychological stress goes uninterrupted and becomes chronic, then it may contribute to a variety of health problems in the long run, such as depression or cardiovascular disease. A person who walks in a forest may experience psychological restoration and so for a short time alleviate the experience of stress. One walk in a forest may do little for health in the long run, but regular walks in a forest, and so regular psychological restoration, may cumulatively reduce the odds of becoming clinically depressed or developing cardiovascular disease. Therapeutic benefits of nature experience are also intermediate to 'harder' health outcomes, though typically over a shorter span of time; they may cumulatively help a person to recover from illness more quickly or completely.

All of the processes of interest here occur within the course of some activity. Some activities, and in particular physical activities, are of themselves thought to promote health, and it may be difficult to separate their effects from the effects of the environment. For example, people commonly walk or run to reduce stress, and they commonly choose relatively natural settings with high restorative quality in which to perform those activities. With their choice, eventual stress reduction attributable to the experience of the environment joins with stress reduction attributable to the physical activity. If they were to run or walk along a street with sometimes heavy car traffic, then their experience might be one of irritation and displeasure rather than reduced stress, and the benefit of the physical activity would be questionable, exposure to polluted air aside (see e.g., Bodin and Hartig 2003; Hartig et al. 2003; Pretty et al. 2005). We will not say more on this point here, as the health benefits of physical activity in natural areas are in focus in Chapters 8, 9 and 10 of this book. In the present chapter we will not focus on specific types of activity, but rather on the psychological process carried within different activities through which a person comes into an experience of nature. We thus treat beneficial processes as independent of specific forms of activity.

5.3 Historical Background

Scientific research explicitly concerned with nature experience and health may have a relatively short history, but the idea that the experience of nature is beneficial for health has deep roots in diverse intellectual and professional traditions. In this section we consider those roots; we address the matter of 'what has been' by looking at the development of thinking on the topic, particularly in Europe and North America. That development has been underway since ancient times and has many complexities, so we cannot do more here than superficially sketch some of its significant aspects and milestones. This sketch will nonetheless suffice as background for the current situation, in which societal trends have converged with developments in diverse scientific and professional fields to stimulate and enable more systematic study of nature experience and health.

5.3.1 The Evolution of the Health Sciences

To begin with, we can place the development of research on nature and health partly within the more general evolution of the health sciences. An early milestone is *Airs, waters, places*, a text traditionally attributed to the physician Hippocrates of Cos (460–370 BC). This seminal work in epidemiology explained that the diseases which afflict the population of a city can be understood through reference to the city's environmental circumstances, such as proximity to stagnant water and exposure to harsh winds. It also called for attention to the particulars of the locations being considered in the planning of a new city, so that the living conditions of future residents would be salubrious rather than harmful. The author of *Airs, waters, places* did not address the processes of particular interest here, but he did emphasize that particular natural conditions were conducive to population health, and he acknowledged the relevance for individual as well as population health of lifestyle factors such as diet, work, and recreation (for further discussion, see Buck et al. 1989).

The health sciences developed through several eras, each with characteristic notions of disease and approaches to prevention (see e.g., Catalano 1979; Rosen 1993; Susser and Susser 1996). The conception of physical and mental disorder as an expression of imbalance among the four humors (blood, black bile, phlegm, and yellow bile) may have predated Hippocrates, but it was still in use into the nineteenth century, perhaps because it entailed recommendations for moderation in lifestyle practices and attention to environmental causes of humoral imbalance that seemed to be effective. A successor, miasma theory, attributed epidemic diseases such as cholera to bad air emanating from sources such as foul water. This motivated sanitary reform measures such as sewage systems and protected water supplies. These were successful, albeit for reasons other than dispelling bad air. Scientists eventually caught on (in the case of cholera, Filippo Pacini in 1854, Robert Koch in 1884), and the germ theory they advanced proved a successful approach to understanding infectious illnesses. Germ theory did not however provide an adequate explanation for the chronic illnesses, such as cardiovascular disease, that came to replace infectious illnesses as the major causes of death in many countries. Instead of searching for a single necessary exposure, health scientists had to disentangle the complex interplay of lifestyle, genetic, and environmental factors during the life course. Psychological and social aspects of health and illness, such as stress and social support, received increasing amounts of attention, and new concepts and methods became available for the study of nature experience and health.

5.3.2 Intellectual, Economic, and Demographic Trends

The development of ideas about nature experience and health also aligns with a number of long-running, intertwined societal trends. During the time that humoralism was the dominant account of personality, health and disease, changes were underway in Europe that would come to profoundly affect conceptions of human-nature relations. The Enlightenment brought not only advances in the application of reason and scientific method, but also a shift toward appreciation of wild nature and the belief that the thoughts and intentions of God could be discerned in natural phenomena (Garraty and Gay 1972). The scientific advances supported industrialization, and industrialization stimulated urbanization, which brought ever more people from rural agricultural work into urban factories. People who had worked outdoors and structured their time around the diurnal and seasonal cycles left their villages, fields and forests for towns and factories in which work was less tightly coupled to natural *zeitgeibers*. The contrasts between rural and urban life intensified in the process. The increasingly stark contrasts helped to feed the Romantic Movement in philosophy, music, the visual arts and literature. Wild nature was exalted, at first by the kind of literate tourists who could afford to leave their urban homes for rambles in the Lake District or the Haslital, then later by a broader band of the general public. At the same time that it stoked appreciation of the natural, the Romantic Movement advanced a critique of the city and urban life, not only with regard to its negative somatic effects but also with regard to mental, social, and moral harm. The advantages and disadvantages of life in a city versus a suburb or the countryside remain a staple of scientific as well as popular literature today, and distinctions between the natural and urban constitute a major theme in current discussions of nature and health. For discussions of historical shifts in attitudes toward nature per se, and of the contrasts in attitudes toward the urban and natural environment, see, for example, Ekman (2007), Nash (1982), Schama (1995), Stremlow and Sidler (2002),and Thomas (1983).

5.3.3 The Development of Approaches to Health Care Involving the Natural Environment

The contrast between urban and rural conditions figured in the development of approaches to care for diverse mental and physical disorders. Common to these was the idea that time in nature, away from the usual urban setting, would facilitate a therapeutic process. For example, in many European countries, people of means could from the 1600s onward go to a spa and take the waters, to soothe their nerves, alleviate hysteria, or ameliorate some somatic illness (e.g., Fuchs 2003; Mansén 1998). The experience of nature was meant to play a role in the healing effects of visiting the spa. At the Ronneby Brunnspark in Sweden, for example, the overall design was meant to support the experience of nature as an adjunct to the other components of the spa program, namely, drinking the mineral water and physical activity (Jakobsson 2004). Another example, moral therapy, proved at the time to be a relatively successful and humane (thus moral) approach to caring for the mentally ill, who to that time had received harsh treatment. As described by Edginton (1997) with regard to the Retreat in York, England, which opened in 1796, moral treatment involved 'the removal of a lunatic from all associations in home or community influencing his or her condition', as well as 'the use of nature as a means of calming insanity' (p. 95). A more recent example is the sanatorium-based treatment for people with tuberculosis. The disease afflicted many people in densely built cities. The sanatoria were meant to isolate infected people from the rest of the population and provide them with good air, sunlight and pleasant views of nature as a possible cure (e.g., Bonney 1901; Gardiner 1901; Anderson 2009; von Engelhardt 1997). The first sanatorium opened in 1859 in Görbersdorf (presently Sokolowsko), Poland, and others sprang up in scenic countryside locations in Finland, Switzerland, California, and other places, where they were used until the discovery of an antibiotic cure for the disease.

Although the tuberculosis sanatoria gave way in the face of medical advances, other historical uses of natural surroundings for health care facilities and programs have persisted to the present day, such as therapeutic camping for children with emotional disorders (e.g., Levitt 1988). Recent decades have seen a surge of interest in therapeutic values of nature experience, in connection with perceived shortcomings of conventional medical approaches that, while effective by some criteria, have seemed insensitive to the needs of the whole person. A growing openness to alternative and complementary therapies has entailed increased attention to nature-based interventions such as therapeutic horticulture (e.g., Irvine and Warber 2002; Sempik et al. 2003; Townsend 2006; Gonzalez et al. in press). In a related development, dissatisfaction with sterile, intimidating, high-tech environments has prompted the creation of 'healing gardens' at many hospitals and clinics (e.g., Cooper Marcus and Barnes 1999; Hartig and Cooper Marcus 2006). With both of these developments, proponents have acknowledged that sound scientific evidence regarding therapeutic values of nature experience is needed to convince a professionally skeptical medical community of the worth of their proposals (see Chapter 11 of this book).

5.3.4 The Development of Environmental Design Professions Concerned with Access to Nature

Urbanization also stimulated the development of environmental professions that came to assume responsibility for providing access to nature for people living in cities. The work of some of the early proponents was grounded on the conviction that nature experience would be beneficial to the health of an urban public. One notable early proponent was the landscape architect Frederick Law Olmsted, whose plans for urban parks in major North American cities reflected an awareness of the somatic and psychiatric medical theories of his time (Hewitt 2006). The open spaces and trees of public parks were to provide for clean air and sunlight, in line with miasma theory (see also Szczygiel and Hewitt 2000), while other features of the design, such as the screening of buildings just outside the park, were intended to help the visitor achieve greater psychological distance from everyday cares, in line with moral therapy.

Town planners also have made assumptions regarding beneficial effects of contact with nature in promoting particular planning strategies. One notable example in this regard is Ebenezer Howard. The central idea in Howard's (1902/1946) book *Garden Cities of To-morrow* was that the advantages of the town and countryside should be joined in the Garden City: 'Human society and the beauty of nature are meant to be enjoyed together. The two must be made one' (p. 48). Howard's garden city idea inspired the founding of the Letchworth and Welwyn garden cities in England as well as the design of neighborhoods in cities around the world (Meacham 1999). As with landscape architecture, attention to nature in the urban context remains a staple of urban planning today, though the concerns extend beyond the health values afforded by experiences of urban nature (see e.g., Whiston Spirn 1985).

5.3.5 The Development of the Environmental Movement

Besides the efforts to bring nature into cities, the nineteenth century was also marked by a movement in some countries to create large national parks, national forests, and wildlife preserves outside of cities as a reaction against the large-scale exploitation of natural resources. This environmental movement was motivated not only by concern for the well-being of nature, but also by concern for the well-being of people (e.g., Grundsten 2009; Runte 1979). For example, the aforementioned landscape architect Olmsted addressed health-promoting functions of nature in an 1865 text that has been described as the philosophic basis for the creation of national parks (see Olmsted 1865/1952). The text comes from a report intended to provide guidance for the governor of California in managing a major transfer of land from the US federal government for the purpose of preserving scenic resources for the benefit of the public. This land transfer included what is now Yosemite National Park. Olmsted's guiding rationale for protecting the scenic values of the park land resembles current formulations concerning stress, mental fatigue, and restoration:

> It is a scientific fact that the occasional contemplation of natural scenes of an impressive character, particularly if this contemplation occurs in connection with relief from ordinary cares, change of air and change of habits, is favorable to the health and vigor of men and especially to the health and vigor of their intellect beyond any other condition which can be offered them, that it not only gives pleasure for the time being but increases the subsequent capacity for happiness and the means of securing happiness. The want of such occasional

> recreation where men and women are habitually pressed by their business or household cares often results in a class of disorders the characteristic quality of which is mental disability, sometimes taking the severe forms of softening of the brain, paralysis, palsy, monomania, or insanity, but more frequently of mental and nervous excitability, moroseness, melancholy or irascibility, incapacitating the subject for the proper exercise of the intellectual and moral forces (p. 17).

Nature protection already had long-standing utilitarian motives. For example, the emergence of scientific forestry in Germany in the late eighteenth century was a reaction to wasteful use of forest trees, and reflected the belief that societies should be as rational in managing natural resources as they should be in other forms of public administration (Ciancio and Nocentini, 2000). The establishment of national parks, in the USA (1872) and then in Europe (e.g., Sweden in 1909), appears however to have gone beyond earlier forms of nature protection in its scope, degree of institutionalization, centralized versus local control, and apparent diversity of motives. The parks protected species and habitats, as well as opportunities for studying them. They protected watersheds. Not least, they protected possibilities for beneficial experiences of wild nature and culturally significant landscapes. For example, Wodziczko (1930), an important Polish proponent of the health values of nature experience, argued that even the most beautifully arranged parks, public gardens, and other green spaces in a city were not sufficient to maintain the body in full health. He claimed that people who become fatigued by life in a large urban agglomeration 'need at least periodically a complete recreation in nature, among green forests, rivers, and lakes'; they should, he argued, '… whenever it is possible, even for a few moments, … escape from among city walls and go to places where nature has preserved its primeval beauty' (p. 40). Wodziczko saw his ideas implemented with Wielkopolski National Park, near Poznan, as well as with public green spaces inside that city (Wodziczko 1928).

Nowadays, concerns of the environmental movement have extended well beyond protecting nature's beauty; pollution, rapid population growth, nuclear energy, nuclear weapons, unsustainable transportation and agricultural practices, environmental justice, and many other issues have come onto the agenda. It is worth noting, however, that many of the prominent figures in the broad environmental movement have expressed their appreciation of nature and outdoor life in their ecological and activist writing (e.g., Brower 1990; Carson 1962; Leopold 1949); the motivation to engage in environmental activism may be rooted in positive experiences in nature.

5.3.6 The Development of Multiple Use Management of Land

Different actors have long had different motives for pursuing environmental protection and conservation, and some of those motives have been at odds. The need to resolve the conflicts that stemmed from different motives provided an impetus for some of the lines of scientific inquiry that have come together in the nature-and-health research field. A prominent example is the conflict in the USA between the conservationists and the preservationists around the turn of the twentieth century. The conservationist Gifford Pinchot studied scientific forestry in France and Germany, and then went on to become the first chief of the US Forest Service. He thought that national forests should be established and managed for the sustainable production of resources. He placed aesthetic and recreational values outside of the concerns of forestry (see for example p. 71 of his autobiography 1947/1987).

Though a better alternative than unrestrained exploitation, Pinchot's utilitarian view was disliked by the preservationist John Muir. The Scottish-born naturalist and co-founder of the Sierra Club acknowledged the utilitarian values of the American wild lands, but he emphasized their aesthetic, recreational and spiritual values

> The tendency nowadays to wander in wildernesses is delightful to see. Thousands of tired, nerve-shaken, over-civilized people are beginning to find out that going to the mountains is going home; that wildness is a necessity; and that mountain parks and reservations are useful not only as fountains of timber and irrigating rivers, but as fountains of life. Awakening from the stupefying effects of the vice of over-industry and the deadly apathy of luxury, they are trying as best they can to mix and enrich their own little ongoings with those of nature, and to get rid of rust and disease (Muir 1901/1981, pp. 1–2).

The conflict between the conservation and preservation motives – sustainable exploitation of natural resources versus appreciation of the ecological and experiential values of nature – eventually led to the development of a multiple use management strategy for public wild lands in the USA (see Pitt and Zube 1987). Public opinion encouraged elected officials to pass legislation that compelled land managers to manage for cultural, recreational and aesthetic values as well as for the consumption of natural resources. This in turn created a demand for knowledge about public preferences regarding different management alternatives. Social and behavioral scientists were recruited to address this demand. For example, at the urging of environmental organizations (see e.g., Brower 1990), the Outdoor Recreation Resources Review Commission was created in 1958 to gather information about, among other things, the values that people assigned to recreational activities in wilderness areas (1962). The work of the ORRRC is an early example of government-commissioned research done to guide protection of experiential values of nature. Since the early 1960s, American social and behavioral scientists in governmental employ or funded by federal land management agencies have continued to study topics related to the health values of nature experience, such as scenic preferences and the benefits of outdoor recreation (for reviews of the earlier work, see e.g., Driver et al. 1987; Ewert and McAvoy 2000; Knopf 1987; Roggenbuck and Lucas 1987; Stankey and Schreyer 1987; Zube et al. 1982).

Conflicts among different uses of natural environments have also stimulated demand for research on nature experience in many European countries. The particulars of the research needs have varied across countries, in line with variations in the environments of concern, the circumstances of the populations wanting to use those environments (e.g., degree of urbanization), and the consumptive and recreational activities pursued in those environments. The conditions for responding to research needs have also varied, given the variations in, for example, environmental legislation and the delegation of responsibility for commissioning and performing such research. It is beyond the scope of this chapter to outline these variations. Simply put, as in the USA, research on topics such as landscape preferences and the benefits of outdoor recreation has been pursued in many European countries over several decades, with the intention of feeding results into policy, planning and land management processes (recent examples include Bell 2001; Bauer et al. 2009; Hunziker 1995; Jensen and Koch 2004; Konijnendijk 2003; Lindhagen and Hörnsten 2000; Scott 2003; Van den Berg et al., 1998; Van Herzele and Wiedemann 2003). This work has helped to prepare the way for the recent intensification of research more explicitly concerned with relations between nature experience and health.

5.3.7 Summary

To this point we have situated the development of thinking about nature experience and health in a context of intellectual and societal developments. These developments have involved the health sciences and conceptions of health; sources of ideas about human-nature relations and approaches to studying them; patterns of production and settlement that affected demand for experiences of nature as well as opportunities for such experiences; approaches to health care which accorded a role to nature experience; environmental design professions; the environmental movement; and the role of government and research in resolving conflicts between competing uses of natural environments. We have also pointed to relations among these different developments.

In closing this section, we want to emphasize that we have sketched only some of the origins of the research area here. We have said nothing, for example, about the development of evolutionary thought, which has opened for a view of health values of nature experience as grounded in adaptations to the environmental conditions of early human evolution. Nor have we discussed the emergence of academic disciplines, such as environmental psychology, that have made significant contributions to research concerning nature experience and health. Those developments will be acknowledged in the next section, in that several of the theories that we will discuss are direct expressions of those developments. Omissions here notwithstanding, we trust that our sketch has sufficed to show that the scientific study of nature experience and health is, like the phenomena under study, situated in long-running social and cultural processes. Today's research does not so much describe novel phenomena as approach familiar phenomena with current scientific concepts and methods.

5.4 Current Theoretical Perspectives

Having discussed 'what has been', we turn to discuss 'where we are now'. In the present section we overview current theories and research concerning psychological processes through which natural environments might provide health benefits.

The presentation here is meant to give a sense of the field of inquiry as it looks today as well as points of entry into the literature. We cover work in three areas: environmental preferences, psychological restoration, and learning and personal development.

The theories to be covered vary in the emphasis placed on three different kinds of influence on behavior: innate, cultural, and personal. Put simply, the common denominator of evolutionary assumptions is that people today retain adaptations to the environments of human evolution. It is therefore beneficial for people today to encounter conditions to which they remain innately adapted (cf. Parsons 1991). An alternative line of reasoning emphasizes the cultural forces that have shaped both the nature that people have available to experience and their shared beliefs about how nature experience affects health. According to this perspective, a person's response to a particular environment at a particular time varies as a function of attitudes, beliefs, and values shaped through learning within a particular socio-cultural context (e.g., Tuan 1974). Within that socio-cultural context, unique individual experiences further shape personal beliefs about whether and how nature is beneficial as well as the choices of activities through which the person comes into contact with nature. Further efforts to understand health in relation to nature will presumably follow the example of Bourassa (Bourassa 1988, 1990), who worked toward the theoretical synthesis of the personal, cultural and innate determinants of aesthetic responses to landscapes. We will return to this issue in the next major section. In the meantime, we wish to emphasize that while the different theories covered here may seem to emphasize one kind of influence, they do not necessarily disallow the others.

5.4.1 Environmental Preference

That people seem to like nature is not a trivial matter. Liking or preferring one alternative over another often influences the choice among courses of action – of which path to take, of where to go during leisure time, of which hotel room to take for the weekend, of where to locate one's home, and so on. Environmental preferences can be said to reflect a functional aesthetic; they signal conditions relevant to well-being. From this perspective, preference for natural environments over other environments is a sign that they are taken to serve well-being. In the following, we overview several theoretical formulations concerned with environmental preferences. All of them assume a basis for preferences in adaptations to the environment that occurred during human evolution. They thus emphasize uniformity or consensus in preferences across cultures, individuals, and time (cf. Purcell and Lamb,1984).

5.4.1.1 Biophilia

The word 'biophilia' was first introduced by Erich Fromm (1964) to describe attraction to the various spheres of life, the process of life, and all that is alive and vital. The term was subsequently popularized by Edward O. Wilson (1984)), who defines biophilia with regard to 'the connections that human beings subconsciously seek with the rest of life' (p. 350). The idea or hypothesis that all people have some innate drive to affiliate with other forms of life has since attracted considerable attention from researchers (e.g., Kahn 1997; Kellert 1993a, b; 1996).

The leading conception of the biophilia hypothesis is that humans have an affinity for life and life-like processes that motivates contacts with plants, animals, and natural landscapes. This orientation to affiliate with other forms of life has genetic determinants. Biological evolution as a process of continuous genetic adaptation of organisms or species to the environment integrates the results of environmentally advantageous genetic changes. Organisms that are better adapted to particular environmental conditions have a higher survival rate and attain greater reproductive success. Accordingly, they have a better chance to contribute their genetic material to the population's genetic pool and, in the long run, to increase the environmental fitness of the whole population.

According to this view, the process of species evolution by natural selection is slow and individual adaptive changes may take hundreds of thousands of years. The biophilia hypothesis thus relies on the observation that for most of the millions of years during which our species evolved, humans coexisted in a close relationship with the natural environment. Therefore, most adaptations in the human organism, including those of the brain and related behavioral reactions, developed as an evolutionary response to needs imposed by this environment. In contrast, the history of human civilization is relatively short. People have gathered in agricultural settlements for around 10,000 years, and in urban areas for a much shorter period. It is considered unlikely that evolution could change existing adaptations during the period that people have occupied such relatively artificial settings. Therefore, according to the biophilia hypothesis, humans still tend to express inherited earlier adaptations and so to like or prefer natural environments where they can function well. According to Wilson (1984), the biophilic instinct emerges unconsciously and 'cascades into repetitive patterns of culture across most or all societies' (p. 85).

The biophilia hypothesis emphasizes people's positive responses to nature. However, nature can also prompt negative, fearful – biophobic – responses (Öhman and Mineka 2001; Van den Berg and Ter Heijne 2005). Some researchers consider the extensive body of findings concerning biophobia to provide support for the biophilia hypothesis (e.g., Ulrich 1993). The ability to respond to positive environmental cues (e.g. potential food and water sources, shelter) as well as to negative ones (e.g. danger from predators, venomous snakes or poisonous plants) could have had adaptive significance during human evolution. Biophilia and biophobia can be viewed as examples of prepared learning (Seligman 1970), reflecting a predisposition 'to easily and quickly learn, and persistently retain, those associations or responses that foster survival when certain objects or situations are encountered' (Ulrich 1993, p. 76). Biting and stinging insects, snakes, bats, and other animals elicit strong aversion or fear in many people. This holds even for people who have not previously had contacts with those animals, perhaps as a result of vicarious learning by observation of the reactions of other people (Lichtenstein and Annas 2000).

Since its original presentation, the biophilia hypothesis has been the subject of numerous critical commentaries. Kahn (1997) provides a thoughtful summary that focuses on three major concerns: (1) the degree to which biophilia is genetically determined; (2) whether negative affiliations with nature contradict the biophilia hypothesis, and (3) how well biophilia withstands scrutiny, if experience and culture are admitted to influence the content, direction, and intensity of biological tendencies. Despite much circumstantial evidence, the biophilia hypothesis seems to be lacking in convincing support, in contrast to biophobia, for which support comes from many well-controlled experiments (see Ulrich 1993; Öhman and Mineka 2001; for a more critical view, see Coelho and Purkis, 2009). Criticisms and evidential shortcomings notwithstanding, the notion of biophilia has been a valuable stimulus for recent research and debate on human-nature relations.

5.4.1.2 Savannah Theory

Another evolutionary theory, which was introduced by Gordon Orians in 1980, seeks to explain environmental preferences through reference to underlying behavioral choice mechanisms that an animal would deploy in the search for suitable habitat. In Orians' view, these mechanisms were shaped in the course of evolution by temporal and spatial variability in habitat suitability. He analyzes factors operating in the choice process that animals might go through in a search for suitable habitat, including the available knowledge about habitat alternatives, time available for selecting among alternatives, and variability in relevant environmental features. Assuming that the selection of habitat typically takes place under conditions of ignorance, Orians argues for the utility of strong, spontaneous emotional responses toward suitable and unsuitable habitats. 'Good habitats should evoke strong positive responses and poorer habitats should evoke weaker or negative responses' (p. 55). At the same time, he proposes that the responses vary as a function of immediate needs. For example, he writes, 'a hungry animal may accept a second-rate site more readily than a well-fed one, since hunger is a signal that good habitats have not been encountered' (p. 55).

Orians groups factors that influenced the suitability of early human habitats into categories of resource availability and protection from predators. His analysis leads to the conclusion that 'tropical savannahs, particularly those with irregular relief providing cliffs and caves, should have been the optimal environment for early man' (p. 57). Thus, strong positive responses to savannah settings should have been selected for in the evolution of human habitat choice mechanisms. He supports his hypothesis through reference to several lines of evidence: emotion-laden landscape descriptions of early explorers in the American Great Plains, which at that time had little of the apparent human presence that would have strongly signaled habitability; spending for homes and for recreation access in places with characteristics of suitable habitat, such as proximity to water; and common practices in the choice and arrangement of aesthetic vegetation so that parks and other spaces resemble savannah environments. In a subsequent text, Orians (1986) marshals additional support for his position, citing among others the findings of Balling and Falk (1982). Those researchers found that, of the people in their sample from the American Northeast, children preferred scenes of tropical savannah over the kinds of natural scenes that would have been familiar to them in their own locale. For the older members of their sample, the more familiar scenes were as well liked as the savannah scenes. Later work with Judith Heerwagen (Orians and Heerwagen 1992; Heerwagen and Orians 1993) further elaborates the analysis as well as the evidential base, including findings of greater preference for tree shapes characteristic of suitable habitat.

The savannah theory is distinctive in linking the emotional response to landscapes with the resolution of the problems associated with identifying suitable habitat. Some independent research has addressed the theoretical claims, as with particular tree forms as cues of suitable habitat (e.g., Summit and Sommer 1999; Lohr and Pearson-Mims 2006). A recent study by Falk and Balling (2009) among students and school children from the rain forest belt in Nigeria provides further support for an innate preference for savannah-like settings. Despite the fact that 80% of the participants had never been outside their own area, both groups expressed a preference for savanna scenes as compared to other biomes, including the familiar rainforest biome. Other scholars have, however, cast doubt on the idea that the savannah should be regarded as the relevant, stable setting for early human evolution, and their arguments and findings present challenges to the theory (e.g., Potts 1998; Han 2007).

5.4.1.3 Prospect-Refuge Theory

A third evolutionary approach also considers the suitability of habitat with regard to a problem that would frequently have confronted proto-humans. In his presentation of prospect-refuge theory, however, Appleton (1975) defines the problem more narrowly than Orians (1980). Assuming that the ability to move toward a goal while out of the sight of predators would have been of primary importance to survival, he asserts that the environment's potential for supporting this ability should have evoked affective responses before other indicators of survival potential. Accordingly, he is more specific in his treatment of symbolic aspects of the human-landscape interchange and in setting out the characteristics of landscapes that should influence preference.

The idea of seeing without being seen motivates Appleton's (1975) analysis of landscape into prospects, refuges, and hazards. Prospects, or views outward, are of two general types. Direct prospects are the views available from the presently occupied place, or primary vantage point. Examples include panoramas and vistas, with panoramas not being bounded by objects in the landscape as are vistas. Indirect prospects, such as deflected vistas, imply views that might be attained if one could reach points farther off in the landscape, referred to as secondary vantage points. A refuge may serve as a shelter or as a hiding place. It may be that it does not serve both functions simultaneously; a refuge might offer shelter from a storm yet not hide the occupant from the sight of a predator. Thus, the distinction between shelter and hide assumes importance relevant to the type of hazard. Aside from function, refuges can also be characterized by their accessibility, efficacy, origin (natural versus artificial), and substance (earth refuges such as caves, vegetation refuges such as trees or grass, and nebulous refuges such as fog). Hazard is important to the analysis as the justification of the need for refuge and for seeing without being seen. A hazard can be animate (e.g., a predator) or inanimate (e.g., weather). It can also be seen in an obstacle to free movement (impediment hazard) or in the absence of a requirement for survival, such as water (deficiency hazard).

Although many hazards may no longer be salient, Appleton (1975) maintains that human response to landscape is still determined to some extent by prospect and refuge values. The aesthetic experience of landscape is thought to be influenced by variation in the objects that symbolize prospects and refuges, the spatial arrangement of symbols, and the equilibrium between prospect and refuge symbols, among other factors. Furthermore, prospect-refuge symbolism is seen to hold on more than one level. It derives from the imagination and experience of the observer as well as from the physical characteristics of landscape objects.

Prospect-refuge theory can in some respects be described as Gibsonian in that it entails the description of landscapes in terms of prospect and refuge affordances. Affordances are functional values inherent in physical characteristics of the environment. In his account of ecological perception, Gibson (1979) argued that people immediately apprehend the functionality of the surfaces that they see, as when a surface is perceived to afford walking or sitting. Appleton (1996) acknowledges this characterization in his retrospective look at the original presentation of the theory.

He also takes the opportunity to address two criticisms of the earlier work. First, he emphasizes that 'there is no significance in the comparative paucity of reference in the book to the cultural case', as one should not 'expect the case for the prosecution to incorporate also the case for the defense' (p. 236). Second, he emphasizes that, '… while cultural, social and historical influences are of great importance, they do not operate in a vacuum'; to the extent that such influences shape landscape tastes, '… they shape it, not out of nothing, but out of something which is already there' (p. 236), namely, an innate component.

Prospect-refuge theory has apparently inspired a substantial amount of discussion, but relatively little focused empirical research. Stamps (2006) identified 214 works that made some reference to the theory, but he could only classify 11% of them as empirical. Recent empirical work by Stamps (2008a, b) provides support for some claims (i.e., preference for views out onto mountains) but not for others, and he recommends caution in assuming the utility of the theory.

5.4.1.4 An Informational Perspective on Environmental Preferences

A fourth approach to understanding environmental preferences differs from the previous three in that it is grounded in cognitive psychology; however, it also builds on evolutionary assumptions and takes interest in the needs of pre-humans. Stephen and Rachel Kaplan offer a view of human evolution as responsive to ongoing demands for the acquisition and rapid processing of information from the environment (Kaplan and Kaplan 1978, 1982, 1989). On descending from the trees for savannah ground well-populated with predators, pre-humans came under selective pressure to build on their perceptual capabilities in the development of an ability to quickly anticipate and respond to events in the environment. For continued survival, sustained in large part by hunting, selection would have favored abilities to comprehend extended spatial areas and to plan.

According to this account, environmental preferences reflect an innate sensitivity to informational requirements of survival. Pre-humans are assumed to have been motivated to expand upon the cognitive maps that they relied upon for their survival. Their success would have been determined to some degree by their responsiveness to conditions which affected way-finding. Aside from ready comprehension of the environment being explored, the possibilities for exploring further would also have shaped preferences. Thus, informational qualities of the visual array that supported needs for both understanding and exploration would have been influential in instituting preferences. The desire to maintain cognitive clarity is assumed to still undergird aesthetic responses. The aesthetic response, though unconscious, is cognitive in character, and guides affect (Kaplan 1987).

Informational qualities are ordered with respect to two dimensions in the Kaplans' (1982, 1989) preference matrix. One dimension is temporal, spanning from what is in front of the person at the moment to what could be in front of the person as he or she proceeds further into the environment. The other dimension refers to what the person is doing with regard to information at the time; the person is seen as engaged in making sense of the information available as well as proceeding to acquire new information. Thus, (1) an immediate need for understanding is supported by the coherence of the perceived environmental elements; (2) the potential for understanding in the future is in the legibility of what lies ahead; a legible view suggests that one can continue moving and not get lost; (3) exploration of what lies in front of one is encouraged by the complexity within the given set of elements; (4) further exploration is stimulated by the promise of additional information with a change in vantage point, or mystery.

With this arrangement, a tension between order and uncertainty is implicated in aesthetic response; sufficient coherence and legibility are needed to make sense of the environment, but their action must be balanced by enough complexity and mystery to entice the individual to gather more information. In addition to the informational qualities, the theory sees particular contents signaling survival values (Kaplan and Kaplan 1982). In modeling preference, natural elements such as trees and water are designated as primary landscape factors because their very presence appears to have a positive impact. Here the preference framework has common ground with habitat theory.

Numerous empirical studies have reported the influences of contents and informational factors on preferences for photographic scenes (e.g., Herzog 1985, 1989 reviewed in Kaplan and Kaplan 1989). On the basis of a meta-analysis, however, Stamps (2004) concludes that the relationships between the four informational factors and preference are far from consistent. One possible explanation for this is that the strength of the relationships may be contingent on the kind of scenes (e.g., of built versus natural environments; cf. Herzog and Leverich 2003). Stamps (2004) offers some specific recommendations for further work with this theory.

5.4.1.5 Fractal Geometry and the Fractal Dimension

The term fractal is used to describe fractured shapes, which possess repeating patterns when viewed at increasingly fine magnifications. This quality of scale invariance can be identified and quantified with a parameter called the fractal dimension, D. The fractal dimension can be defined as a measure of the extent to which a structure exceeds its base dimension to fill the next dimension. Thus, for a fractal line, D will be greater than one and up to two. Similarly for a fractal surface D will have a value between two and three.

From the start, the development of fractal geometry was strongly linked to issues relating to the mathematical description of forms and shapes that are found in nature, such as mountain ranges and coastlines (Mandelbrot 1983). The ubiquity of fractals in the natural environment (Barnsley 1993; Barnsley et al. 1988; Gouyet 1996) has motivated a number of theories concerning the relationship between the pattern's fractal character and the corresponding perceived visual qualities. The ability of observers to discriminate between fractal images based on their D value has been shown to be maximal for fractal images with D values corresponding to those of natural scenes (Knill et al. 1990; Geake and Landini 1997), triggering discussions as to whether the sensitivity of the visual system is adapted to the fractal statistics of natural environments (Knill et al. 1990; Gilden et al. 1993). Observers who displayed a superior ability to distinguish between different D values were also found to excel in cognitive tasks involving 'simultaneous synthesis' (the ability to combine current perceptual information with information from long term memory), with the authors speculating that natural fractal imagery resides in the long-term memory (Geake and Landini 1997). Furthermore, Aks and Sprott (1996) noted that the aesthetically-preferred D value of 1.3 revealed in their studies corresponds to fractals frequently found in natural environments. They speculated that this 'may point to an abstract form that may be shared by nature and human preference' (p. 12). This kind of speculation follows lines of thought similar to those which attribute environmental preference and aesthetic appraisal of particular landscape elements to evolutionary factors.

A more general theory discusses fractal aesthetics in terms of the condition experienced when the fractal structure of the observed environment matches the fractal structures that underlie cognition and perception (see, for example, Briggs 1992). For example, the spatial information in a scene is thought to be processed within a 'multi-resolution' framework where the cells in the visual cortex are grouped into so-called 'channels' according to the spatial frequency they detect. The way these 'channels' are distributed in spatial frequency parallels the scaling relationship of the fractal patterns in the observed scenery (Field 1989; Knill et al. 1990; Rogowitz and Voss 1990. Thus, an aesthetic experience might be expected if, for example, an artwork or a view from a window matches this scaling relationship of the channels.

The number of empirical studies concerning how aesthetic experiences relate to fractals is small, and the visual stimuli used have been very different. Some studies have shown that people prefer fractal patterns over non-fractal patterns (Taylor 1998, 2003), but a question of particular interest has been whether particular fractal dimensions are preferred more than others. The studies initially led to very different results, with preference shown for both higher D (Pickover 1995) and lower D values (Aks and Sprott 1996). The inconsistency suggests that there is no universally preferred fractal dimension, and it was suggested that the aesthetic qualities might instead be dependent on how the pattern was generated (Taylor 2001). This hypothesis was tested using natural, man-made and computer-generated fractals, but surprisingly it was found that fractal dimensions in the range of 1.3–1.5 were most preferred, irrespective of the pattern's origin (Taylor et al. 2001; Spehar et al. 2003). The result pointing to preference for mid-range D values has since been supported by studies on landscape silhouettes extracted from photographs (Hagerhall et al. 2004; Hagerhall 2005), where mid-range fractal dimensions seemed to be most preferred and also had the highest score on perceived naturalness.

5.4.1.6 Closing Comments on Environmental Preference

We have given considerable attention to environmental preference here because a preference can be taken as an indication of conditions relevant to well-being. A preference for one environment over another might lead a person into relatively beneficial circumstances. This does not mean, however, that an expression of preference itself constitutes an improvement in well-being. In the following, we review theories that more directly address the issue of how the experience of nature can serve health. We do not leave preferences behind, however, in that some of the research to be covered in the following considers the correspondence between preferences and benefits of nature experience relevant for health.

5.4.2 Theories About Psychological Restoration

The theories just overviewed all assume that environmental preferences have some innate basis. To justify the assumption, they refer to various challenges faced by pre-humans in the environments of their time. Even though people today may no longer face those challenges, it is argued that they retain a disposition to respond positively to environmental features that would have been conducive to the survival of their ancestors. Those ancient tendencies may serve people today by guiding them into opportunities for restoration.

The term 'restoration' covers processes through which people recover resources that they have diminished in their efforts to meet the demands of everyday life. Those resources vary in kind. Physiological resources include the ability to mobilize energy for action aimed at some demand, whether acute, as when running to catch a train, or persistent, as when working hard for many days to meet a deadline. Psychological resources include the ability to focus attention on a task, even when noise or other distractions make it hard to concentrate. Social resources include the willingness of family and friends to provide help. Because a person depletes various resources in meeting everyday demands, a potential or need for restoration arises regularly. New demands will come along, so the person must restore the depleted resources or risk not being able to meet the new demands. Over time, inadequate restoration can translate into problems with mental and physical health (Hartig 2007).

With populations today concentrated in urban environments, the need for restoration ordinarily arises with activities in an artificial or built environment. Because nature experiences often involve getting away from those places where restoration needs arise, they may permit restoration of depleted resources. Nature experiences may at the same time promote restoration in that they have features that a person may find engaging and pleasant, for reasons like those described in theories about environmental preferences. Thus, the restorative effects of nature experiences may have some evolutionary basis, but the dynamic that is commonly of interest – induction of restoration needs with activities situated in built environments followed by movement into a more natural one to address those needs with other activities – has a fundamentally cultural character.

Theories about restorative environments must specify the antecedent condition of resource depletion from which a person needs restoration; describe the process of restoring the given resources, and; characterize the environments that promote that process, as compared to merely permitting it (Hartig 2004). Two theories have guided much of the recent research on restorative effects of nature experiences. Although they both emphasize the restorative qualities of nature, they differ in their specifications of antecedent condition and restorative process.

5.4.2.1 Psychoevolutionary Theory

Roger Ulrich's psycho-evolutionary theory (Ulrich et al. 1991; see also Ulrich 1983) is concerned with recovery from psychophysiological stress. Stress is defined as a process of responding to a situation perceived as demanding or threatening to well-being. Ulrich assumes the operation of an evolved system for directing behavior in situations that are relevant to continued survival and could be experienced as stressful. That adaptive system involves 'hard-wired' affective responding in the selection of a behavioral strategy (i.e., approach or avoidance) and the simultaneous mobilization of physiological resources needed to execute that strategy. Stress, in this work as elsewhere, becomes manifest in increased negative emotion and heightened autonomic arousal, among other changes.

The theory proposes that restoration can occur when a scene elicits feelings of mild to moderate interest, pleasantness, and calm. For someone experiencing stress and needing to renew resources for further activity, it could be adaptive to continue viewing the scene in a non-vigilant manner. This initially depends on visual characteristics of the scene that can rapidly evoke an affective response of a general character, including interest. This response is thought to be 'hard-wired'; it does not require a conscious judgment about the scene, and indeed it can occur before a person can formulate such a judgment. The characteristics of the scene that elicit the response include gross structure, gross depth properties, and some general classes of environmental content. In this regard, Ulrich (1999) maintains that '… modern humans, as a partly genetic remnant of evolution, have a biologically prepared capacity for acquiring and retaining restorative responses to certain nature settings and content (vegetation, flowers, water), but have no such disposition for most built environments and their materials' (p. 52). Thus, the theory assigns a restorative advantage to natural environments and features of nature over artificial environments.

The process of restoration would go something like this, then: a scene with moderate and ordered complexity, moderate depth, a focal point, and natural contents such as vegetation and water would rapidly evoke interest and positive affect, hold attention, and thereby displace or restrict negative thoughts and allow autonomic arousal heightened by stress to drop to a more moderate level. Restoration would become manifest in, for example, more positively toned emotions and lower levels of physiological parameters such as blood pressure, heart rate, and muscle tension.

Experiments guided by this theory have documented differential change in emotional and physiological outcomes measured during or immediately after viewing actual or simulated natural and urban environments. For example, Ulrich et al. (1991) had university students view a stressful industrial accident film and then a 10-min video of a natural setting, urban traffic, or an outdoor pedestrian mall. After the stressor, the downward trajectories for *frontalis* muscle tension, skin conductance, heart period, and pulse transit time were steepest with the nature simulations. Changes in self-reported affect converged with the physiological results in showing a greater degree of restoration with the nature videos (see also, e.g., Chang and Chen 2005; Parsons et al. 1998; Park et al. 2007).

5.4.2.2 Attention Restoration Theory

Stephen and Rachel Kaplan's attention restoration theory (Kaplan and Kaplan 1989; Kaplan 1995) is concerned with restoration from attentional fatigue. They assume that a person's ability to direct attention depends on a central inhibitory capacity or mechanism. To focus on something that is not of itself interesting, the person must inhibit competing stimuli that are more interesting. It takes effort to do this, and the person's ability to inhibit competing stimuli will become fatigued with prolonged or intensive use. Loss of the inhibitory capacity has a variety of negative consequences. Those consequences include irritability, failure to recognize interpersonal cues, reduced self-control, and increased error in performance of tasks that require directed attention.

A person can restore a diminished capacity for voluntarily directing attention when he or she experiences *fascination*, a mode of attention which the Kaplans' assume to have an involuntary quality, not require effort, and not have capacity limitations. When a person can rely on fascination in ongoing activity, demands on the central inhibitory capacity are relaxed and a capacity for directing attention can be renewed. As described by the Kaplans, fascination is engaged by objects or events, or by processes of exploring and making sense of an environment. Yet fascination is not sufficient for restoration. The theory also refers to the importance of gaining psychological distance from tasks, the pursuit of goals, and the like, in which he or she routinely must direct attention (being away). Further, fascination can be sustained if the person experiences the environment as coherently ordered and of substantial scope (extent). Finally, the theory acknowledges the importance of the match between the person's inclinations at the time, the demands imposed by the environment, and the environmental supports for intended activities (compatibility).

According to ART there are four progressive stages of restoration (Kaplan and Kaplan 1989). The first stage is referred to as 'clearing the head', which allows random thoughts to wander through the mind and gradually fade away. The second stage of restoration is recharging directed attention capacity. At the third stage, one can clearly hear unbidden thoughts or matters on one's mind, due to reduced internal noise and enhanced cognitive quiet which are facilitated by soft fascination. The final and deepest stage involves 'reflections on one's life, on one's priorities and possibilities, on one's actions and one's goals' (Kaplan and Kaplan 1989, p. 197). Although it may be assumed that restoration progresses with increasing involvement and time spent in nature, it is not clear how much exposure to nature or time is required for this process under optimal conditions.

Although many environments might afford the experience of being away, fascination, extent, and compatibility, the Kaplans (1989) have argued that natural environments should more readily do so than other environments. For example, natural environments may more readily afford being away because there are few reminders about work demands and a relative absence of people, interactions with whom may require paying attention to one's own and the others' behavior. The Kaplans also assert that natural environments are rich in aesthetically pleasing features, such as scenery and sunsets, which evoke moderate, or 'soft', fascination that permits a more reflective mode. In this regard, they suggest that there may be an evolutionary basis for finding particular natural features to be appealing, as they have done in their informational perspective on environmental preference.

Quasi – and true experiments have tested the proposition that experiences of natural environments promote directed attention restoration better than experiences of other environments. In these studies, the researchers have operationalized directed attention capacity in terms of performance on tasks that require a subject to focus attention. For example, Hartig et al. (1991) report a field experiment in which proofreading performance was measured after 40 min spent in a nature reserve, city center, or a passive relaxation condition. On average, the university students who were randomly assigned to the natural environment condition showed better posttest proofreading performance than that of the subjects assigned to the other two groups.

5.4.2.3 Extensions of Research Concerned with Restorative Environments

The restorative environments topic has inspired much discussion and research in recent years. Some work has considered whether the processes described in psychoevolutionary theory and attention restoration theory might run concurrently (Hartig et al. 2003). More recent work has appropriately sought to address shortcomings with sampling in the early experiments, most of which involved university students in just a few environmental conditions. Some studies have sought to assess the restorative effects of a broader range of environments (e.g., Berto 2005), while others have taken an interest in special populations other than students (e.g., Ottosson and Grahn 2005). Aside from sampling, recent work with attention restoration theory in particular has sought to use performance measures that more precisely capture the operation of the inhibitory mechanism on which the capacity to direct attention is assumed to depend (e.g., Berman et al. 2008; Laumann et al. 2003). Still other research has sought to develop measures of the components of restorative experience described in attention restoration theory, for use in tests of the theory as well as for practical purposes (e.g., Hartig et al. 1997; Laumann et al. 2001; Herzog et al. 2003; Pals et al. 2009). These different kinds of studies have in various ways affirmed the earlier findings of a restorative advantage of nature, and they have raised still other methodological issues. The extension of the research area with the use of additional environmental comparisons, study populations, measures, and research designs is enriching the body of findings. At the same time, it is creating challenges for eventual meta-analytic research that will try to summarize the available findings in quantitative terms.

Another way in which the research area is being extended has to do with the links between environmental preferences and restorative experiences. For example, investigators have measured skin conductance (Taylor et al. 2005; Taylor 2006) and brain wave activity (Hagerhall et al. 2008) in response to fractal images, and obtained results which suggest that fractal dimensions in the preferred mid-range may contribute to stress reduction. Hagerhall (2005) has proposed that fractal geometry in natural scenery combines complexity and new information with order and predictability due to the self-similarity between scales, and this may engage interest in ways that promote restorative soft fascination (cf. Joye 2007). Van den Berg and colleagues (2003) could in an experiment show that a video of a walk through a natural environment promoted greater post-stressor improvement in emotion than a video of a walk through a built environment, and that this difference partially mediated the difference found in preferences expressed (as beauty ratings) for the environments. Nordh and colleagues (2009) found that average ratings of preference for 74 small urban parks, given by one group of people, correlated strongly ($r = 0.88$) with average ratings of the likelihood of being able to restore in those parks, as given by a separate group of raters. Links between environmental preferences and possibilities for restoration have important practical implications. Knowing that preference reliably indicates the possibility of restoration, at least for some categories of environments, supports the use of the extensive literature on specific physical environmental predictors of preference in the effort to design settings that will serve restoration. As noted by Velarde et al. (2007), the empirical literature on restorative environments so far provides little specific guidance on how landscape architects and others might design restorative environments, as most studies have had very limited environmental sampling.

With regard to the relationship between nature experience and health, perhaps the most significant issue of extension has to do with cumulative effects. The research mentioned so far has had to do with what can be called discrete restorative experiences, in which, on a given occasion, isolated in time, a person in need of restoration enters a situation that allows for it, as with a visit to a park after a hard day at work (Hartig 2007). It is important to know just what happens in a discrete restorative experience, and the available evidence does speak of a restorative advantage of nature for such experiences (Health Council of the Netherlands 2004); however, one such experience of itself will probably do little to promote lasting good health. Rather, a basic assumption underlying research on restorative environments concerns their cumulative effects: access to environments with relatively high restorative quality during periods available for restoration will cumulatively promote greater health benefits than access to environments of lesser restorative quality. Note that this assumption has three components. One involves the environments to which a person has visual or physical access. The second involves the periods or respites in which restoration can occur, whether brief and in passing or of substantial duration and dedicated to the purpose of restoration. The third involves the span of time over which repeated restorative experiences can generate cumulative effects. Taken together, these components of the ‘cumulative effects assumption’ have encouraged attention to people in their everyday contexts, where they would ordinarily and regularly seek out or otherwise find possibilities for restoration on a regular basis over an extended span of time (Hartig 2007). Many studies have built on this line of reasoning, and many of them have reported associations between nature experience and variables relevant to health and well-being. They have done so for diverse populations and circumstances, referring to therapeutic as well as preventive benefits. Some examples are hospital patients recovering from surgery (Ulrich 1984), women receiving treatment for breast cancer (Cimprich and Ronis 2003), people with clinical depression (Gonzalez et al. in press), residents of urban public housing (Kuo and Sullivan 2001), children living in rural poverty (Wells and Evans 2003), urban office workers (Bringslimark et al. 2007; Shin 2007), leisure home owners (Hartig and Fransson 2009), people who have recently experienced a stressful life event (Van den Berg et al. 2010), the Dutch general population (de Vries et al. 2003; Maas et al. 2006), and the English general population (Mitchell and Popham 2007, 2008).

A final set of studies should be mentioned here, as it shows how environmental preferences can work in support of restorative experiences. Staats et al. (2003), (Staats and Hartig 2004; Hartig and Staats 2006) found in a series of experiments that the difference in preference expressed for a forest walk over a walk in a city was larger when there was a greater need for restoration. This was the case with subjects who were simply asked to imagine themselves as either fatigued or fresh as well as with subjects who were actually relatively fresh at the beginning of the day versus fatigued after an afternoon lecture. Moreover, the subjects' ratings of preference for the different walks correlated strongly with their ratings of the likelihood that they would experience attentional recovery during the given walk. This pattern of results speaks to two important points: people come to learn that some places are more likely to support restoration than others, and they may be able to deliberately apply that knowledge in managing their energy, attentional capacity, and other adaptive resources (see also Korpela and Hartig 1996; Korpela and Ylén 2009).

5.4.2.4 Closing Comments on Psychological Restoration

Preference for a natural environment might lead a person into circumstances that are beneficial because they support restoration. The experience of restoration can help the person to perform more effectively, feel better, get along better with others, and so on. In the long run, recurrent restorative experiences can help the person to enjoy better health. Restorative experiences in nature can occur as part of a deliberate strategy for managing adaptive resources, as well as incidentally, in the course of living in an area with nature nearby. All of this said, experiences in natural environments do not only serve health through processes of restoration. They also serve health through processes in which people learn new skills, come to better understand their own capabilities, and otherwise develop in positive ways. We now turn to discuss such processes.

5.4.3 Learning and Personal Development

Of particular interest here is a class of models for benefits of nature experience that focus on the way that behavior is shaped by the perceived contingencies of actions performed in natural environments. Such models build on the idea that the reinforcement or feedback that shapes a person's behavior in a natural environment differs from that which he or she receives in everyday environments. The net effect of the difference is a change in patterns of behavior and views of the self. In general, these models look to the natural environment as a setting for personal growth and the correction of maladaptive practices through the confrontation of problems or challenges as well as through opportunities for reflection. More specific outcomes mentioned in this literature include improved problem-solving ability, greater self-reliance, and changes in self-concept, self-esteem, body image, and perceived locus of control (for reviews, see e.g., Driver et al. 1987; Levitt 1988). Effects typically unfold over the course of days or weeks, with some persisting well beyond the time actually in the environment.

Discussions of learning and personal development as beneficial aspects of nature experience often refer to a person or group acting within a program that is implemented in a wilderness environment (e.g., Russell 2000; Ewert and McAvoy 2000). Moreover, the participants in such programs are often young people with special needs. The combination of the therapeutic program with the environmental experience presents problems for those wanting to understand the beneficial effects of nature experience per se. The structure, staffing, and activities of the program may be more salutary for participants than the environment in which the program is being conducted. The natural environment may facilitate the conduct of program activities, but that does not mean that particular features of the natural environment itself are essential to the success of the program. Studies of the benefits of such therapeutic camping and outdoor challenge programs have been troubled by methodological problems such as a lack of comparison groups, and this has prevented a clearer view of the role of the environment. These points and the details of various programs are discussed in a number of reviews (e.g., Driver et al. 1987; Levitt 1988; Ewert and McAvoy 2000).

There are reasons to believe, however, that the environment of itself supports beneficial change. In a review of related literature, Knopf (1987) lists five ways in which natural environments have been differentiated from everyday environments as settings for behavior. First, a natural environment, and wilderness in particular, challenges ‘accustomed behavior patterns, resources, and problem-solving styles’ (p. 787). Second, a natural environment is impartial or indifferent, and gives little negative or judgmental feedback (see also Wohlwill 1983). Third, the relative manipulability and predictability of a natural environment means that the person need not be consumed with defensive, coping behaviors (after Bernstein 1972). Fourth, it permits a greater degree of self-expression. Finally, natural settings allow a greater sense of personal control. This last hypothesis has however been challenged by Kaplan and Talbot (1983).They maintain that the relaxation of efforts to control the environment was important to the participants in their wilderness program.

Newman’s (1980) model for the amelioration of learned helplessness through structured wilderness programs also offers insights on what might prove beneficial for people acting outside of a program context. Learned helplessness follows from an inability to perceive contingency between one’s efforts toward a desired outcome and the outcome that actually follows. A person learns to believe that he or she cannot influence outcomes more generally (Seligman 1975). The condition is attended by emotional, cognitive, motivational, and possibly self-concept deficits, such as impaired problem-solving ability, an inability to persist at a task in the face of failure, low self-esteem, and depression (e.g., Abramson et al. 1978). People who are suffering from learned helplessness tend to attribute their failures to stable, global, internal causes, such as a persistent, pervasive lack of ability. Conversely, they tend to attribute their successes to external, specific, and possibly unstable causes, such as good luck in the particular instance (Abramson et al. 1978).

According to Newman (1980) the structure of Outward Bound-style programs and the characteristics of their wilderness settings help a person to develop clear and realistic patterns of causal attributions and expectations. They also promote acquisition of skills and mastery, encourage a sense of competence or controllability, and help direct perceptions of competence in order to positively influence self-concept and self-esteem. Several wilderness characteristics are thought to be instrumental in this. First, in wilderness there are lessened demands on information-processing capabilities. A person who is freed from having to deal with the usual mental noise may be able to gain needed insight into their attribution patterns. Second, stressful conditions in everyday environments (e.g., noise, crowding, stimulus ambiguity) are not present or they are more easily seen as being under one's control. Conditions that are not under one's control, such as the weather, are readily seen as impartial and out of the control of all people. Third, the novelty and threat values of wilderness evoke close attention and coping efforts. Dealing with manageable doses of confusion and anxiety provides an opportunity to develop a sense of competence in dealing with unexpected situations. Finally, being in a wilderness environment means engaging in basic survival activities that promote competence building and provide opportunities for making more accurate attributions about success and failure.

Reser and Scherl (1988) make similar observations about ways in which wilderness encounters encourage adaptiveness and personal development, but without placing the encounter in the context of a structured program or referring to the correction of pathological conditions. They present a model for person-environment transactions that occur in intrinsically motivating activities such as running or wilderness trekking. They argue that the person-environment transactions which occur during these activities involve feedback that is clear and unambiguous. Because of these qualities, the information has a reward value proportional to the ambiguity and lack of clarity in information that the person draws from the environment in general. Reser and Scherl further assume that the feedback which the person receives from the everyday physical and social environment is typically indirect, ambiguous, routinized, and role-prescribed. Their model is also interesting because it integrates aspects of a learning approach with attentional and information processing considerations from evolutionary models such as that of the Kaplans. Clear and unambiguous feedback has reward value in part because of its utility in optimal functioning for a biological information-processing system.

5.4.3.1 Closing Comments on Learning and Personal Development

Theories about learning and personal development provide an important complement to theories about psychological restoration in the effort to understand how nature experience serves health. People may benefit from experiences in natural environments not only by restoring depleted resources, but also by acquiring new capabilities. With activity in a natural environment, a person may correct a mundane deficit, such as directed attention fatigue, or a more serious one, such as learned helplessness. In either case, the activity may segue into a process of development and growth that does far more than simply correct the deficit. The natural environment as a setting for therapy and education receives more attention in Chapters 11 and 12 of this book.

5.5 Issues for Future Research

Having discussed 'what has been' and 'where we are now', we turn finally to discuss 'where we are going'. In the present section, we first consider some additional directions for research. We then identify some general issues for research to address in the foreseeable future. These include challenges to the evolutionary assumptions that are made by some theories concerned with nature experience and health, as well as individual differences in responses to nature.

5.5.1 Additional Topics for Research

In the foregoing section we discussed a number of psychological processes that have implications for well-being and health. There is too little space here to go into the many possible directions for further research concerning those and other processes, but two other topics deserve at least brief mention here. They are self-regulation and place attachment.

In our discussion of restoration and restorative environments we mentioned that people come to learn that some places are more likely to support restoration than others, and that they may be able to apply that knowledge in managing their adaptive resources. This kind of behavior is integral to self-regulation as described by Korpela (1989); the person acts to maintain a favorable pleasure-pain balance, assimilate the data of reality into a coherent conceptual system, maintain a favorable level of self-esteem, and maintain relatedness to others (Korpela et al. 2001, p. 574). The person attends to these functional principles with the use of a variety of strategies, such as the selection of a place in which he or she can feel a particular way, be alone or with others, and so on, as desired. Self-regulation will periodically involve restoration (Korpela and Hartig 1996), and some people may on a given occasion prefer to go to a natural environment for that purpose, but they may turn to nature for other reasons as well (see also Scopelliti and Giuliani 2004). They may, for example, want to experience a feeling of vitality (Ryan et al. 2010). Whether for vitalization or restoration, the use of environments for self-regulation is seen as having clear relevance for health. Further research might fruitfully study a broader range of complementary processes within a self-regulation framework, including restoration and vitalization with nature experience.

A second topic that deserves mention here is the feeling of a connection to nature. Several researchers have in recent years proposed concepts that relate to this general theme, which involves the feelings that people have when they are in nature as well as the feelings that they have toward nature. These concepts include emotional affinity with nature (Kals et al. 1999), inclusion of nature in the self (Schultz 2002), environmental identity (Clayton 2003), and connectedness to nature (Mayer and Frantz 2004). Recent empirical work confirms the impression that these concepts overlap to a large degree (Brügger et al. in press). Nonetheless, it is of interest that these expressions of an emotionally laden bond with the natural environment appear to motivate behaviors intended to reduce harmful impacts on the environment. In a similar vein, research has found that people who endorse the use of natural environments for psychological restoration perform more behaviors that could be considered environmentally friendly (Hartig et al. 2007). Research can thus consider a dynamic in which health promotion and protection of the environment are mutually reinforcing. This is not a new idea; we alluded to it in our discussion of the development of the environmental movement. It remains however for researchers to further study its practical potential.

5.5.2 Challenges to Evolutionary Assumptions

We suggested earlier that efforts to understand health in relation to nature will increasingly try to account for the combined contributions of innate, cultural and personal determinants of aesthetic responses to nature. To do this will require, among other things, attention to developments in evolutionary theory and related research. The evolutionary assumptions that underlie much of the current thinking about nature experience and health apparently have undergone little review since their formulation in the 1960s and 1970s. Consequently, some researchers still take it as an article of faith that too few generations can have passed for humans to have acquired biological adaptations to built, especially urban environments. The validity of this belief ought to be assessed in light of current research (Joye 2007). For one, paleoanthropologists have questioned the idea that the savannah was the unique environment of evolutionary relevance (Potts 1998). For another, 'humans spread out of Africa's savannas at least 1 million years ago', and 'we have had plenty of time since then – tens of thousands of generations – to replace any original innate responses to savanna with innate responses to the new habitats encountered' (Diamond 1993, pp. 253–254; cited in Kahn 1997).

Aside from work in paleoanthropology, recent decades have witnessed a sustained challenge to the orthodoxy that the environment does not affect genes as they pass from one generation to the next; the environment has been accorded a role in the generation of heritable genetic variation, in addition to its role in the selection of adaptive variants (Jablonka and Lamb 1998). This may open for more rapid change in ecologically relevant traits in natural populations. While geneticists and molecular biologists are busily investigating the processes of epigenetic variation and inheritance, ecologists are working to get a grasp on their real-world causes and consequences (Bossdorf et al. 2008). Their work may enable a more precise description of the relationship between health and nature as part of a process, long since recognized, in which biological selection and culture have come to play mutualistic roles; people shape the environment which then shapes them (cf. Dobzhansky 1962; Dubos 1965; Hartig 1993). In this process we can understand individuals not only as carriers and reproducers of genes, but also as carriers of meaning who reproduce something of the meaning structure of the culture in which they are embedded. If a particular culture maintains that a strong link holds between nature and health, individuals within that culture may act on the environment in a way that both reinforces those meanings and affects the environment which generates and selects genetic variation.

5.5.3 Individual Differences in Responses to Nature

Perhaps in keeping with evolutionary conceptions that emphasize uniformity in response to nature, the research on nature and health has not yet seen a sustained effort to address the possibility that there are systematic differences across individuals in responses to nature. There are several types of personal variables that may account for differences in the strength and/or direction of nature-health relations in the short or long-term. These include socio-demographic variables such as gender, age, income, education, and socio-economic status; personality traits such as sensation-seeking (Zuckerman, 1994); motivational orientations and needs such as the need for autonomy (Deci and Ryan 2000) and the need for structure (Van Den Berg and Van Winsum-Westra in press); knowledge-related variables such as images of nature (De Groot and Van den Born 2003); personal experience with certain types of environments, including regional or local familiarity, childhood experiences (Ewert et al. 2005), and place attachments; and, finally, phases across the life span, including the various developmental stages of children (Kellert 2002).

Traditionally, research on individual differences in response to nature has focused mainly on the socio-demographic correlates of visual preferences for landscapes with varying degrees of human influence (e.g., Strumse 1996; Simoni 2003; Van den Berg et al. 1998). Other research on visual preferences has looked beyond socio-demographics to consider personality variables. For example, Abello and Bernaldez (1986) found that those of their subjects classified as less ‘emotionally stable’ preferred landscapes containing structural rhythms and recurrent ‘patterns’, while those with high scores on ‘sense of responsibility’ tended to reject hostile, defoliated or wintery landscapes, despite their greater legibility.

Personal variables may not only moderate visual preferences for nature, but are also highly relevant to people’s health responses. In health psychology it is commonly acknowledged that people cope very differently with health threats (Leventhal et al. 1984). These differences are not only related to personal variables (e.g., neuroticism), but also to the availability of social and environmental resources that may be used to deal with health threats (Stockdale et al. 2007). Consistent with this latter notion, recent epidemiological research in the Netherlands has found that relations between green space in the living environment and self-reported health are stronger for groups who are more home-bound, and thus more dependent on the supply of green space in their neighborhood, such as children, housewives, and the elderly (De Vries et al. 2003; Maas et al. 2006). Other recent research suggests that gender as a marker of social roles and behavioral norms may also condition the health benefits that adults realize from opportunities for experiencing nature. For example, in a longitudinal population study of urban residents in Sweden, ownership of a leisure home was prospectively associated with a lower likelihood of early retirement for health reasons among men (Hartig and Fransson 2009). Among women, highly educated ones in particular, the likelihood of early retirement was greater with leisure home ownership, possibly because the leisure home imposed additional domestic work that outweighed the benefits of contact with nature. In addition to their implications for further research, such facts deserve consideration in the policy, planning, and health care contexts in which ideas about health benefits of natural environments are put into practice.

5.6 Conclusions

Ideas about health in relation to the experience of nature have a long history. The current research on the topic can be seen as a recent expression of a number of long-running, intertwined, social and cultural processes. Those processes have converged with developments in scientific and professional fields to provide compelling reasons for systematically studying nature experience and health and relatively good scientific capabilities for doing so. In challenging 'common sense' views about nature and health, researchers today are using those methods and theories now viewed as scientifically credible, but researchers in the future will undoubtedly, in line with their professional responsibility, find fault with some of the methods and formulations used today. Nonetheless, there is good reason to think that our understanding of these phenomena is improving, as are the capabilities for putting them to use. Issues at the interface of research and application are addressed in the next two chapters.

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Chapter 6
Health Benefits of Nature Experience: The Challenge of Linking Practice and Research

Ann Van Herzele, Simon Bell, Terry Hartig, Marie Therese Camilleri Podesta, and Ronald van Zon

Abstract While there is a growing base of knowledge concerning the health benefits of nature experience, this knowledge appears to be insufficiently translated into practice. The perceived gap between research and practice is often explained by a lack of hard evidence on the effects and mechanisms at work. In this chapter we argue that strengthening the evidence base is only one of the areas where more needs be done. Converting the evidence into practice is a process that requires concerted attempts with different kinds of effort, and should therefore be viewed from different perspectives. We examine the topic from three distinct perspectives: problem definition (who is responsible?); acceptability (what constitutes acceptable evidence?); applicability (can the evidence be used in practice?). Throughout, we use examples from various disciplinary fields to illustrate the significant challenges and complexities faced in joining practice and research.

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6.1 Introduction

The previous chapter discussed the various ways in which psychological, social, and cultural processes can link the experience of nature to human health and well-being. It appears that we now have a substantial base of evidence concerning the physical and mental health benefits of nature experience. The literature on the topic is growing rapidly and, often thanks to networks with researchers, international donor agencies, national governments and other institutions, research has been financed in many countries. In several European countries, publicly accessible reviews of research have been produced and disseminated widely as, for example, in the UK (OPENspace 2003, 2008), the Netherlands (Health Council and RMNO 2004) and Norway (Bioforsk 2006). A basic awareness of the health benefits of contact with nature is also evident in society at large. People tend to consider the natural environment to be an important influence on their health and wellbeing. Leisure surveys, for example, have revealed that respondents visit the natural outdoors primarily because they want to relax and break away from the stress of the city and the routine of their job (Knopf 1987; Chiesura 2004; Bell 2008). '*I can recharge my batteries*' is a typical expression in this context.

However, set against this rather optimistic picture is a widespread sense of dissatisfaction with the application of research on nature and health relationships (e.g., Nilsson et al. 2007). Many researchers believe that the findings from their studies could be given a higher priority and used better in healthcare and in health-promoting decision-making in urban planning and park design. One example illustrating this point is that even something as simple as taking exercise in a green area is commonly left out of the consideration of appropriate treatment options when medical doctors give advice or write a prescription for their patients. An analysis of videotapes from 2,784 patient consultations with 142 Dutch family doctors found that exercise or sport was mentioned in about 26% of the doctors' advice, but 'nature' was never mentioned at all (Maas and Verheij 2007). In various European countries, the interest in more specialized treatments such as horticultural therapy and care farms is increasing, but there are still very few health organizations that are willing to invest in the development of this area (Abramsson and Tenngart 2006; Hassink and van Dijk 2006).

Clearly, the present challenge is to apply the knowledge on nature and health relationships in such a manner that the fuller potential of these relationships is realized. It is remarkable, however, that in this context the perceived gap between research and practice is often explained by a lack both of awareness and of hard evidence on the effects and mechanisms at work (Nilsson et al. 2007). The solution is then typically sought in increased investment in new research, combined with greater coordination and communication of existing knowledge. An exhaustive review study in the Netherlands (Health Council and RMNO 2004), for example, concluded that if the important link between nature and health is to play a serious role in both healthcare and debates over spatial planning, it will be necessary to expand our knowledge base concerning the mechanisms that are responsible for the beneficial health effects of nature.

The production of high-quality evidence is still considered the most critical factor for successful implementation of research into practice. If the evidence is seen as being of low credibility and weak, it is likely to be ignored. However, as we will demonstrate in this chapter, much more than sound evidence is necessary. Professionals are not ready simply to apply new knowledge, even if it is of the highest quality and widely disseminated by the health promotion organisations. Let us consider again the simple example described above, where nature was never mentioned whenever family doctors gave advice to their patients. This phenomenon can be explained in various ways, each having different consequences for any attempt to get the scientific results into practice.

Firstly, the doctors might be unaware of the evidence about health and nature because it is not presented or discussed in medical journals, conferences or seminars, which they use to update their professional knowledge. In this case it is necessary to raise awareness of the evidence in ways that are likely to be acceptable for them. Secondly, the explanation could be that the doctors have looked at the evidence but they or their guiding authorities are not yet convinced of the beneficial effects of nature, which means that implementation efforts should focus on increasing acceptance of the evidence among family doctors and health agencies. Thirdly, the doctors might be sympathetic to the use of nature as part of a health package, but they do not regard it as their role (or within their interest) to promote the beneficial effects to their patients. Hence, transferring responsibility for including nature-based therapies or prevention strategies in advice and prescriptions to family doctors may be appropriate here. Finally, perhaps the doctors were reluctant to include ‘nature’ in their advice or prescriptions because they had no idea about how this could be done in practice. In this case, efforts should focus on translating research into methods for practice (e.g. specifications of types of natural settings and nature-related activities).

What these ‘causal stories’ do make clear is that getting the evidence into practice is usually a process that requires concerted attempts with different kinds of effort, and should therefore be viewed from different perspectives. Other examples could, of course, be found from other professions to demonstrate the multi-faceted nature of research application. In fact, the broader the definition of health, the more inclusive it is in terms of diverse professionals being currently or potentially engaged. Table 6.1 presents an overview of professionals that could be involved in applying research on health benefits of nature experience. We have roughly divided

Table 6.1 Illustrative list of professionals currently or potentially engaged in practice that incorporates nature experience as a beneficial component

Medical (White)	In between (Candy-striped)	Environmental (Green)
General practitioners	Horticultural therapists	Horticulturalists
Cardiologists	Physiotherapists	Foresters
Endocrinologists	Psychologists	Landscape architects
Gerontologists	Pedagogists	Planners
Pediatricians	Animal therapists	Urban designers
Nurses	Occupational therapists	Ecologists
Diabeteologists		

them in three groups: those legitimized as medical health profession (white), those in environmental professions (green), and those occupying ‘in-between’ roles (candy-striped). Any attempts to enhance the application of research on nature and health not only have to take into account the diversity of the field but also its cross-disciplinarity. The challenge lies not only in bringing research findings and professionals closer together, but also in bringing the professionals together as well.

In this chapter we look at the challenges of joining practice and research on nature and health from three distinct perspectives: problem definition (who is responsible?); acceptability (what constitutes acceptable evidence?); applicability (can the evidence be used in practice?). Whereas the perspectives addressed are general ones, reaching across different professions, the examples used throughout the chapter often come from specific disciplinary fields. Other examples represent more integrated approaches (several of these are described more fully in the next chapter of this book).

6.2 Challenges of Joining Practice and Research

6.2.1 Who is Responsible?

To become involved in applying a given knowledge base, professionals (and their institutions) must be aware of its relevance in relation to any problems perceived and, importantly, they must be aware of the role they themselves can play in solving those problems. Thus, much will depend on what the ‘problem’ is and how it is defined. As Deborah Stone (1989, p. 282) reminds us: “Problem definition is a process of image making, where the images have to do fundamentally with attributing cause, blame and responsibility”. Let us take the example of the much-cited report, ‘*Reducing risks, promoting healthy life*’ by the World Health Organization (WHO 2002), which identifies physical inactivity as a leading risk factor for health in Europe. However, even when there is a strong statistical and logical link between physical inactivity and health, there is still a range of candidates to take responsibility for the problem. It is common in public healthcare, for example, to presume that people with sedentary lifestyles do not realize how important it is to be physically active or, alternatively, decline to change the lifestyle they find easy and comfortable. It is reasonable to assume that individuals, even if well-informed about the benefits of physical activity in natural surroundings, would prefer to take a drug for high blood pressure, for example, than to go out for a walk. However, even in this case various ‘white’ professions in the field of prevention, and also those in education, can play a role in enhancing awareness and supporting more active lifestyles. One example is the BTCV Green Gym program in the UK, endorsed by local health services and aimed at inactive people or people who want to getter fitter, but don’t like traditional gyms or sport centers (see the next chapter). Alternatively, instead of blaming the victim – the ‘inactive people’ – the facts presented in the WHO report may be used to criticize urbanism in general for its failure to provide environments that invite and stimulate people to be physically active. Undoubtedly, the green professions can play a role here. ‘Play forests’ situated close the city (for example, the Play Forest Mastbos in the Netherlands) are good examples of initiative taken to ‘return’ children and youths to nature as well to actively involve them in design and construction (see also the next chapter).

All of this is to say that the same facts can be interpreted differently, with each causal story having different consequences for possible courses of action. Good stories provide a store of reference points to draw on, giving professionals that could be potentially involved a new idea about their specific role and creating alliances between them (Van Herzele 2006). In the field of nature and health, responsibility cannot indeed be transferred to one single profession. A good example of alliance creation around a shared story is the Health Concordat in the Netherlands signed by Staatsbosbeheer (the Dutch forest service) and VGZ-IZA group (a private health insurance company). Together they develop innovative projects to promote the role of the natural outdoors in delivering health and wellbeing.

Despite the acknowledged importance of problem definition and story creation as a precursor to action, there is little inquiry about it in the field of nature and health. What is clear, however, is that science itself has been active in producing its causal stories. A quick survey of the international literature would show that environmental psychology has a long tradition in presenting natural environments as possessing restorative qualities (e.g., Knopf 1983; Kaplan and Kaplan 1989). Researchers in the domain of public health and preventive medicine took up the topic only more recently and have primarily associated natural environments with an increased likelihood of being active (e.g., Ball et al. 2001; Giles-Corti and Donovan 2002; for a broader perspective, see Frumkin 2001). The causal theories differ in the sense that in the former field, the experience of nature is of itself presented as having health enhancing properties, independent of the specific activity, while in the latter, nature is one of a variety of setting features that invite health-enhancing physical activities. Selectivity is always present as researchers highlight certain aspects whilst inevitably neglecting others (Van Herzele 2005). In this sense, researchers’ representations not only give credence to the importance of nature for health, but they are also implicitly acts of power, in that they direct attention to interventions that they see as important and hence, transfer responsibility to some professions and institutions rather than others.

Just as different causal theories place the burden of reform on some people rather than others, they also empower people who have the tools or skills or resources to solve the problem in the particular causal framework (Stone 1989). In particular, the ‘green’ professionals may welcome and use scientific evidence on nature and health to enable themselves to appear to be able to remedy the problem (for example, a lack of natural green space in particular areas), thus claiming responsibility for it. Researchers and professionals of practice may empower each other in this respect. The Norwegian Institute for Agricultural and Environmental Research, ‘Bioforsk’, for example, is very open about that. An important reason to produce a review report on nature and health relationships was “… to show the government the importance of urban green areas. In that way, there may be allocated more funding for area acquisition and money for the establishment and management of urban green areas" (Floistad et al. 2008). In effect, the green professions often constitute a delivering and a demanding party at the same time.

Having science on your side may help. However, there is no guarantee that the problem definitions derived from science will move the concept of nature and health forward on policy agendas. Another strategy to follow is to start from nature as a solution and to look for problems that happen to be high on the policy agenda and could be solved with it. One example to learn from is a problem story to promote the Integrated Healthcare model:

> There is an urgent need for Integrated Medicine training, teaching and research. The combination of aging populations, technological progress and an informed, demanding clientele will result in increasing financial strain in all healthcare environments. Predominantly tax based systems, such as Britain's National Health Service are particularly vulnerable to meltdown unless new approaches can be found to return people to health with simpler and cheaper holistic strategies (http://www.integratedhealthtrust.org).

The creation of linkages with discourses that dominate the policy forums of the time has also been evident in the promotion of urban forests (linked to quality of life in cities) (Van Herzele 2005) and particular types of community gardening (linked to the social inclusion of people with mental health problems) (Parr 2007).

6.2.2 *What Constitutes Acceptable Evidence?*

As is the case with all kinds of evidence, research findings on nature and health are open to multiple interpretations and different views exist on what evidence should be taken into account (Photo 6.1). In the UK, for example, there is currently a wide debate in the area of natural healthcare about what constitutes acceptable evidence, whose definition should be employed and about whether the outcomes should concern physical health issues or wider issues like reducing inequalities. Moreover, when evaluating the same evidence, different decision makers will use different criteria. Policymakers, for example, may look for societal gains in health and efficiency, while doctors may consider the wellbeing of their patients to be most important (Sheldon et al. 1998).

Furthermore, professions not only take different views about what constitutes relevant and credible evidence, but their views may have a different weight as well. Dopson et al. (2003) described the organization of healthcare as largely dominated by the medical profession, and the biomedical science model governs what is considered legitimate evidence. Prevailing views on what constitutes acceptable evidence may hamper simple interventions like writing a medical prescription to take physical exercise in nature, as well as the development of specialized treatments such as horticultural therapy and care farms. For example, the rehabilitation garden at Alnarp (Sweden) is inspired by a variety of theories about how nature-based interventions might help people suffering from a burnout syndrome (Stigsdotter and

Photo 6.1 Prevailing views on what consitutes acceptable evidence may hamper simple interventions like writing a medical prescription to take physical exercise in nature (Photo: Ulrika Stigsdotter) (*See Color Plates*)

Grahn 2002). That it took 2 years before medical doctors wanted to send patients there may have been due in part to a lack of acceptable evidence. The on-going efforts to evaluate the effects of the rehabilitation program at Alnarp can help not only in the further development of treatment methods and garden design, but also in enhancing credibility and acceptance by the healthcare system.

The 'medical model' in treating evaluations has, however, limitations as well. Henwood (2002, p. 13) for example, warns against relying upon an overly limited set of easy measures of health outcomes in evaluations of practical schemes: "The area of evaluation of health interventions is one where a desire for 'precision' of measurement can sometimes overwhelm the more difficult task of interpreting the meaning or implications of findings. Changes to more intangible aspects of wellbeing (e.g., sense of comfort, rootedness, restored mental vigor) and to the fabric of communities that are health-sustaining or enhancing are important issues for consideration."

Coming back to our main point, what is important to consider is that professionals are not passive recipients of research evidence. They do not simply receive information, and then decide whether to use it. Rather they engage in seeking information, in debating that information with peers, and frequently, in using their professional networks to actively adapt or translate what is advocated to their own situation (Fitzgerald et al. 2003). Professional networks or 'communities of practice' (Wenger 1998) are a prime basis for face-to-face interaction, for information and experience exchange, and for interpretation of evidence. They are thus key to the acquisition of scientific acceptance. Whereas little is known about the role of traditional, existing professional networks in the diffusion and promotion of acceptance of research on nature and health relationships, examples of new networks exist that involve professionals sharing natural healthcare or health promotion practices. Such networks may provide an arena for sharing experience and continuing professional development. One prominent example involves 'Forest schools', which philosophy is to encourage and inspire individuals of any age through positive outdoor experiences (http://www.forestschools.com/, see also the next chapter). Efforts are underway to establish a network within and between European countries aimed at developing communities of knowledge and giving confidence to those wishing to set up and run a forest school.

Whereas professional communities or networks may stimulate learning and change internally, they may block such processes externally. Several studies in the field of healthcare have demonstrated that both knowledge and social boundaries exist between professions and that they frequently inhibit the flow of knowledge (Brown and Duguid 2001; Dopson et al. 2003; Ferlie et al. 2005). Effective diffusion of knowledge is most likely where practice is shared (Brown and Duguid 2001). However, different professional groups develop distinctive knowledge bases, research cultures and practical approaches. Even when people of different but closely-related professions such as doctors, physiotherapists, and nurses work in multidisciplinary teams, knowledge does not readily flow across the professions.

This problem is exacerbated by specialization, which also further complicates assignment and acceptance of responsibility for acting on the evidence. For example, the trend in medicine today is for specialization and super-specialization among medical practitioners. In this context, there is an ever increasing need for better co-ordination within and between various disciplines. In fact various networks exist to achieve this purpose. One example is Doc@Hand, an advanced platform of knowledge sharing and decision support for healthcare professionals (http://www.ehealthnews.eu/dochand). However, networking beyond the healthcare community is less in evidence, though efforts have been made in a number of countries to build new alliances – forums, networks and partnerships – across organizations and professions. One example is I'DGO – Inclusive design for getting outdoors – which is a research consortium consisting of a core group of academic researchers who, together with a wide range of partners, constitute a virtual centre of excellence focusing on design of outdoor environments to include older people and disabled people (http://www.idgo.ac.uk/index.htm, see also the next chapter). Furthermore, through collaboration in specific projects of natural healthcare, practice itself can act as a linking device that helps interested parties finding common ground, foster effective interchanges, mobilize new resources and speed the spread of new work practices. 'Walking the Way to Health Initiative' (http://www.whi.org.uk, see also the next chapter) in the UK is an example of good cooperation between two professional groups: the green professions represented by Natural England, and the white professions represented by the British Heart Foundation. The initiative provides a lot of support and a learning network for people who wish to lead programs in their area.

6.2.3 Can the Evidence be Used in Practice?

To have an effect on application in practice the evidence must not only reach practitioners but also become mainstream or the routine in their practice. However, academics cannot expect professionals of practice to adopt alternative approaches unless they demonstrate them effectively. Two critical but related points need attention here. First, as other chapters in this book illustrate, there are still substantial gaps within much of the available evidence. Second, not all of the evidence is presented in such a manner that it can readily be used in practice. When such gaps are combined with the many limitations and barriers faced by implementers, it makes the selection of appropriate interventions difficult (Blamey and Mutrie 2004).

In the field of health-enhancing physical activity, for example, substantial gaps relate to knowledge of the most appropriate settings in which interventions may take place; the minimum or optimum length of a program; the ideal intensity or saturation necessary to guarantee an impact; and the amount of tailoring for particular sub-groups that is required (Blamey and Mutrie 2004). Even when there is a strong evidence base for an intervention, there is often insufficient evidence on the conditions that make such intervention likely to work. Furthermore, practitioners have limited time to search and uncover evidence on what does and does not work in a given context and they can be criticized for progressing with certain programs despite insufficient evidence. Some institutions have attempted to overcome such problems more generally. For example, in the UK, the National Health Service produced guidelines that attempt to promote best and safest practice within the knowledge currently available (National Health Service 2001).

The other critical point is that mainstream research on nature and health relationships is difficult to translate into recommendations for practice. Using theories and empirical evidence to guide medical practice, program planning or urban design, requires translation of more or less abstract research on why people benefit from contact with nature into practical choices or decisions that are consistent with the research evidence. For this purpose, the linkages between what is advocated and current practice must be made explicit. This is often far from easy, and the ease or difficulty is likely to depend on the extent into which respective knowledge cultures may diverge. In some instances, research into the health benefits of nature may easily fit with dose-effect reasoning in medicine. For example, beneficial effects of certain levels of physical activity can quite easily be translated into individually tailored programs of physical exercise. However, as we mentioned above, even that is not always the case.

Especially in the field of environmental psychology, the implementation problem is already ‘built-in’ in much of the design of the research studies. First, the emphasis in research on benefits of nature experience has been primarily on urban constraints rather than opportunities; the positive aspects of urban living are often insufficiently appreciated (Verheij 1996; Henwood 2002; Karmanov and Hamel 2008) or assumed to exist (Hartig 1993). One approach, for example, is to contrast natural environments with urban environments lacking the beneficial properties of the former. Consequently, where planners or urban designers aim to improve health-enhancing capacities of cities, the emphasis on urbanity as a negative variable may hinder the effective application of research. Second, implicit in much of the research into human-environment relationships is the emphasis on the discovery and interpretation of the construction of human preferences, attitudes and values, rather than on ‘place creation’ (the lay out of a park, the choice of vegetation, etc.) that follow from those constructs (Van Herzele 2005). Likewise, these studies do not necessarily provide guidance to effective site-specific action. Moreover, how can planners handle abstract concepts of an environment’s restorative quality, such as ‘mystery’ and ‘complexity’ (Kaplan and Kaplan 1989) in a concrete planning situation?

Again, the diversity and cross-disciplinarity of the field is a complicating factor. In the field of medicine, for example, most traditional interventions are developed by medical researchers, presented in medical journals and prescribed or carried out by medical doctors. The product chain is more or less clear, the participants are familiar and confident with the system and they know the language. In the field of nature and health this is far from the case. A significant part of the work of translating research into practice is essentially about reconciling different knowledge cultures. This is especially evident in the case of planning. Whereas much science is about analysis (what is, what was), planning is about composition or synthesis (what will be). As a future-oriented activity, planning is all about thinking and acting now with the intention of ‘making a difference’ to the value of spaces and places in the future (Van Herzele 2005). It follows that the generalized information made available from mainstream research might be useful in providing warrant or justifications for certain policies and plans but it is of little value for planners who must make practical decisions.

In his study of landscape perception in the Netherlands, Coeterier (1996) maintained that environmental psychologists work inductively: they try to abstract general rules from individual cases. Planners and designers instead work deductively: they translate general rules into concrete measures. He suggested that researchers and practitioners therefore may meet halfway, at the level of principles for practice. Thus, the type of information practitioners require is scientific evidence that is appropriate to put into practical guidelines regarding what is to be done. Practical guidelines may indeed have an important role to play in facilitating the application of research, that is, by making abstract theory easier to imagine, to translate into action programs, and to address technically (Van Herzele 2005).

There are surprisingly few published guidelines explaining how to put the research findings into practice and apply them to specific situations. Guided by theory and empirical evidence on nature experience, concrete recommendations have been made by Anne Beer (1990) and by Kaplan, Kaplan and Ryan (1998).

In particular, the latter book – 'With People in Mind' – has focused on the psychological dimensions of having nature nearby. However, translating research results into practical guidelines is not easy, partly because the information is seldom in a format that can be used for site-specific situations. An alternative approach is to test and develop the required knowledge within practice itself. This relates to a methodological approach known as 'action research' (Greenwood and Levin 1998). Establishing causality – for example, why one benefits from nature experience – is not the prime interest here. Rather it is learnt from experience how one benefits from what. An example that comes close to this idea is the earlier mentioned rehabilitation garden at Alnarp, where the continual evaluation of patient outcomes is contributing to improving treatment methods and garden design.

Furthermore, and more generally, it must be recognized that practicing professionals, and the institutions they serve, do not start from a blank sheet. People work within an inherited set of institutional arrangements and routines that set an important context for their working practices. It seems obvious, therefore, that highly defined or 'micro' interventions like placing more green plants in a hospital would be much easier than interventions that require organizational and technical changes such as introducing horticultural therapy in that same hospital. Moreover, practicing professionals may hold differing interests and positions in the topic. As we mentioned before, the green professions can more readily take advantage of almost any evidence on a positive relationship between nature and health to strengthen their positions. In contrast, the white professions appear to a much lesser extent a demanding party in this topic, and for several professionals in this field such evidence might be rather disturbing to established practices. As Fitzgerald et al. (2003) suggest, a medical practice community may be reluctant to accept the efficacy of a novel treatment because it threatens their established skill base and thus threatens their status and professional position.

Finally, in many cases, a contributing factor in implementation is whether the research can be applied to a large population. In natural healthcare, in order to be of use, many applications need to be adapted to specific physical and social environments (e.g., Hartig and Cooper Marcus 2006). But the more adapted they are, the more selective they might become. For example, garden designs for people with visual impairment or for people recovering from brain injury or burnout are only applicable for, and also communicated to, specific segments of the population. Implicit in any application or technology is a social 'code' that makes it potentially applicable to a limited group (Leeuwis 2004). This aspect of healthcare applications is not necessarily a problem, but it is not always recognized in practice.

6.3 Conclusions

In this chapter we have sought to make links between Chapter 5, which examined the theoretical basis for nature and health and wellbeing and the generation of formal research in this area. The focus in this chapter was on the challenges and complexities of applying that research in practical settings. We have noted that there are several issues which can potentially create barriers preventing the research findings from being implemented in practice, such as lack of awareness among professionals of practice about the role they can play in research application, the standard of evidence required by the medical profession, the constraints of working (and networking) across professional and organizational boundaries, and the character of the research evidence itself, being difficult to translate in practical guidelines for effective (site-specific) action.

Owing to the complexities noted above, applying research has its challenges and much more needs to be done. Improving and extending the evidence base is only one of these areas and in the long run may not be the most important factor. This may be the institutionalized aspects of the professions and their traditional ways of working. Projects such as the Walking the Way to Health Initiative, jointly developed and run by English Nature and the British Heart Foundation may be good examples of how different disciplines can actually work together. Another issue that needs further attention is the way professionals can take account of how decisions and practices are perceived by a public actively engaged in judging what is personally and socially of value (Henwood 2002). With an increasing emphasis on community involvement in the design and delivery of community-based programs, there is an obvious balancing act required between making local adaptations to programs and ensuring enough of the intervention is intact to maintain the key criteria that made it effective in the first place (Blamey and Mutrie 2004). In several instances, however, joining practice and research is a process with no fixed end point or goal to reach. Practical experience is built with trial and testing. New approaches, even when they had originally started from broad theory, are likely to change over time. Whatever started as a traditional evidence-based practice – using formal research to inform the work of professionals – may evolve through experience and feedback, and as a consequence new goals may come into the picture. A more experiential approach to nature-health relationships (also known as 'action research', see Greenwood and Levin 1998) has also a strong potential for application in wider processes of public policy and planning. Rather than concentrating attention on specific objects, such as the lay out of a park, the aesthetic quality of streets, a view from the window, etc., the emphasis is here on designing effective methods to obtain and evaluate the health effects in populations as an integral part of the policy and planning process.

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Chapter 7
Health Benefits of Nature Experience: Implications of Practice for Research

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Abstract This chapter takes the theories and applications discussed in the previous Chapters 5 and 6, and considers the implications for practice and research. It takes as a starting point the fact that practice in applying therapeutic benefits of access and exposure to nature is not simple and that the benefits can be obtained in a number of different ways. Moreover, a single area of green space may deliver many different benefits to different people in different ways. A scenario is used to demonstrate this. The other dimensions which affect therapeutic aspects concern the potential benefactors – their life stage, lifestyle and contextual factors. The issue of research and building up the evidence base is also considered, with project evaluation and action research being two of the most promising routes. This scene setting is then developed into a demonstration of some projects which apply knowledge about the benefits to health of green areas and which have been scientifically evaluated and the results of which can be used to improve practice in the future. In conclusion the chapter suggests that the accumulation of the evidence base is a cyclical process of practice based on current evidence followed by evaluation and modification of practice which is then evaluated and so on.

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7.1 Introduction

One of the cornerstones of this book is a belief in science as a means to understand and develop promising nature-and-health applications. Most if not all of the chapters in this book implicitly or explicitly affirm the belief that scientific research can bring about more effective use of nature-based practices in the service of human health. Yet, the attribution of generative power to science is only one of the foundational components of this book. Another has to do with the ways in which practice can stimulate research. It is important to remember that some of the practices that researchers have taken interest in over the past several decades have histories that stretch back hundreds, if not thousands, of years. In many places, at different historical moments, people have applied widely shared beliefs about experiences and activities in natural surroundings as means to promote good health and prevent ill health, and they have done so without what would today be considered high-quality scientific evidence as a justification.

In the world of practice the relationship to research is not a clear and linear one. Quite often practice is implemented through a range of mechanisms, and from a number of directions. It may be the case that an intervention is first made on the basis of a personal belief. For example, an influential person may believe on the basis of his or her own experience that going for a walk serves health, and that person may then begin to encourage official support for the idea that it would be a good thing if other people walked more. Once again, if people started walking as the result of a promotional campaign by a health agency, it would then be possible to evaluate the health effects in a formal study, the results of which could be fed into improvements in practice, such as recommendations regarding how often to walk, for how long, at what level of effort, and so on. Alternatively, there may be no intervention organized by a health agency but instead a local green initiative such as the establishment of a park, which may encourage people to go out of doors for exercise because it is on their doorstep. Once again, an evaluation project may be able to demonstrate a variety of benefits for health and well-being, and these research results may then feed back into further practice.

It follows from these examples that the relationship between research and practice can take several forms. Practice may stimulate formal evaluative research that feeds back into practice. Informal evaluations of practice in one context may stimulate the spread of the given practice into other contexts, where it is again evaluated informally. Basic research, not initially intended to guide practice, may come to be applied in specific ways that are then evaluated, formally or informally. This is hardly an exhaustive list of possibilities, and indeed the ones listed here are deceptively simple, in that they portray a seemingly straightforward, linear process. The field of practice is fuzzily bounded both physically and theoretically, and the relationships between practice and research are often messy and untidy, with multi-stranded feedback loops.

The present chapter addresses some of the implications of practice for research on health benefits of nature experiences. The chapter is organized in four main parts.

First, we illustrate through a scenario just how complex the relations between practice and research can be. Second, we present a conceptual framework that can be used to identify some of the sources of complexity in implications of practice for research. Third, we present a number of examples that illustrate practical applications that, while much more limited in scope, nonetheless present challenges for research. Fourth, we acknowledge barriers to use, and note that practice generates research needs with regard to ways to overcome barriers and strengthen facilitators of use.

7.2 Complex Relations: A Plausible Scenario

In the cases of interest to many practitioners in this area, the locus of the research-practice interface is some kind of green area, in which different people, activities and setting characteristics interact over time. In the following, we present a scenario that illustrates some of these interactions. The scenario concerns the involvement of a local community in the creation and maintenance of a neighborhood green space, as well as the benefits of that involvement in terms of health and wellbeing. This scenario takes a realistic situation, based on an amalgam of several actual examples, and illustrates the complexities of the situation that can present challenges for researchers interested in determining how benefits arise and at what level they occur.

The situation concerns former industrial land in a river valley lying between two main residential areas of a hypothetical European city. This land is available for the creation of a new public green space that will be within easy reach of the residents of both residential areas. One of the residential areas is a poor, run-down inner city area of mixed housing – public housing in blocks of flats, private sector rented multiple-occupancy houses and flats, and older, small private houses built at the time of the industrial development of the area. This area has high unemployment, an ethnically mixed population including recent immigrants, and a mobile migrant worker population employed in construction and the service sector. The other residential district comprises a leafy suburb of well-off middle class detached and semi-detached houses, some newer developments of flats for younger professional people, and several sheltered housing developments for older people. The area has many gardens with lots of trees, and it connects with green-belt land on the other side of the district. Most of the residents are car owners.

The existing health and well-being conditions of both areas conform to the stereotypes described above. The residents in the middle class area are generally healthier, but many do not take sufficient exercise, are unfit, overweight and suffer from other ailments. The residents of the poorer area tend to suffer from overweight, lack of exercise and a diet which is less good than that in the middle class area, though many of the men in manual jobs are fitter.

An initiative by the city council has highlighted the potential of the derelict land as a place for environmental improvement and for the development of a local recreation area. The plan is for a new urban woodland park. The planners believe that if they develop the area without the involvement of local communities, then the new park will be likely to suffer from vandalism and neglect, so they promote the idea of a community woodland and set up a public meeting to promote the idea and to facilitate the development of a group of local residents to take the project forward. After some time a committee is formed from residents of both areas, therefore linking them together in pursuit of a common goal.

The planning phase brings the community together in a series of meetings and other events. This enables people to work together and to foster the beginnings of a community spirit and start to build up social capital. Once the planning is underway and local children as well as adults have been involved, planting begins. This affords many opportunities for everyone who wishes to take part. Tree planting can be quite hard physical work so it provides good exercise in fresh air for those taking part. The children learn about nature and establish a sense of identity with the new woodland which will be a valuable place for play over the coming years. Some who do not plant come and join in the support of the project, which thus gets some otherwise socially isolated and depressed people out of their house, meeting other community members and helping to reduce their psychological distress. Members of the immigrant community also take part and so help to overcome some of the cultural barriers to using green areas.

Once the woodland has become established it becomes a well-used play resource, opening for the children who planted it to become attached to it and protective of it. Both their improved health and fitness and their emotional attachment to the place may stand them in good stead in later life. The paths and benches installed at the time of planting were made by local residents and also encourage attachment. These facilities enable the older and less able members of the community to use the area for fresh air, exercise and to meet each other. It also enables the widows and widowers to meet other people of all ages and to feel less socially isolated. The ongoing maintenance, litter collection and additional work on paths or other facilities keeps many people active and in contact.

The regular use of the area makes it feel more secure so that women and some members of ethnic minorities feel safe using it at most times of day. Parents with young children also like to use the woods because they are safe and they can get out of the house for some time and meet other parents with young children. Access to the woods is free and once there, it does not matter which part of the area people live in, so that middle class parents meet working class parents and the children can play together with few worries about safety.

People who feel tired and stressed after the workday are able to visit the woods to wind down. Many people take advantage of the network of paths to walk or jog for a while before or after work.

As the children grow older, the woodland which they helped to plant matures along with them. They know the woods well and feel comfortable using it for more social activities. Eventually they grow up and have children themselves. Since they grew up with the woods – and helped to plant them – they are happy to introduce their children to them at a very early age. They are also happier to let the children play freely at quite a young age because they know the woods are safe and that the neighbors will keep a look out.

The woods offer a democratic space where everyone is free to go regardless of social background. It also offers different opportunities to different individuals and different sections of society. The resource created is used by local practitioners, such as doctors who recommend that their patients take more exercise or visit the area to recover from stress, as well as teachers who use the space to let their young charges burn off energy while learning about the natural world. Altogether, returning to the point of this scenario, practice, as expressed in the process of establishing the woodland, generates many intertwined processes of interest to researchers concerned with relations between nature experiences and health. The scenario suggests that researchers could in fact try to evaluate the effects of the new woodland on the whole community from a variety of health and wellbeing standpoints, recognizing that different members of the community may together have enhanced their well-being in multiple ways – physically, mentally and socially – through involvement in the project over time. In order to explore this potential further, it should be useful to consider more systematically how particular individuals have health and well-being needs which might be served by a local green space project. Toward this end, in the next section we present a conceptual framework that comprises some of the relevant variables indicated in the scenario. Among other things, the framework specifies some sources of complexity in implications of practice for research.

7.3 A Conceptual Framework for Indentifying Sources of Complexity in Implications of Practice for Research

The conceptual framework can be considered as a three-dimensional matrix that comprises the life stage of an individual at a given time, a number of lifestyle factors that affect the health and well-being of that individual, and a set of social variables which describe the broader context for that individual's life. Any individual will therefore, at a given time, at a particular life stage, demonstrate a particular combination of lifestyle and other factors and will occupy a place within the community both in the sense of where he or she lives and the social settings and the networks to which he or she belongs.

Many of the different variables are related. Thus, when one aspect of a person's circumstances changes, this will also affect other aspects. The resulting changes may increase or reduce the state of health and well-being of the person. The role of the natural environment in mediating or moderating these changes will inevitably depend on its accessibility to the person and the degree to which he or she takes the opportunity to engage with it in whatever way or degree is comfortable.

It is assumed that contact with nature can operate in several different ways on an individual at the same time (physically, mentally, and socially, for example), and that when members of a social group or community engage with nature together, the effect on the individual members can be multiplied into a wider additional community benefit, as described in the hypothetical scenario.

The matrix is necessarily a simplified representation of reality, a tool to check the many elements that may interact in a specific situation. It is by no means complete, covering all relevant elements, but it serves the purpose of demonstrating that there are indeed many elements that interact when practice opens possibilities for people to come into contact with nature in ways that research may subsequently show have implications for health.

Life stage This term refers not to age groups but rather to stages that an individual passes through, to some extent independent of age except at the extremes of early childhood and late retirement. In Table 7.1 we provide a practical derivation from life stages described by Erikson (1950) that still have currency in important respects. In the table we describe briefly the main attributes of each life stage for the purposes of this chapter.

Lifestyle factors At each life stage, the opportunities for developing and maintaining a foundation for good health and well-being, as well as the kinds of health challenges faced, depend on a number of lifestyle factors that may be partly a matter of personal choice and partly socially and culturally determined. This is the second dimension of the matrix. Table 7.2 presents a selection of those lifestyle factors that are frequently cited as being important for a range of medical conditions such as diabetes, cancer and other illnesses.

The factors listed above tend to be associated with each other. For example, poor people tend to live in poor housing, have less satisfying jobs or no job at all, have a poorer diet, low levels of exercise, be least well-educated and as a result also have the worst levels of physical and mental health and life expectancy. People with more economic resources have more choices and this is reflected in relatively better health and a longer life expectancy.

Social and community variables While the factors listed in the previous section might be attributed to individuals or families, they may also be looked at as manifestations of wider issues that also affect health and well-being at a community or societal level. Communities are generally considered to be either communities of place, where the geographical location determines the members of a community, such as a rural village, or communities of interest, where common interests unite people who might otherwise live in different areas. Social aspects such as the composition of the household also affect the way in which individuals participate in social networks. Increasing mobility also has an impact. This is the third dimension of the matrix (Table 7.3).

As with lifestyle factors, it can be seen that these social and community variables are not independent but tend to work together.

The scenario of the urban woodland park provided a variety of insights into how the new park functions and what benefits it provides. It illustrated how people at each life stage gain benefits from regularly using it. The woods provide a means of obtaining increased physical fitness through direct work in them or from using them for walking, jogging or playing. Children and young people can use them freely and gain an increased sense of self confidence and attachment to place which may be passed on to the next generation when they have children of their own. Single people have a chance to meet other people in a shared community space and

Table 7.1 Life stages

Stage	Characteristics of the stage
1. Young childhood	This is the stage at which individuals are most dependent on others – their parents and carers – and lasts until they begin to participate in activities away from their parents and with some degree of independence, for example walking unaccompanied to school or playing out of doors by themselves with little or no supervision. The age at which this takes place may vary. In a rural location, children may wander freely at a young age, perhaps five or six, while in an urban area where the parents perceive there to be many risks, the child may not be allowed out alone until they are 10 or 11
2. Pre-adolescence	This stage starts at the end of early childhood and lasts until around 13 years of age in girls and 15 in boys, although it can vary substantially. Children are given more freedom of action and can undertake activities unsupervised. Their territorial range of movement increases as they get older. Children are interested in exploring their environment
3. Adolescence	At this time social concerns begin to dominate over exploration of the environment, as children's sense of themselves increases and they struggle to establish a sense of identity separate from their family and as part of a peer group. Boredom may occur, leading to acts that represent some form of rebellion against adult society
4. Young adult	Post adolescent individuals are usually studying or working, although some may be unemployed. They begin to mature, gain more freedom and have few ties or responsibilities. They have their own incomes and tend to socialize in small groups with similar interests. Pairing off tends to occur at some point, although there is much variation in the age at which they start families. Some individuals remain unattached or paired off but child-free, others delay settling down and having children until they feel forced to do so by approaching biological limits. Thus this stage may extend until some people are in their 40s, while a teenager who becomes pregnant and has a baby may begin the next stage while still in adolescence
5. Families with children	This life stage sees the focus of the person shift from him- or herself and the peer group to the family unit, including children and their needs. Often financial issues affect freedom, limiting the scope to continue with activities pursued before having children, and many people may find this a dislocating experience. A parent's needs, especially while the children are young (pre-adolescence), are subservient to those of the children. While a parent may give older children more independence, they are still responsible and it is not until the children leave home that parents can recover some of the freedom they enjoyed before having the children. It may also be the case that, on having children, a parent gives up a career that he or she had pursued for many years The struggle of balancing work and child care can put strains on relationships. Some couples divorce or separate and bring up the children in different ways

(continued)

Table 7.1 (continued)

Stage	Characteristics of the stage
6. Empty nesters	For those people who have had children, this stage typically sees them leaving home for college or other pursuits. This stage may be a shock to the parent/s who have shared a home with children, since they have focused on them for 18 or more years and suddenly they have to become accustomed to a host of new possibilities. The empty nesters are commonly still working, although if they had children late in life they may be approaching retirement age by the time the children leave, so that they have a larger income than when they were younger and may be able to participate in a range of new activities. This transition may also place strains on a relationship with a spouse/partner and also lead to identity problems following the cessation of the parental role. However, additional responsibilities may also arise as their aged parents may need extra care and attention around this time
7. Retirement	The age at which people give up working varies from country to country and place to place. In many instances, the age of 60 sees many active and experienced people suddenly forced to give up the work which they have been doing for 40 years. For some this is a relief, for others it is a shock, since their life and even sense of identity and self-worth may be strongly associated with their work and career. Others may not be able to afford to give up work – small farmers may keep working and never formally retire. For those with good pensions and in good health, retirement may offer chances to develop new interests, to become involved in activities which make use of their work or professional skills in new ways. Others, perhaps with lower pensions and perhaps less well-educated, may have fewer possibilities. As time goes on, health and well-being issues become more important and limiting. This is the final life stage. Some might spend it alone, after the death of a spouse or partner

Table 7.2 Lifestyle factors

Factor	Characteristics of the factor
1. Nutrition	The kind of food people eat and the balance of key nutritional elements clearly have a significant influence not only on the level of overall health but, in the case of children, how they grow and develop and their health expectations in adulthood and later life. In Europe, food security is not a problem but achieving a correct balance of food groups and avoiding becoming overweight is a major issue
2. Amount of exercise	This has a major effect on fitness, health and well-being. Children need exercise to develop cardio-vascular health, flexibility, agility and motor skills. Exercise is necessary throughout life, but it is less and less an everyday part of many people's lifestyles in Europe and elsewhere. The combination of poor diet and lack of exercise is a well-known phenomenon contributing to the rise in obesity levels

(continued)

Table 7.2 (continued)

Factor	Characteristics of the factor
3. Work	The type of work and working conditions can affect health and well-being for those of working age, but the effects can continue beyond working life and into retirement. Hard manual work is less and less common, but while it can help to maintain fitness it may also result in longer term physical health problems. Conversely, office work may lead to significant degrees of mental stress but offer little opportunities for physical exercise. Some work situations may still expose people to hazardous environments, although health and safety legislation has reduced the risks to health and well-being of such circumstances in most European countries. Fewer people work mainly out of doors and indoor environments may contain less obvious stressors
4. Education and income	The level of educational attainment generally has a strong association with earning power, material standard of living, and choices regarding, for example, housing type and location. Poor people generally also live in poor environments, have poor diets, and suffer poorer physical and mental health. Better educated people generally exhibit the converse, being longer lived, better housed and with more awareness of how to keep a higher level of health and well-being through diet, exercise, and other lifestyle practices
5. Disability	Many people suffer from one or more forms of physical or mental disability which reduces their opportunities to participate fully in society. Older people are more likely to become disabled in some way. Locomotor disability and visual, hearing or mental impairments manifest themselves in different ways and affect a person's functional capacity in different ways
6. Leisure activities	In times of increasing leisure availability and opportunities people can choose to be physically active or sedentary, to pursue mentally stimulating hobbies or to avoid them. If work does not provide physical exercise or mental stimulation then hobbies and pastimes might be used to fill this gap. However, many popular games involve nothing more than sitting in front of a computer or television screen. A computer game may be mentally stimulating, but it offers no physical exercise. Television may offer neither. Older people who keep their minds occupied are more likely to retain their mental faculties
7. Living environment	The location and quality of housing has a strong association with health and well-being. A poor standard of housing – crowded, poorly heated, damp or unsanitary – may have obvious implications for health while poor surroundings, unattractive environments and lack of amenities such as open space or community facilities may contribute in less direct ways, perhaps associated with mental illness. Choice of living location is associated with income levels as noted above

Table 7.3 Social and community variables

Variable	Characteristic of the variable
1. Household structure	Households have been changing over recent decades. The nuclear family of two parents and a number of children has reduced in significance to be supplemented by single person households (including divorced and widowed persons), single adults living together, same-sex couples and single parent families. The "traditional" family provided social support, especially if extended to other family members living nearby, such as grandparents. For the other types of household, the persons concerned might feel more socially isolated and lacking in social support unless they make special efforts to participate in different communities of interest
2. Neighborliness	In many traditional communities, both urban and rural, neighbors helped each other and offered all kinds of support, from helping bring in the harvest in farming areas, to looking after children in working class industrial cities. Depending on how the community still operates, the level of neighborliness may be still strong (in rural areas) or very weak, especially in urban areas with a high turnover of residents, where few people know their neighbors
3. Migration	Recent years have seen a significant increase in various forms of migration in Europe. Migration as such is not new but there have been changes in the patterns and nature of migration. People arrive from outside Europe, people from one country move to another within Europe, and people move around within countries. The degree of social support they find on arrival at their destination can have a big impact on the way migrants assimilate themselves and their sense of well-being
4. Ethnicity	The ethnic make-up of society is also connected with migration. Many migrants belong to specific ethnic groups and may be able to tap into the existing networks. Ethnic groups may also live in certain locations, often urban and frequently not of very good quality. Ethnic cultures may differ from the host country
5. Urban structure	Cities are not homogeneous places. Different areas may have different densities of housing, better or worse access to transport, shopping or leisure facilities, be close to or far from green areas and be characterized by different social groups of residents. Some leafy suburbs are well endowed with gardens and green spaces or are close to large parks. Others may have high density, with few amenities and poor quality urban fabric. Social groups frequently tend to be segregated by their incomes and other factors and are found in particular areas of a given city or rural area

members of immigrant groups also have a chance to assimilate into the community and to find a space for social intercourse. The presence of nature moderates stress and has other positive effects on the mental health of many people of all ages. Older people can maintain contact with other generations and obtain fresh air, exercise and mental stimulation.

The scenario thus provided a preview of issues that could be specified with the conceptual framework just laid out. It also illustrated how the conceptual framework might be applied in identifying ways in which to provide for contact with nature as a general means to achieve benefits to health and well being. The next step in this chapter is to examine some of these themes in greater detail, to look at some specific practices that are being or might be evaluated by researchers, and to demonstrate how research evidence can be applied.

7.4 Illustrative Practical Applications that Present Challenges for Research

This section takes a number of examples where people in different target groups, defined with regard to age, ethnicity, gender or other variables, are helped and encouraged to make use of the outdoors and nature for the purpose of improving their health and well-being. These examples are from a number of projects where there has been a tendency to emphasize the needs of particular groups rather than to consider the wider community. However, such a focus on a target group entails a risk of foregoing opportunities to benefit a broader group. On the other hand, target groups may serve as proxies for a broader range of connected issues, so provisions for them may provide 'spill-over' benefits for others.

To ensure that the examples used here stand as a sound collection of good practices, the following criteria have been used in their selection

- There is a preference for good practices in which *research* has been done concerning the health effects.
- There is a broad diversity of intended or experienced *health effects*.
- It provides for wide *coverage* of possible nature/target group combinations.

Table 7.4 gives an overview of a range of possible good practices for different target-groups. The examples described in the table and at greater length below the table are chosen from among many possible examples of good practice. Contact information is not provided here, out of concern that addresses and telephone numbers may change. Interested readers should be able to locate the most recent contact information on the internet.

The next section describes a smaller selection of examples from Table 7.4 in somewhat more detail.

7.4.1 BTCV Green Gym, UK

The BTCV Green Gym provides physical activity and benefits for well being through gardening and local environmental improvement. Participants take part in activities such as planting trees, growing food on allotments and creating nature areas Van den Berg (2010). There are over 70 Green Gyms in the UK. All BTCV Green Gyms have the following features:

Table 7.4 Overview of good practice examples

Target groups	Nature-type or -activity	Name of example
Inactive people People who want to get fitter, but don't like traditional gyms or sports centers People with minor mental health problems, such as stress, depression or anxiety Children who don't take enough exercise, including overweight children	Program of physical activity through gardening and local environmental improvement. Participants take part in activities such as planting trees, growing food on allotments and creating nature areas	BTCV Green Gym, UK
For all	Outdoor circuits or tracks with gymnastic equipment laid out at intervals that are intended to encourage healthy physical exercise	Parcours Vita, Switzerland
Consumers in general and city dwellers in particular Special target groups are the elderly, people who are mentally challenged, drug dependent and homeless people, and children in special education	This project consists of the following three practical studies: – The setting up of a participation market that promotes the exchange of information and collaboration with care farms and learning farms in the vicinity of Amsterdam – A study of the characteristics of care farms and the development of instruments for measuring their effects – A participatory study that looks at the effects of learning by children on a learning farm	Green Care Amsterdam, the Netherlands
All people, especially those who take little exercise or live in areas where many have poor health	Program of walking for people in their own communities	Walking the Way to Health, UK
Elderly people	Activities in a specially equipped "green room" and a garden which is constructed to "non-bending height"	Seniors active in green rooms and gardens, the Netherlands
People with psychiatric problems	Doing meaningful work, living in a group and undergoing treatment in and around a care farm	De Hoge Born Care Estate, the Netherlands

Children from 6 to 12 years old who come as a group or with their families, and school classes, school trips and scouting groups	Wooded areas on sites where children can play freely. They are managed and laid out in such a way as to have extra appeal for children. A "play wood" is laid out to maintain its natural character. Man-made structures are kept to a minimum and natural materials are used wherever possible; the site is not equipped with traditional 'playground' equipment. In other words, the natural characteristics of the landscape are enhanced and exploited to increase the opportunities for playing	Woods for children to play in ("speelbossen"), Belgium and the Netherlands
Disturbed and disruptive children	A woodland is used for holding different lessons and children spend time there instead of in conventional classrooms. The woodland does not need any special features	Forest schools, UK
Ethnic minorities	A variety of activities are supported that open for experiences in green areas, and especially non-urban, countryside environments which are not familiar to some ethnic groups living in inner city locations	Black Environment Network, UK
People with a range of disabilities – physical, sight impairment, hearing impairment, mental health and learning disabilities	Forests of any sort, in all types of ownership made more accessible for general recreational access	Forestry Commission program for promoting access to woodlands by disabled people, UK
People prone to heart and circulation problems	Urban green areas used for walking	Glasgow City health walks, UK
Elderly people	Urban green spaces and parks close to where people live and the streets leading to them, reducing the barriers to increasing physical exercise for elderly people	Inclusive Design for Getting Outdoors, UK

- As a minimum, they offer weekly (approximately 3 h) sessions of practical activity throughout the year.
- They are endorsed by local health services, including doctors and nurses, who recommend people to take part in BTCV Green Gym.
- They follow health and safety procedures, including a risk assessment, first aid provision and warm-up and cool-down stretches to prevent injury.
- They aim to become self-sustaining. BTCV trains the participants so that they form their own community group which takes full responsibility for running the Green Gym program. These groups are run entirely by volunteers, independently of BTCV, after the first 2 years.

Target groups: The target group will vary, depending on the needs of the local community where the project is located. In general, the target groups include inactive people (people doing less than 30 min of physical activity five times a week, which is the Chief Medical Officer's recommendation), people who want to get fitter, but don't like traditional gyms or sports centers, and people with minor mental health problems, such as stress, depression or anxiety.

In addition, BTCV has launched a 'School BTCV Green Gym', where children who don't take enough exercise, including overweight children, can take part in Green Gym as an after-school club or as a physical education lesson. Each Green Gym session can accommodate approximately 12 participants, so each BTCV Green Gym involves approximately 40 participants a year.

Research into health benefits: The health benefits have been independently evaluated by the School of Health and Social Care at Oxford Brookes University. A National Evaluation began in 2003, and it found that BTCV Green Gym is socially inclusive and successful in introducing traditionally excluded groups to environmental conservation volunteering, whilst keeping an emphasis on health.

The the evaluation also found that 90% of participants who joined with well below average scores for mental and physical health showed an improved score over a time period of approximately 7 months.

7.4.2 Walking the Way to Health (WHI)

WHI (now referred to as "Walking for Health") is the largest national body promoting and setting the standards for guided health walks. It is a joint initiative between Natural England and the British Heart Foundation. According to the website, the short definition of a health walk is: "a purposeful, brisk walk undertaken on a regular basis." It can include any walk which is specifically designed and carried out for the purpose of improving an individual's health (English Nature 2010). The website goes on to say that it is the relative intensity of the walk for the individual and the regularity of participation that can really have an impact on heart health. With regard to cardiovascular health, the walk should be purposeful and 'brisk' (in other words more than just a stroll). Furthermore, it is claimed that organized walks (brisk or not) can have a health impact on individuals by providing an opportunity to socialize (good social networks enhance health) and a distraction from everyday stresses. The WHI thus aims to encourage people, particularly those who take little exercise, to do regular short walks in their communities. There are currently over 525 local health walk schemes.

This project also links with the national stepometer initiative, which gives stepometers to people to measure their actual levels of physical activity, via their general medical practices, thus linking the medical profession with the green sector and the walking initiatives.

Finally, the program also promotes Green Exercise, which is defined as any informal physical activity that takes place outdoors, such as gardening, cycling and walking in urban parks. Green Exercise connects people to nature in their local areas and is promoted as a cost-effective way of improving the nation's physical and mental wellbeing. Natural England is funding a 3-year Green Exercise program comprising one demonstration project in each of the nine government regions. This program began in November 2007.

Target groups: A general aim is to target less physically active people who are in a risk category for cardio-vascular disease as well as anyone who should increase their activity level.

Research into health benefits: In the past, there have been several evaluations of the initiative and at present Natural England is working with the National Institute of Clinical Excellence on a new nationwide evaluation designed to assess the link between health and the natural environment and help with promotion to healthcare professionals and potential funders. This in turn should help to determine the extent to which walking has a positive impact on both physical and mental health.

7.4.3 Seniors Active in Green Rooms, The Netherlands

Residents of Schoterhof Care Centre (Zorgcentrum Schoterhof) are given the opportunity to be closer to nature and even bring a little nature into their lives by means of a modified garden and a green room. The garden is made accessible for people in wheelchairs, and it does not require bending. The green room is a conservatory-type room where nature-related activities take place. With the aid of volunteers, indoor nature activities (e.g., sowing seeds, taking cuttings, working with plants, arranging flowers) are offered and residents can work in the garden either independently or under supervision. Residents who do not participate in the activities can simply enjoy the green room and the garden.

The objective is to initiate a new, nature-experience-based service focused on the accommodation, care and well-being of the elderly. The idea behind this is to enable residents to function independently for as long as possible and to provide them with meaningful activities with which to fill their days. This, in turn, adds to the welfare of the residents, volunteers and employees in the care home for older people. As a result of its low level of demand, nature in this context provides possibilities for enhancing well being for all conceivable target groups.

Target groups: The target group consists of residents of the care centre, psychogeriatric residents from the psychogeriatric nursing department and district residents aged over 65. People who are mentally and physically challenged may participate. Approximately ten participants join in the activities, which take place once a week. Other residents/visitors can make use of the conservatory for special events such as birthdays. The garden is open to everyone for gardening or just enjoying and has a spacious patio that is accessible to wheelchairs. The conservatory accommodates about ten participants plus supervisors. The patio provides room for 25 people and can be expanded onto the lawn.

Research into health benefits: Van den Berg and Custers (2010) recently carried out a study into the effect of greenery on participants during an activity. The study entailed measuring the degree to which participants' cortisol levels dropped during an activity carried out in a green room in comparison with a similar activity not carried out in a green room. For an evaluation in Dutch, see Andreoli (2003).

7.4.4 Forest Schools

A Forest School is an innovative educational approach to outdoor play and learning (2010). The philosophy of Forest Schools is to encourage and inspire individuals of any age through positive outdoor experiences. By participating in engaging, motivating and achievable tasks and activities in a woodland environment, each participant has an opportunity to develop intrinsic motivation and sound emotional and social skills. Children can learn about the natural environment, learn how to handle risks, and learn to use their own initiative to solve problems and cooperate with others. Children use full sized tools, play, and learn boundaries of behavior, both physical and social, helping them to grow in confidence and self-esteem. Forest Schools have children visit the same local woodlands on a regular basis and programs run throughout the year, for about 36 weeks, with children going to the woods in all weather (except for high winds).

Children, and more and more adults, need time to thoroughly explore their thoughts, feelings and relationships. This time and reflective practice develops understanding of the world, the environment and everything within it through the use of emotions, imagination and senses. It is anticipated that the forest environment also serves these activities. Being in the forest (or any green area) and away from built internal spaces is thought to provide a different level of stimulus and have positive effects on levels of anger, ability to concentrate, and other outcomes.

Target group: Children of all ages who have been excluded from mainstream school or ones at risk through behavioral problems, attentional disorder, and other psychosocial issues. "Normal" pupils are excluded.

Research into health benefits: A study by Jenny Roe (2007) documented benefits to target pupils with behavioral problems of spending time in a forest school. Rebecca Lovell (2009) has demonstrated the physical health benefits to the target children.

7.4.5 I'DGO (Inclusive Design for Getting Outdoors)

The overall aim of I'DGO has been to identify the most effective ways of ensuring that the outdoor environment is designed inclusively to improve the quality of life of older people (2010). Until now, little has been known as to what particular attributes of the outdoors are relevant to older people's quality of life.

7.4.5.1 Target Group: Older People Aged over 65

Research into health benefits: Surveys of people aged 65+ across Britain showed the importance of the outdoor environment in people's lives. Older people go out into their local neighborhood very frequently, regardless of season, and walking is very much the predominant form of transport. The three major reasons given for going out are: socializing, getting physical exercise and fresh air, and contact with nature.

Analysis showed that pleasantness and safety of open spaces, and the distance to them, were significantly associated with participants' satisfaction with life. A neighborhood environment that makes it easy and enjoyable to go outdoors was a significant factor in whether or not participants attained recommended levels of physical activity through walking (regardless of any sensory or mobility impairment), and it was a significant predictor of their health in general.

In terms of outdoor activity levels, good quality paths to local open spaces made a difference to the total time older people spent outdoors, as did good facilities in local open spaces and the presence of water. The most important aspects of local open space to participants were safety, having appropriate facilities, trees and plants and activities to watch, good maintenance, and no heavy traffic en route.

7.5 Barriers and Facilitators

The last example above illustrates an important point. Practice may have to help people overcome barriers to access if people are going to use natural areas. Regardless of whether or not it is possible to demonstrate positive health effects of using green spaces, it will be difficult to maximize such benefits if people are unable to visit them or do not feel comfortable visiting them. Using green areas, especially forests and woods, is not necessarily an attractive option for many people. If the area seems threatening in some way, then the idea of visiting, however beneficial for physical or mental health it may be, may well lack appeal.

Negative factors and perceptions can act as barriers to people, preventing them from obtaining the benefits of visiting green areas. Research into some of these aspects is quite well known. For women brought up in urban areas, woods, forests, and natural areas in general can be seen as fearful. Perceptions include fear of getting lost and fear of being attacked by strangers (Burgess 1995, Ward Thompson et al. 2004). Other factors that are known to affect the level of comfort include low levels of management, neglected sites, the presence of litter, and evidence of perceived anti-social behavior such as alcohol bottles, drug syringes, fires, vandalism and graffiti.

Parents may take decisions on behalf of their children by forbidding them from visiting certain places alone because of the perceived risks. In fact, urbanization with the concomitant increase in traffic that this entails, has taken children off the roads where they previously used to play, since parents prefer keeping them indoors watching television and playing video games because they perceive this as a risk free environment, although in actual fact this is certainly harmful to their health in the long term.

Ethnic groups may feel uncomfortable visiting forests or wooded areas because doing so is not part of their culture. People from tropical or sub-tropical regions may associate forests with the presence of dangerous wildlife such as poisonous snakes. If they came from rural areas where work was hard, the concept of visiting natural places to relax or for recreation may be an alien concept.

Disabled people may also be deterred from visiting green areas unless they are confident that they are accessible. Information on the condition of paths, such as gradients, surfacing and cross-slopes, are often needed, along with signs and benches. These provisions help disabled people feel confident that they can visit easily and obtain the benefits they seek. Improvement meant to improve access to disabled persons will also improve access to other users, such as the elderly and families with pushchairs.

People may adopt other strategies to overcome barriers, such as women going in pairs or groups rather than alone, or with a dog for protection; they may only choose places that they know are safe and accessible, which may mean travelling to a location further from home. Children may also visit places against their parents' wishes because they feel safe going there and also find such places more attractive for the simple reason that they have been banned for going there.

Practice thus has implications for research in that it calls for ways to overcome barriers and strengthen facilitators. The solution to the problem is generally by a combination of good management of green areas to reduce or remove the visible signs of neglect and danger and to reinforce a sense of welcome through targeted information and, perhaps, by the presence of identifiable staff such as rangers or park keepers. Another strategy is to manage the perception of risk by providing information about the true levels of crime or accidents in green areas, which are frequently much lower than the perception and also lower than in streets and residential areas. However, changing perceptions can be difficult.

7.6 Conclusions

In this chapter we have addressed the implications for research of practices that rely on natural environments as means to promote health, well-being, and development, in individuals and in groups or communities. In doing this, we sought to provide a contrasting view with regard to the relationship between research and practice in the nature-and-health field. The discussion here has in some ways been more speculative, and in other ways more solidly grounded in the specifics of what people do in natural areas, than the discussion in Chapter 5, which examined the theoretical basis for research and some practice concerning nature and health. The discussion here has also looked at a quite different set of research-practice challenges in comparison to Chapter 6, which addressed the problems faced in bringing research into practice.

The scenario presented in the first section suggests that there are a multitude of benefits to be gained from a range of ways of participating in nature-based activities. These may be informal and suit the individual's personal motivation, while others may be part of a community venture leading to social benefits which have an indirect but valuable benefit for well-being on top of the physical benefits of fresh air and exercise. Other activities may be organized and promoted by organizations targeting specific social groups such as older people or ethnic minorities, specific health issues such as ADHD in young people, or the exercise needs of adult males with high risk of heart disease. Such projects themselves, while sometimes implementing research findings, perhaps with faith in the benefits rather than being based on very compelling evidence, can themselves contribute to the evidence base in this area. This relates to a methodological approach known as 'action research'. Rather than research being a linear process of producing knowledge, which is later applied to practice settings, action research integrates the development of practice with the construction of scientific knowledge in a cyclical process (see Greenwood and Levin 1998). Establishing causality – for example, why one benefits from nature experience – is not the prime interest here. Rather it is learnt from experience how one benefits and from what. Over time, a 'repertoire of cases' can be developed and the findings generalized to theory. An experiential approach to nature-health relationships has also a strong potential for application in wider processes of public policy and planning. Rather than concentrating attention on specific objects, such as the layout of a park, the aesthetic quality of streets, a view from the window, and so on, the emphasis is here on designing effective methods to obtain and evaluate the health effects in populations as an integral part of the policy and planning process. Some of the examples cited in this chapter have contributed to the development of the evidence base by acting as action research models.

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Part III
Promoting Physical Activity

Chapter 8
Contributions of Natural Environments to Physical Activity

Theory and Evidence Base

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Abstract The idea that nearby nature stimulates people to be more physically active is quite popular. In this chapter the literature regarding the link between physical activity and the residential environment is scrutinized. More specifically, after introducing the main concepts and a theoretical framework the evidence regarding three categories of activity is examined: physical activity in general, walking and cycling (mainly by adults), and outdoor play by children. Overall activity is deemed important because of its link to total energy expenditure, and thereby health. However, the other two categories are more likely to be linked to green aspects of the environment. Also attention is paid to the possibility that activity undertaken in a natural environment is especially beneficial for one's health. At

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the end of the chapter conclusions are summarized, directions for future research are proposed and policy recommendations are given, as far as possible given the current state of affairs.

8.1 Introduction

8.1.1 What Is Physical Activity and Why Is It Important?

There are many different definitions of physical activity. The American Centre for Disease Control (CDC) defines it as '*any bodily movement produced by skeletal muscles that results in an expenditure of energy*'. The World Health Organization refines this definition slightly, calling it '*any force exerted by skeletal muscles that results in energy expenditure above resting level*' (Caspersen et al. 1985; Cavill et al. 2006). In simple terms, it is comprised of the physical actions in daily living, in household chores, in leisure time activities (including sports, gardening, cycling, walking, etc.) and in occupational activities (NIH 1996). International minimum recommendations for health-enhancing physical activity recommend 30 min every day (1 h for children) of moderately intense activity, which means getting somewhat out of breath without necessarily sweating (Cavill et al. 2006; WHO Europe 2002).

A great deal of research has shown that physical activity has positive effects on both physical and mental health (Cavill et al. 2006), especially when it occurs regularly and with sufficient intensity (Bauman 2004). Undertaken regularly, physical activity can reduce the risk of heart disease (Berlin and Colditz 1990), some cancers (notably colon (Slattery 2004; Friedenreich et al. 2006) and breast (Monninkhof et al. 2007)) and musculoskeletal problems (Brill et al. 2000). It has been shown to be an effective treatment for depression (Dunn et al. 2001) and can even help recovery from invasive medical treatments (see for example Mutrie et al. 2007). Conversely, health problems can arise when physical activity is not undertaken enough. In particular, when someone does not expend enough of the energy they brought into their body by eating and drinking, they will gain weight (Bull et al. 2004). If a person becomes overweight or obese, they are more likely to develop health problems which can include type II diabetes, heart disease, stroke, certain cancers and musculoskeletal problems (Cavill et al. 2006; Behn 2006).

8.1.2 Why Is There Concern About Physical Activity Levels?

In recent years, in economically developed societies, there has been a fall in the amount of physical activity people undertake (Tudor-Locke et al. 2001; Dollman et al. 2005; Sjöström et al. 2006). The development of densely populated cities, rising car ownership, use of numerous labor saving devices and systems and a fall in physically active employment, coupled with reductions in the availability of environments dedicated to physical activity, such as playgrounds for children and sports grounds for adults, has acted to reduce both the need and opportunity for people to be physically active. Between 1977 and 1995, for example, there was a 37% decline in the number of trips made by American children by foot or by bicycle (McCann and DeLille 2000). At the same time the calorific value of our food (that is, the amount of energy it provides when consumed) has increased, and food has become more plentiful (Wright et al. 2004; Putnam 1999). The consequences of these changes are that more energy is consumed while less energy is needed, because of the lower levels of physical activity. This has resulted in much higher numbers of overweight people, particularly amongst populations which consume greater quantities of processed food (Lobstein and Millstone 2007).

8.1.3 Why Might Natural Environments Be Important for Physical Activity?

As governments and policy makers have searched for solutions to growing health problems which stem from being sedentary and overweight, they have tried to promote or induce higher levels of physical activity. It seems that this is a very difficult thing to do, and whilst there has been some success for small scale interventions (Marcus et al. 2006) there has been little success in improving physical activity rates across whole populations (Dunn et al. 1998). More recently, attention has turned to the natural environment, sometimes called green space, as a means to help encourage physical activity. The important question for policy makers and for this section of the book is: can natural environments help promote or induce physical activity? There are good reasons to ask this question. Natural environments are perceived as more attractive than built environments (Van den Berg et al. 2003) and because some bodily movement (for example, walking or cycling) is often necessary to experience them, it may be that they do inherently promote physical activity. However, the 'idea' that natural environments are useful for promoting physical activity is not the same as solid evidence for their true effectiveness upon which policy and spending decisions can be made.

8.1.4 The Effectiveness of Interventions to Alter Population Level Health-Related Behavior

Since health and health behaviors in general have numerous complex and multi-factorial influences it can often be immensely difficult to alter or improve them. Even very intense efforts to alter a specific behavior, such as taking exercise, are frequently not successful at securing large scale, long-term behavior change (see for example Hillsdon et al. 2002; Lamb et al. 2002; Harrison et al. 2005). Furthermore, if there is more success at altering health and behaviors for some groups than for others, health inequalities can be created or exacerbated. In general, interventions which are 'upstream', i.e., structural, environmental or legislative (such as banning smoking, separation of pedestrians and vehicles or compulsory seat-belt wearing) seem to work best in improving health, not increasing inequalities (and perhaps reducing them) (Macintyre 2007). Interventions based on information or education; for example, warning people about the dangers of alcohol or adverts encouraging exercise, seem most prone to exacerbating inequalities (Macintyre 2007). This may be because more advantaged groups pay more attention to and/or find it easier to act on health promotion advice. Furthermore, the health benefits of a successful behavior change intervention might not be equally distributed. An intervention which is successful at encouraging people to use a woodland trail might have more benefits for someone who was previously sedentary than for someone who was already very physically active and has simply shifted the location of their physical activity to the woodland trail from elsewhere.

8.1.5 The Success of Environmental Interventions to Improve Physical Activity Rates

In a systematic review, Kahn et al. (2002) found evidence of effectiveness in a variety of strategies for improving physical activity rates. These included information based, behavior and social based, and environmental and policy based interventions. Whilst it is very difficult to identify which types of interventions were 'most' successful because this depends of the kinds of evidence available, in general environmental interventions such as community-scale urban design and land use policies that support physical activity, appeared more successful. The 12 studies of this kind that qualified for review had a median improvement in some aspect of physical activity (e.g., number of walkers or bicyclists) of 48%. This compares favorably, for example with a median improvement of just 5% from large-scale, intense, highly visible, community-wide campaigns with messages directed to large audiences through different types of media, including television, radio, newspapers. There was no attempt to review impact of these interventions on inequalities, or to differentiate between impacts on those who were previously sedentary and those who were already physically active elsewhere or in other ways. An example of two similar small scale environmental interventions, with very different results, can be seen in Photos 8.1 and 8.2.

8.1.6 What Do We Need to Know?

To help us decide if natural environments can help promote physical activity, it is important to weigh the evidence carefully. To help in this process, we approach the evidence with a set of questions.

Photo 8.1 Even though this exercise pavilion is close to many people, it is hardly used. The local residents do not seem motivated to use it (Photo: Ulrika Stigsdotter) (*See Color Plates*)

Photo 8.2 This exercise area is frequently used by users that pass it on their run, walk or cycle tour (Photo: Jasper Schipperijn) (*See Color Plates*)

1. Are people who live near natural environments more physically active?
2. If proximity to natural environments is associated with greater physical activity, is there a dose-response relationship (i.e., does greater proximity equate to greater activity), and how strong is the relationship?

3. Is there evidence that the natural elements are causal in any relationship between natural environments and physical activity?
4. Do these relationships between natural environments and physical activity vary according to population characteristics (e.g., age, sex, socio-economic status, ethnicity, country of origin)?
5. Is there something specifically beneficial about physical activity performed in a natural environment, when compared to that performed elsewhere (e.g., indoor or built environment)?

8.2 Conceptual Framework and Structure of the Overview

The attention for the (natural) environment as a factor that may influence the physical activity rates of people has already produced quite a lot of research. Recently several reviews of such studies have been published (Humpel et al. 2002; Owen et al. 2004; Giles-Corti et al. 2005b; Davison and Lawson 2006; Ball et al. 2006; Ferreira et al. 2007). Usually these reviews do not limit themselves to the green or natural aspects of the environment, but are concerned with the environment in general. Rather than seeing this as a disadvantage, we feel that this helps to put the role of natural elements and green areas into perspective. Swinburn et al. (1999) have developed a taxonomy dividing the environment into different categories of relevant characteristics, the so-called ANGELO-framework. ANGELO stands for 'analysis grid for environments linked to obesity'. The framework distinguishes two scale-levels, micro and macro, and four aspects: physical, economical, political and socio-cultural. The micro level refers to the local environment in which the individual lives, works, obtains an education, and performs leisure activities and such. It can be subdivided into different settings: residential neighborhood, school environment, workplace, etc. The macro environment can be divided into different sectors, e.g., the educational system, the healthcare system, different levels of authorities, the food sector. This chapter will have a strong focus on the physical aspect of the micro-environment(s), especially the residential setting. In this paragraph we will present a conceptual framework that helps to structure the overview of research thus far. Later on we will present and discuss the conclusions of these reviews and other studies with regard to the evidence base that they provide.

Starting point is that the physical environment may stimulate or impede physical activity. Several authors (Giles-Corti et al. 2005b; Ball et al. 2006) suggest that it is important to be specific about the type of activity when looking at its environmental correlates. The relevant environmental aspects may vary strongly from activity to activity. Consequently, clearer and stronger relationships may be observed when the environmental aspects under study are tailored to the specific activity at hand. This specification may go beyond the activity as such, and include the motivation or context in which it takes place. Furthermore, because of differences in preferences and/or (personal) constraints, a distinction between population segments might also be helpful.

To focus our overview, we have selected the following three categories of outdoor activity: (a) physical activity and green space in general (Section 8.3); (b) walking and cycling for transport and recreation (Section 8.4); (c) outdoor physical activity by children (Section 8.5)

Finally, we will also devote a section of the chapter to the possible additional benefits of being physically active in a natural environment, compared to being active in another type of environment. That is, benefits other than the amount of energy spent during the physical activity (Section 8.6).

The first category is included because within some studies physical activity has been defined broadly and no subcategories of activity have been distinguished. However, it is also relevant because it focuses on the total amount of activity, which in the end seems what is relevant with regard to energy expenditure. The second category is included because active transport, i.e., to get to a destination by foot or bicycle for other than leisure purposes, nowadays for many people is an important source of physical activity (see e.g., Breedveld and Van den Broek 2002). Furthermore, especially for adults, walking and cycling also constitute the most common active outdoor leisure pursuits. We will concentrate on the role of (nearby) natural elements and green areas in the participation in this type of leisure activity. The third category focuses on children and will be mainly concerned with outdoor play, which is an important way of energy expenditure for this age group (Baranowski et al. 1993; Sallis et al. 1993b; Bakker et al. 2008). Each category of activity will be treated in a separate paragraph. Individual differences will be taken into account within each of these three categories, in as far as the studies being discussed pay attention to such differences, and the paragraph does not already have a clear focus on a specific segment of the population.

The above division into categories of activities has been made because of the different environment aspects that may be relevant for each of the categories. Nevertheless, at a more conceptual level it is still possible to identify a number of factors that are likely to be of importance for (almost) all of the categories, although their physical appearance/preferred levels may vary widely from activity to activity. Pikora et al. (2003) developed a framework of the potential environmental influences on walking and cycling based on available research on this topic. They distinguish four different features, namely *functional*, *safety*, *aesthetic* and *destination*.

The *functional* feature in the framework relates to the physical attributes of the street and path that reflect fundamental structural aspects of the local environment. Namely the specific attributes of the path, the type and width of the street, the volume, the speed and type of traffic, and the directness of routes to destinations. See Photo 8.3 for an example of a high quality recreational path.

The *safety* feature incorporates two elements of safety; personal safety (such as presence of lighting and level of passive surveillance) and traffic safety (such as availability of crossings).

The *aesthetic* feature includes factors which make for an interesting and pleasing environment. Here the presence, condition and size of street trees; the presence of parks and private gardens; the level of pollution; and the diversity and interest of natural sights and architectural designs within the environment are aspects to be considered.

Photo 8.3 Good trails are essential for many forms of active recreation (Photo: Jasper Schipperijn) (*See Color Plates*)

The *destination* feature relates to the availability of community and commercial facilities in neighborhoods. Where there are appropriate local destinations within easy reach there is an increased chance people will walk. In other literature this is also called proximity or connectivity. Proximity relates to the distance between trip origins and destinations. Connectivity characterizes the ease of moving between origins (e.g., home) and destinations (work, shop, play) within existing street and sidewalk/pathway structure. Connectivity may also be considered an aspect of the functional feature.

The framework of Pikora et al. (2003) deals with the local environment at large. Besides being a part of this environment, green areas can also be considered a specific category of destinations within (or outside) this environment. To a large extent similar features are also relevant at this more specific level: (a) *destination*, accessibility of the area, distance and infrastructure (by mode of transport); (b) *safety*, personal and traffic, with importance of latter depending on modes of transport within the area; (c) *functional*, suitability for the activity at hand, internal infrastructure and required facilities to make the activity physically possible; supplemental facilities and other amenities (not required, but appreciated); (d) *aesthetic/pleasantness*, scenic beauty, noise level, crowdedness, etc.

The attractiveness of the area as a setting to perform the activity at hand may be considered an overall concept in which the aforementioned aspects are integrated (highly accessible, very safe, very well suited for the activity and pleasant setting as well).

8.3 Natural Environments and Physical Activity in General

8.3.1 What Do We Mean by Physical Activity in General?

Many studies of the relationships between natural environment and physical activity are focused on specific types of activity such as walking or cycling. Indeed, an important aspect of natural environments is that they may encourage or favor particular types of activity, over others. However, some of the evidence on associations between natural environments and physical activity is focused on activity 'in general'.

8.3.2 Why Record or Measure Physical Activity in General?

It is sometimes better to record or express all the physical activities which study participants do in a single measure. If overall level of activity is the focus of a study, the specific activities which contribute might not matter too much. This is particularly the case when the study wants to compare activity levels of different groups, each of whom might prefer different kinds of exercise. Men, for example, may be more likely than women to achieve their physical activity in 'formal' activities such as team sport or running, but that does not mean that the activities of women are less important or healthy. This is particularly important in research on children's physical activity. The kinds of play that children may enjoy in green or natural environments can be very hard to describe or capture in terms of a single 'activity'. Furthermore, it might be that a natural environment promotes a particular kind of activity but that this is at the expense of another activity; thus overall amounts of physical activity could be unaltered. For that reason, a simple summary measure of activity can be very useful.

8.3.3 How Is Physical Activity Measured?

There are two principal means of measurement. In the first, a questionnaire or survey will ask the respondent how many minutes of various kinds of physical activities they have taken part in, and at what intensity, over a specified period of time. A summary measure can then be derived. One commonly used example of such a summary measure is the International Physical Activity Questionnaire, or IPAQ (Craig et al. 2003). Self-reported measures of activity have the advantage of being easy to gather from large numbers of people, but they are limited in their reliability and objectivity (Kohl et al. 2000).

In the second, an objective instrument is used to record the body's movement or energy expenditure. Accelerometers are a popular choice for the objective assessment of physical activity in studies of both adults and children. They are small and unobtrusive, and their information can be validated in a laboratory setting (Chen and Bassett 2005). They can record the body's movements in various directions and are thus suited to measuring physical activity derived from a wide variety of activities. However, they are limited in their ability to measure activity such as cycling, climbing, or other upper body-based exercise.

Identifying the most suitable method of assessing physical activity for a given situation is complex; often a combination of validity, reliability, accuracy and practicality must be considered (Melanson and Freedson 1996; Taylor et al. 1984). Whilst subjective measures may be relatively easy to gather, biases in tendency to over or underestimate the quantity of activity completed have been observed among various population groups (Adams 2005; Durante and Ainsworth 1996). Children in particular, may over or underestimate their activity levels (Sallis et al. 1993a). On the other hand, large scale deployment of objective measuring instruments is rarely possible and studies with large numbers of participants are usually the most powerful.

8.3.4 What Does the Published Literature Tell Us About Physical Activity and Green or Natural Environments?

There are very few studies which report analyses of general levels of physical activity specifically in association with green or natural environments. However, there are a reasonable number of studies concerned with determining 'environmental correlates' of physical activity. These consider various aspects of physical and social environment, often including natural or green spaces. Humpel et al. (2002) reviewed literature on environmental factors associated with adults' participation in physical activity. They reviewed studies which made objective assessments of environment and those in which residents assessed their own environments. Their results, thus drawn from a variety of study designs, show evidence for positive associations between physical activity and the presence of parks within walking distance of home, hills, and 'pleasant scenery'.

Also Ellaway et al. (2005) found in a cross-sectional study that in residential environments containing high levels of green, the residents' likelihood of being frequently physically active was more than three times as high and the likelihood of being obese reduced by 40%. Atkinson et al. (2005) showed that physical activity is favored in neighborhoods characterized by residential density, mixed land use, and street connectivity, but also by proximity to green and open spaces for recreational needs. However, Wendel-Vos et al. (2007) found in a systematic review of 47 studies that social support, having a companion, and connectivity of trails to be associated with different types of physical activity in the neighborhood (e.g., active commuting). There was less consistent evidence for physical activity and availability, accessibility and attractiveness of green spaces. For example, they identified numerous studies which did not show any positive relation between physical activity and green space (Wendel-Vos et al. 2007).

Others have been more specific in their exploration of the role of parks. Brownson et al. (2001) reported that access to parks in the neighborhood was associated with respondents being nearly twice as likely to meet the recommended level of moderate or vigorous physical activity compared to those without such access. Enjoyable scenery in the neighborhood was also associated with being more likely to meet the recommendations, albeit to a lesser extent. Giles-Corti and Donovan (2002) focused on access to recreational facilities, including parks, and their role in encouraging physical activity. Parks located near to home were used by more respondents than those located elsewhere, and public open space was the second most frequently used recreational 'facility' (28.8% of respondents). Both these studies tried to isolate the significance of parks from other factors known to be associated with variation in physical activity rates. Giles-Corti and Donovan (2002) found the physical environment's direct influence on activity was secondary to individual and social environmental determinants. This suggests that access to a supportive physical environment is useful for encouraging activity but may be insufficient to independently increase the meeting of recommended levels. It should also be noted that variety in park environment was often not controlled for in the studies. There is evidence that the type or design of the park might influence physical activity, with aesthetically pleasing parks containing tree-lined paths being more encouraging to activity than empty open space (Giles-Corti et al. 1996).

Other studies have looked at these relationships for particular subsections of the population. Cohen et al. (2007) studied the use of parks by low income minority groups. Interestingly, two thirds of park users they observed were sedentary. However, interviewees identified the park as the most common place they exercised. In analyses, Cohen et al. determined that both park use and exercise levels of individuals were predicted by proximity of residence to the park. In a more detailed study, Cohen et al. (2006) explored further the significance of access to green space for physical activity rates among adolescent girls. There are more details on studies of children later in the chapter but, briefly, Cohen et al. (2006) suggested that, for the average girl with 3.5 parks within a one-mile radius of home, the presence of parks accounted for 36.5 extra non-school minutes of activity per 6 days. However, their study was unable to determine whether these higher rates of exercise were actually due to park use, or if it was because more attractive neighborhoods, with more parks, tend to contain physically active families, normalizing the behavior. Other studies have focused on older populations (e.g., Chad et al. 2005), or those with a specific illness. Deshpande et al. (2005), for example, found a 'dose-response' relationship between parks and physical activity among diabetics, where higher dose was defined by shorter walking time to the park.

Some studies have explored dose-response relationships using ‘accessibility’ to natural spaces or paths, instead of a simple measure of distance. Often these measures are of perceived accessibility and it does appear that when accessibility to natural environments is perceived to be greater, physical activity rates are generally more likely to be higher. However, there is insufficient literature to determine the direction of causality. Those who are generally more physically active may regard their park as more accessible because their physical activity makes it easier for them to access the park, rather than because the readily accessed park makes them more physically active.

One problem with studies exploring the relationship between physical activity and access to natural environments is that in general terms, it is often wealthier people who can afford to live in the more pleasant, greener places (Bolitzer and Netusil 2000; Hobden et al. 2004) and research has shown that wealthier populations tend also take more exercise for recreation (Popham and Mitchell 2007; Macintyre and Mutrie 2004; Mutrie and Hannah 2004). Although usually statistical corrections are applied to minimize this problem, establishing whether the natural environment has an independent impact on physical activity can therefore be difficult.

It is also important to note that not all studies find access to natural environments to be associated with physical activity levels. Hillsdon et al. (2006), for example, found no evidence of clear relationships between recreational physical activity and access to green spaces in an urban setting. In fact, in their useful review of evidence for relationships between parks and recreational facilities, and physical activity, Kaczynski and Henderson (2007) found that nine of 37 included studies focused on parks, open space or trails showed non-significant relationships. However, Kaczynski and Henderson concluded that positive associations between natural environments and physical activity were rather more common than those between other types of recreational facilities and physical activity. It should be noted that not all the studies they reviewed concerned ‘physical activity in general’.

8.4 Walking and Cycling

8.4.1 Introduction

Walking and cycling are forms of physical activity that are accessible to the majority of the population regardless of income, age and location. It is estimated that more than 96% of the people in Europe are able to walk and more than 75% to ride a bicycle (WHO Europe 2002). At the same time there are substantial differences in walking habits and the use of bicycles throughout Europe. According to Eurostat (2005), in Switzerland 40% of all trips still are covered by walking compared to 7% in Denmark (and about 20% in most other countries). Cycling accounts for a sizable share of daily mobility in countries like the Netherlands (26% of all trips) and Denmark (15%), but is of very low impact in the UK (2%), France (3%) and several countries on the Mediterranean shore. In a smaller survey in nine countries, the time spent for daily travel on foot or bicycle amongst people aged 20–74 varied from 14 min (Finland and Norway) to 29 (Slovenia) (de la Fuente Layos 2005). In the Netherlands and Denmark, the annual mean distance travelled by bicycle was about 1,000 km, in Germany and Sweden about 300 km, and in Spain, Portugal and Luxemburg it was less than 50 km (EC 1999).

The above numbers are regardless of motive and environment. With regard to motive a distinction may be made between leisure (recreational) and transport (e.g., commuting) mobility. The ratios of active leisure and transport mobility, considering and comparing the absolute amounts of trips and the time spent on the activities, vary significantly between age and social groups. Students and senior citizens, possibly due to different life stages, show on the one hand a much higher proportion of leisure mobility than do e.g., commuting middle-ages, but on the other hand the total amount of senior citizens' physical activity tends to be lower compared to children or students. However, since leisure mobility also includes transport (e.g., getting to a leisure or recreational destination), at least 75% of overall active mobility is for transport and much less is for recreation. Bearing this in mind, WHO Europe pointed out that '*walking and cycling for daily transport has greater potential than leisure activities for getting people physically active*' (WHO Europe 2002, p. 4).

In this section we will first focus on walking and cycling as a means of transport. After that we will pay attention to walking and cycling for recreation. However, a strict distinction of potential health effects referring to these two motives for physical activity is sometimes difficult to make.

8.4.2 Walking and Cycling for Transport

Epidemiological studies suggest that there are substantial health benefits to be gained from physical activity as a means of transport (active transport to get to a destination). However, while many studies examined the associations with overall physical activity, only a few were able to study the independent health effects of transport-related physical activity such as walking and cycling (WHO Europe 2002, 2007). Some studies showed that people having the option of walking and cycling for transport reasons, i.e., destinations within reasonable distance have a lower prevalence of overweight and obesity (Saelens et al. 2003; Giles-Corti et al. 2003; Wen et al. 2006). Andersen et al. (2000) found strong protective health effects of cycling. Even after adjusting for different 'risk' factors like the general and leisure physical activity level, socioeconomic background and smoking, the mortality rate of the study subjects cycling to work was 39% lower than for those who did not (Andersen et al. 2000). Matthews et al. (2007) found similar results – among others – for cycling for transport and mortality in Chinese women. For walking for transport the result just failed to reach significance in this study ($p < 0.07$).

Cooper et al. (2006) found that children who cycled to school were 8% fitter than children who used other kinds of transport, including walking, and concluded that a 10–15 min session of cycling twice a day was enough to increase fitness in children.

Furthermore, observational studies have consistently shown that children who walk or cycle to school engage in more additional physical activities than do those who travel using other means (Cooper et al. 2003).

Even though the mentioned studies showed interesting protective effects or increases in physical activity, there are very few studies investigating the potential specific effects of walking or cycling for transport in urban green areas (Wendel-Vos et al. 2007). Nevertheless, Taylor et al. (1998) stated that natural environments are perceived as more attractive than built up environments and that green areas may stimulate residents to undertake physical activity such as walking and cycling, e.g., for transport purposes (Taylor et al. 1998; Bedimo-Rung et al. 2005). Some more recent studies support this statement, but others did not (see e.g., reviews by Kaczynski and Henderson 2007; Wendel-Vos et al. 2007).

Studies on the relationship between environment and active transport primarily come from the US and Australia, and most of them have investigated the environmental characteristics of residential neighborhoods (e.g., Craig et al. 2002; Saelens et al. 2003; Humpel et al. 2004; Powell 2005). Some types of active transport, for example commuting, do however partly take place outside these neighborhoods and therefore, most likely the overall commuting route environments are more important for understanding the relationship between environment and physical activity through commuting.

Studies of active commuting in Stockholm, Sweden, have dealt with the issue of which environmental variables along the commuting routes may stimulate active commuting, and which may inhibit it. Based on correlational studies, perceived levels of exhaust fumes and congestion in mixed traffic environments appear to have the potential to inhibit commuting by bicycle in inner urban environments, whereas for commuting by foot, noise levels have the same inhibiting role. On the other hand, for both these modal choices, aesthetics and green elements, respectively, appear to potentially have a stimulating effect on active commuting (Schantz and Stigell 2006; Schantz and Stigell 2007). The next phase of the study is to see to what extent stimulating and inhibiting environmental factors are associated with actual commuting behavior.

According to a study conducted in Bielefeld (Germany), accessibility of green areas is essential in people deciding to use them as an alternate route of active transport. Urban green areas were used as an alternative route by 56.1% of the Bielefeld residents, and 76% get to these green areas at least once a week staying there median 30–60 min (Frank et al. 2004). The results of this investigation, however, did not show whether the residents use these routes for active transport to avoid densely trafficked streets, or just because these green routes are more time-effective due to fewer traffic lights.

Maas et al. (2008) did not find any significant relationship between the percentage of green space in the living environment and the amount of or time spent with walking trips for commuting purposes. Furthermore, the results showed a negative relationship between the percentage of green space in a one-km radius and the amount of cycling trips for commuting purposes, but a positive relationship concerning the time spent for those that did cycle (Maas et al. 2008). These results are in line with those from Wendel-Vos et al. (2004). A higher amount of nearby green space can be caused by more agricultural areas, which can be found in the outskirts and suburban parts of cities. People living in these parts that do cycle to work, presumably often located in the city centre, are likely to spend more time commuting. In accordance with these studies, Den Hertog et al. (2006) demonstrated the density of different facilities and parking possibilities – within an urban environment – to be important determinants for the amount of physical activity undertaken. In neighborhoods with a high density of facilities such as shops, and without private parking spaces, people more often choose to walk or cycle. Consequently, there are often higher amounts of physical activity in city centers with hardly any green areas, whereas people with more green space in their living environment less often walk or cycle due to car availability and reduced facility density (Maas et al. 2008).

8.4.3 Walking and Cycling for Recreation and Exercise

In this subsection the literature on walking and cycling especially for recreation is reviewed. With 'for recreation' it is meant that the activity of walking or cycling is undertaken for leisure purposes, for the pleasure they themselves provide. However, we will also include walking and cycling for exercise purposes under this heading. Furthermore, some studies do not distinguish between motives, or include both walking for transport as well as walking for leisure purposes.

As recently once again confirmed in a Dutch study, most recreational walking and cycling trips take place close to home. Even though in this diary study a lower limit of being away from home for at least 1 h was used, about 68% of all recreational walks used no other means of transport first (CVTO 2007, p. 57). For cycling trips this was even higher: 89% (ibid, p. 58). Moreover, especially the habitual behavior and activity pattern will be relevant with regard to overall physical activity levels, more so than the occasional long-distance trip. Although the review in this section is not limited to green areas, they will be given special attention, as will solitary natural elements such as street trees (Lee and Moudon 2006). With regard to green areas within the living environment, we will use a broad definition, for example also including agricultural areas. Finally, walking and cycling for recreation is especially common among adults (in some cases accompanied by young children), and most of the studies seem to be focused on this segment of the population.

As for green areas as specific destinations for walking and cycling for pleasure, it may be noted that especially for walking it is quite common to use a car or other means of transport first to drive to an attractive destination area and to go for a walk there. So, a distinction may be made between trips on which other means of (usually motorized) transport is used first and those on which one starts walking or cycling as soon as one leaves one's dwelling. In the latter case there may be no destination at all; one might be just going for a stroll in the own neighborhood. On the other hand, one might be visiting a nearby green area, such as an urban park. The distinction between taking a walk in the neighborhood and visiting a nearby green area by foot is not always clear. Furthermore, also when there is no specific destination, natural features may play a role by making the neighborhood environment or the streetscapes more attractive. Cycling, because of its action radius, is always likely to mainly take place outside the own neighborhood.

If another means of transport is used first, the range of destinations within reach tends to become much larger, depending on the mode of transport and on how much time one is willing and able to spend on travelling to and from the destination area. The latter is usually strongly related to the time one wants to or is able to spend in the destination area itself. The total amount of leisure time available is an important consideration (as is one's willingness to spend it on the trip). Usually longer trips take place during the weekend, days off or holidays. The larger choice of destinations is assumed to increase the demands with regard to the attractiveness of the destination area. This includes both functional (e.g., walking facilities or network of cycle paths) and aesthetic features. The safety feature is likely to remain important, although traffic safety may be less important once the destination area has been reached, depending on what modes of transport are allowed within the area, or, more specifically, on the paths. Other safety or health dangers may become more prominent, e.g., tick bites (Lyme's disease).

In a review by Owen et al. (2004), a distinction was made between exercise and walking for pleasure on the one hand and walking for transportation purposes on the other. Eighteen studies were identified. The environmental attributes associated with walking for exercise or pleasure, were different from those associated with walking to get to and from places. Relevant aspects for walking for pleasure appeared to be an aesthetically pleasing environment (e.g., perceived presence of pleasant and attractive natural features), convenience of facilities for walking (e.g., trails); and accessibility of destinations such as parks and beaches. These specific findings appear to be largely based on a study by Ball et al. (2001) among a cross sectional sample of Australian adults. More recently, based on a study among Australian adults living in Perth, Giles-Corti and others (2005a) concluded that access to attractive, large public open spaces was associated with higher levels of walking.

Pikora et al. (2006) have tried to empirically determine the relative importance of the four features they discerned earlier (functional, safety, aesthetic, destination) with regard to neighborhood walking by adults. They concluded that functional features were correlated with both walking for transport and walking for recreation. Destination factors were correlated with walking for transport, but not with walking for recreation. Aesthetic considerations (including green aspects) seemed to be (weakly) linked with walking for recreation only. In their study safety aspects were correlated with neither walking for transport, nor walking for recreation. In an Australian study, Owen et al. (2007) observed a relation between an objectively determined score on a walkability index and walking for transport by adults, but no such relation for walking for recreation. This index did not include the aesthetics of the neighborhood. In a recent Dutch study Maas et al. (2008) even observed a negative relationship between the local amount of green space and walking and cycling for leisure purposes. It should be noted that in the latter study green space often mainly consisted of agricultural land, usually considered a less attractive type of destination for walking (at least in the Dutch context).

Harrison et al. (2005) came to another conclusion regarding safety and fear of crime than Pikora et al. (2006) did. Based on their study among adults in northwest England, they concluded that feeling safe had the potential largest effect on population levels of physical activity. More specifically, Foster et al. (2004) concluded that English men are more likely to walk at least 150 min a week if they report having access to a local park, while their walking is not influenced by concerns about safety. English women, according to them, seem to be more concerned with walking in safety. The presence of green space itself may also have consequences for social safety. Maas et al. (2009) concluded that whereas in general the amount of local green space is positively associated with feelings of social safety, in highly urban areas larger amounts of enclosed green space are associated with reduced feelings of social safety.

As for specific segments of the population, Li et al. (2005) conducted a study among elderly residents of Portland (Oregon, USA). They observed a significant relationship between the area of green and open space for recreation within the neighborhood and the level of neighborhood walking of older adults (over 64 years of age). Perhaps it is especially for elderly adults that walking (and cycling) for pleasure is a suitable or common means of getting exercise. This type of recreational activity seems to be less popular with adolescents, whereas children usually undertake the activity in the company of (one of) their parents or guardians. At the same time, for the elderly safety issues are likely to be relatively important (Loukaitou-Sideris 2006).

Some studies do focus on recreational facilities, but not limit the physical activity to walking and/or cycling. Kaczynski and Henderson (2007) reviewed the evidence specifically with regard to parks and recreation settings, outdoor as well as indoor, as environmental correlates of physical activity. Based on the 50 studies they retrieved, they concluded that proximity to parks or recreation settings was generally associated with increased physical activity. However, not all the reviewed studies are equally relevant for our present purposes, in the sense that the environmental correlate sometimes involved another aspect than natural elements and green areas (indoor recreation settings). In other cases the study that was reviewed looked at a very location-specific activity, such as the use of a new trail (e.g., Evenson et al. 2005). In such cases location substitution may have occurred. Furthermore, in some cases negative relationships were observed with green environmental characteristics.

So far we discussed studies looking specifically at the relationship between the local supply of parks and other green areas and the amount of physical activity, either in total or more specifically in the form of walking and cycling mainly for transport or for pleasure. There are many more studies dealing with the visiting of parks, forests and/or nature areas. Given that walking is the most common activity during a visit to such areas, visitation levels may be considered a crude proxy of physical activity gathered by means of walking. A distinction may be made between studies that look at levels of visitation accumulated over different parks, etc. and studies that look at the visitation of a specific green area. Given the present focus, the former studies are of more interest than the latter.

An example of the first type of study is the one by Grahn and Stigsdotter (2003). Although this study on residents of mid-sized Swedish towns (all ages) focuses on stress reduction, it also looks at the yearly number of visits to urban open green spaces and the yearly amount of time spent in such areas. Both are clearly related to the (self-reported) distance to the nearest urban open green space. Also other studies show that the accessibility of a certain type of green space (nearness to, amount of) is strongly positively associated with the recreational use a resident makes of this type of green space (see e.g., De Vries 2004). Conversely, people tend to make use of green and natural areas that are nearby, and do not seem very inclined to compensate for the local lack of a specific type of area by visiting natural areas further away, at least not fully (see also Maat and De Vries 2006). So, people with more nearby green space are likely to spend a larger proportion of their outdoor leisure time in a natural environment. This is something that we will come back to in Section 8.6 of this chapter.

8.5 Children's Physical Activity in Green Spaces

8.5.1 Introduction

Also for children there is a growing concern that they are becoming more sedentary (Fjørtoft 2004; Sallis et al. 2000). This is partly due to increasing interest of children in watching television and playing computer games. Furthermore, suggestive evidence shows steep declines in the number of destination children reach by walking or cycling, and at the same time, an increase in the reported use of motorized vehicles (Tudor-Locke et al. 2001).

In 2005, less than 10% of the children between 4 and 12 years old in the Netherlands met the Healthy Norm for Physical Activity which states that children should be moderately physical active for 1 h per day (De Vries et al. 2005; Kemper et al. 2000). Australian data suggest that 20–25% of the children are not sufficiently active to confer health gains (Booth et al. 2000). Promotion of children's physical activity is important to combat the international obesity epidemic that extends to childhood and to establish an early habit of lifestyle physical activity that can be sustained into adolescence and adulthood (Tudor-Locke et al. 2001).

Whether or not children are physically active depends on demographic, psychological, social and environmental factors (US DHHS 1996). Concerning the environment, the social, school, home and neighborhood environment can influence children's physical activity. Children can play indoor as well as outdoor. Playing outdoors has been associated with a higher level of PA than playing indoors (Sallis et al. 2000; De Vries et al. 2008). In this paragraph we will focus on a specific type of outdoor environment, namely the natural outdoor environment. The traditional outdoor playground is usually barren, covert with asphalt and has metal playing equipment. Natural environments represent a dynamic environment and a stimulating and challenging playground for children (Photos 8.4 and 8.5). Trees, shrubbery, and broken ground can be important triggers of young children's physical activity. The richness

Photo 8.4 This stream is a much more popular play area among local children than the playground next to it (Photo: Ulrika Stigsdotter) (*See Color Plates*)

Photo 8.5 Also this playground is highly popular in summer (Photo: Jasper Schipperijn) (*See Color Plates*)

of forms, colors and materials stimulate not only the imagination of children but also provides movement challenges and a diversity of opportunities for playing and moving (Fjørtoft 2004; Boldemann et al. 2006).

8.5.2 *Where Do Children Usually Play?*

Studies on where children usually play show that parks are attractive places for children to play in. An Australian study showed that 53% of children's play occurred at home ground, 24% occurred in parks and playgrounds and 6% occurred on the streets (Tandy 1999). A study by Veitch et al. (2006)) showed that children usually play 'in the yard at home or at a friend's house, the street and local parks'. Safety concerns, the child's level of independence, the presence of nearby children, and facilities at parks and playgrounds were considered to have the most impact on playing. A study from Prezza et al. (2001) showed similar results. They showed that environmental factors such as living in an apartment block, living near a park and the age of the neighborhood were important determinants for whether children play independently.

It is however important to note that playing does not necessarily have to be related to the amount of physical activity. In the next section research which investigated whether natural environments promote physical activity is discussed.

8.5.3 *Does a Natural Environment Promote Children's Physical Activity?*

8.5.3.1 Do Parks in the Neighborhood Promote Children's Physical Activity?

Most studies on the relation between natural environments and children's physical activity investigate whether neighborhood parks promote children's physical activity. Neighborhood parks are easy to access for children because they are often in the vicinity of their homes. Furthermore, neighborhood parks could provide a place for parents with young children to meet and allow their children to play.

In a mixed method study, Hume et al. (2005) explored which aspects of children's home and neighborhood environments were deemed important by them, and found that these did include open spaces and parks, However, when using accelerometers to explore children's physical activity levels, Hume et al. (2005) found that the frequency with which open spaces and parks in the neighborhood were mentioned was not associated with physical activity rates. Yet, in a study which also used accelerometers to measure physical activity in children, but which measured environmental characteristics objectively, Roemmich et al. (2006) found that the quantity of park land in the neighborhood was clearly related to physical activity rates. Roemmich et al.'s (2006) study is useful because it separates the contribution of park land from other recreational space. Their results suggest that each 1% increase in park area was associated with a 1.4% increase in average physical activity. Other work from this team suggests that for older children access to parks is associated with greater increases in physical activity for boys than for girls, but this was not the case for the younger children (Epstein et al. 2006).

Early results from a study underway in Scotland echo these findings, with time spent in forest environments boosting physical activity rates about equally for younger boys and girls (Lovell 2010). In a study by Hoefer et al. (2001), use of neighborhood parks explained 5.1% of variance for boys' total physical activity, after adjusting for parental transportation. This suggested that active boys found ways to access physical activity locations by walking or cycling, leading the authors to conclude that the availability of neighborhood parks and playgrounds may stimulate physical activity that does not rely on adult transport.

Cohen et al. (2006) further explored the significance of access to a park for physical activity rates among adolescent girls. They found that every additional park in the half-mile around a girl's home was associated with an increase in moderate/vigorous physical activity by 2.8% or 17.2 non-school minutes of activity per 6 days. They suggested that, for the average girl with 3.5 parks within a 1-mile radius of home, the presence of these parks accounted for 36.5 extra non-school minutes of physical activity per 6 days. This would indicate, albeit crudely, a form of 'dose-response' relationship between quantity of green space and physical activity. However, their study was unable to determine whether these higher rates of exercise were actually due to park use, or if it was because more attractive neighborhoods, with more parks, tend to contain more physically active families.

A few other studies explored the relation between reported access to parks nearby and physical activity. These studies concluded that children who did not report limited access to parks nearby engage more in physical activities (Alton et al. 2007; Mota et al. 2005; Kipke et al. 2008). Timperio et al. (2004) examined associations between perceptions of the local neighborhood and walking and cycling among children aged 5–6 years and 10–12 years. Among older girls, parent's belief that there were no parks or sports grounds near home was associated with a lower likelihood of walking or cycling (OR = 0.5, 95% CI = 0.3–0.8). A study of Den Hertog et al. (2006), performed in four different districts in Amsterdam, The Netherlands, showed that the availability of a park of high quality and with a high offer of play areas, rest places and walking routes which was within reach of the residents, was important for children's levels of physical activity. Overall, these studies suggest that (access to) a park in the neighborhood promotes physical activity of children.

8.5.3.2 Do Other Natural Environments in Neighborhoods Promote Children's Physical Activity?

Two studies focused on the relation between neighborhood green space and physical activity. Using a physical activity diary, De Vries et al. (2005) explored the relationships between aspects of environment and physical activity in children aged 6–11. In univariate analyses, adjusted for age, sex, body mass index, and highest level of maternal education, physical activity was significantly ($p < 0.05$) associated with the proportion of green space in the neighborhood. However, in multivariate analyses, other features of the neighborhood were found to be more strongly associated with activity levels.

Taylor et al. (1998) conducted a study in a deprived neighborhood in Chicago and investigated whether the amount of vegetation in courtyards, mainly consisting of trees and grass, influenced the frequency of playing. They found that in the courtyards with more vegetation, the frequency of playing behavior was higher. Furthermore, children displayed more creative playing behavior and had more contact with adults.

8.5.4 Does Green Space in and Around the School Environment Promote Children's Physical Activity

Two different studies investigated whether green elements in the outdoor (pre) school environment promoted children's physical activity. Boldemann et al. (2006) used pedometry and assessments of the environment to investigate whether outdoor preschool environments with a large outdoor area which was characterized by (a) play structures/areas adjacent to trees and shrubbery or integrated in areas with the character of wild nature and (b) open spaces located in between play structures/areas influenced children's physical activity. Environments with both these two characteristics could yield 1,500–2,000 more steps in a child staying seven hours at preschool and spending half the time outdoors. On the other hand, Cardon et al. (2008) showed that the presences of vegetation or height differences in 39 randomly selected preschools were not significant physical activity predictors in boys or girls (on average 5 years old).

8.6 Benefits of Physical Activity in Green Space Versus in Urban and Indoor Settings

The following paragraph will analyze effects and outcomes of physical activity in different environments. Why might physical activity be more beneficial in green space than in urban settings? First, main theories and their relevance for restorative benefits of exercise in green spaces will be discussed, followed by their empirical evidence.

8.6.1 Main Theories Explaining the Beneficial Effects of Green Space

A first theory applicable to the relations between exercise environment and perceptions of physical symptoms, fatigue and health is the *competition of cues model*. According to this model, internal sensory stimuli and external environmental cues compete for attention (Pennebaker and Brittingham 1982; Pennebaker and Lightner 1980; Watson and Pennebaker 1989). It suggests that being in natural physical environments, for example, may promote physical and psychological well-being by increasing external attention, decreasing the amount of attention directed towards internal states, and thus decreasing, e.g., the number of current health complaints (Watson and Pennebaker 1989).

Two other theories are relevant for additional benefits of physical activity in different environments. Kaplan and Kaplan's (1989) *attention restoration theory (ART)* explains the positive, restorative effects of green spaces on the overuse of directed attention (= mental fatigue). According to the ART an environment has restorative potential (qualities) if four components, being away, fascination (effortless attention), coherence (coherent physical environment of sufficient scope) and compatibility (match between personal purposes and environment), are available in the human-environment interaction. Based on this theory restorative environments contribute to restoration by recovering directed attention and by clarifying and restructuring thoughts, which further leads to reflecting on immediate unresolved problems as well as on life's larger questions such as personal goals and one's place in the overall scheme of things (see also Chapter 5). Compared to the ART, which is focused on cognitive processes, Ulrich (1983), Ulrich et al.'s (1991) *stress reduction theory (SRT)* is more focused on emotional and physiological processes. The SRT is based on the belief that viewing or visiting natural environments after a stress situation rapidly promotes physiological recovery and relaxation (Ulrich 1983).

8.6.2 Exercise-Related Empirical Support

8.6.2.1 Running

According to the *competition of cues model* the more interest-commanding external cues there are, the less attention is drawn inwards. For example, joggers exercising in an interesting, natural setting (a wooded cross-country trail) have been found to run faster but report only a similar amount of fatigue and physical symptoms after the run to joggers exercising on a boring lap course (Pennebaker and Lightner 1980). Concurrently, when people have been instructed to produce a certain intensity level while running (e.g., light or hard) they do it differently in field and treadmill conditions. In an experiment with 12 physically active males the subjects ran faster and had higher heart rate as well as blood lactate levels in a field setting (a natural setting by a lake without other people, snow or ice) than in a treadmill condition although they perceived their physical exertion level, that is, the intensity of the exercise, similarly in both conditions (Ceci and Hassmén 1991). One potential theoretical interpretation of these findings suggests that the perception of fatigue and physical symptoms might be reduced or slowed down in natural environments offering interesting and engaging external cues, that is, fascination.

Harte and Eifert (1995) tested ten trained runners during an outdoor run in a campus area (presumably including some green space) and two indoor treadmill running conditions. All subjects participated in all four conditions: three experimental and one control. Subjects ran 12-km on a designated route around James Cook University campus. All subjects completed the course in less than 45 min. In the indoor run-external stimuli setting and the indoor run-internal stimuli setting subjects were advised to run at a similar speed and exertion level as they normally would outdoors for over all 45 min. There was only one difference between the two indoor settings; in one condition subjects wore earphones and listened to a tape cassette with 'outdoor noises' while running (e.g., sounds of wind, cars, people walking past, birds, and so on). In the other condition subjects listened to their own breathing through earphones connected to a sensitive microphone attached to their chests. The control condition was 45 min of quiet inactivity in the laboratory. The study found that after the outdoor run, subjects felt less anxious, less depressed, and less angry and fatigued, and more invigorated than before the run. In contrast, the two indoor runs had less positive effects on mood. After the indoor internal-stimuli run subjects felt tenser, more depressed, angrier, and more fatigued than before the run. Running in a campus area reduced negative emotions whereas running on a treadmill in a laboratory did not. A significant increase in systolic blood pressure and perceived exertion after all three running conditions was found. Noradrenalin and cortisol secretions were higher during the internal-stimuli indoor run, whereas levels of increase in adrenalin secretions were similar over all conditions. The findings support the notion that setting, attention, and cognitive appraisal may alter the emotional experiences associated with physical exercise.

When Bodin and Hartig (2003) conducted a within-subject field experiment with 12 regular runners they did not find statistically significant differences in emotional or attentional outcomes between a park route and an urban route. However, the effect sizes for more tranquility and less anxiety after running in the park route were medium-sized, indicating potential for the hypothesis that the park may promote restoration while running to a greater degree than the urban environment. Moreover, runners significantly preferred the park to the urban environment and judged it to be more psychologically restorative.

Contradictory results with competitive and non-competitive runners were reported by Kerr et al. (2006). They measured changes in emotions and stress (before and after) to compare the psychological effects of exercise in laboratory and natural environments. Significant increases in positive, and decreases in negative emotions pre- to post-exercise were found irrespective of indoor and outdoor conditions. For the recreational (non-competitive) runners, only for emotion pride higher levels were observed in the natural as compared to the laboratory environment. No explanation for this somewhat surprising finding was presented. Competitive runners (i.e., members of a running squad) were more excited and less anxious after running irrespective of the type of environment. More interestingly, stress from tension and effort was higher with natural than with laboratory running, which again was an unexplained finding. The overall conclusion by the authors is that the actual running environment may be somewhat irrelevant to experienced runners. We might speculate here that stress from tension and effort might well be higher after running in natural settings because the earlier findings suggest that people tend to run faster (Pennebaker and Lightner 1980) and have higher heart rate (Ceci and Hassmén 1991) when jogging in a natural setting. Non-competitive runners seem not to perceive or report these feelings whereas competitive runners as in Kerr et al.'s study (2006) do.

Again, contradictory results with this conclusion are presented by Pretty et al. (2005). An independent panel of 50 people categorized 309 photographs on a five point scale according to how well it represented a rural pleasant, rural unpleasant, urban pleasant or urban unpleasant scene. Four groups of 20 subjects were exposed to a sequence of 30 scenes projected on a wall whilst exercising on a treadmill. A fifth group acted as a control group exercising with a white blank screen. For most of the subjects the intensity of the exercise meant a jogging pace, but for others it was a fast walk. A clear effect of exercise in different outdoor scenes on blood pressure, self-esteem and mood was found. Rural pleasant scenes had the greatest effects in reducing blood pressure. Both rural and urban pleasant scenes produced a significantly greater positive effect on self-esteem than the exercise-only control. This shows that exercise in both rural and urban environments has positive psychological effects. On the other hand, both rural and urban unpleasant scenes reduced the positive effects of exercise on self-esteem. The rural unpleasant scenes had the most dramatic effect, depressing the beneficial effects of exercise on three different measures of mood. Pretty et al. (2005) conclude that threats to the countryside and green space represented in rural unpleasant scenes have a greater negative effect on mood than already urban unpleasant scenes. Note that in general, urban scenes with green, such as urban parks, domestic gardens or allotments, together with water and blue sky, were categorized as pleasant.

A quasi-experimental study by Hug et al. (2008) showed varying results. The study compared the physical and psychological benefits of exercise in self-selected indoor and outdoor environments. The survey was conducted on site in the urban forest and in fitness centers in Zurich. The physical activities performed indoors and outdoors included running, cycling and general fitness training, and were thus to some extent similar. There was a significant interaction effect between exercise environment and the four measures for restoration outcome. Increases in feeling mentally well-balanced and decreases in suffering from everyday hassles were higher outdoors, whereas the stress reduction and increases in physical well-being were more emphasized indoors. Exercise induced a positive effect averaged across the four indicators of well-being which did not differ between the indoor and outdoor locations (indoor versus forest). One further result was that people exercising in the forest judged air quality to be better. Participants exercising in the forest were more excited about exercising again at the present site, were more reluctant to leave the forest and did not think that exercising in the gym would provide better opportunities for restoration.

A prospective study of over 500 middle-aged women showed that the main running area (open countryside runners versus runners in a constructed environment) was not related to the progression from irregular running to regular running. However, those who perceived themselves to be in poor health and had an unattractive neighborhood were more likely to regress from regular running, compared to those who assessed their neighborhood as attractive (Titze et al. 2005; see also Sproston and Primatesta 2004). The study did not specify the aspects of attractiveness but suggests that green spaces and green streets may have contributed to these assessments.

8.6.2.2 Walking

Results from the study by Hartig et al. (2003) combining ART and SRT theories show that after a stressor condition by the midpoint of a 50-min walk in a nature reserve the participants had 6 mmHg lower systolic blood pressure levels (on average) than participants walking in the urban surroundings, indicating greater stress reduction. Furthermore, positive affect increased and anger decreased in the nature reserve by the end of the walk, whereas the opposite pattern emerged in the urban environment. Performance on an attentional test improved slightly from the pretest to the midpoint of a walk in a nature reserve, while it declined in the urban setting. The natural environment was a 4,000 acre vegetation and wildlife preserve in a canyon of mountains. The urban site was an area of medium-density professional office and retail development in the city (Hartig et al. 2003).

8.6.2.3 Playing in the Green Space and Children

There are only a few studies focusing on whether physical activity or playing in green space has more beneficial health effects for children than in other types of environments. Fjørtoft (2004) investigated whether a natural play environment influenced playing behavior and motor development of Norwegian children aged between five and seven. She concluded that playing in a natural environment improved motor fitness, especially balance and coordination abilities. A study from Van den Berg et al. (2008) examined whether playing in nature is positively related to behavior indicators which indicate a healthy and balanced development of children. With good controlled experimental design this study showed that a brief visit to a natural environment provoked more varied and creative behavior and more exploration of the environment. Furthermore it provoked concentration. Finally, a study from Faber Taylor et al. (2001) performed in the US found a weak but significant positive relation between the naturalness of the playing environment and the seriousness of ADD (Attention-Deficit Disorder) symptoms such as difficulty in completing tasks, listening or following directions.

8.7 Summary, Conclusions and Future Directions

In this chapter we have presented and analyzed an expanding body of evidence on the issue of whether there is a relation between green space/green elements and levels of physical activity or not. For this purpose we have been using the following set of five questions that will be reflected on in this summary:

1. Are people who live near natural environments more physically active?
2. If proximity to natural environments is associated with greater physical activity, is there a dose-response relationship (i.e., does greater proximity equate to greater activity), and how strong is the relationship?
3. Is there evidence that the natural elements are causal in any relationship between natural environments and physical activity?
4. Do these relationships between natural environments and physical activity vary according to population characteristics (for example, age, sex, socio-economic status, ethnicity, country of origin)?
5. Is there something specifically beneficial about physical activity performed in a natural environment, when compared to that performed elsewhere (e.g., indoor or built environment)?

We thereafter conclude and point at different potential future research directions to further the understanding of these complex issues.

8.7.1 Natural Environments and Physical Activity in General

Perhaps the strongest conclusion which can be reached is how little quality evidence there is about the association between natural environments and general levels of physical activity. Almost all of the cited studies were in urban settings; few considered results by demographic or social group, by type of green environment or at different spatial scales. Furthermore, adding to the uncertainty on these matters is the fact that sometimes different spatial scales have been used for the determination of physical activity and the environmental correlate, i.e., it is not always known where the measured physical activity has been taken place. Thus, correlations between the levels of physical activity and the amount of green space may be spurious. Much more work is therefore needed to explore these associations.

When the definition of physical activity is a general one, the available evidence suggests that greater proximity to or accessibility of natural environments is frequently associated with elevated physical activity levels. However, findings are mixed, with dose-response relationships sometimes detected and sometimes not. The literature does suggest that perceptions of accessibility might be more important than the physical distance in determining the association with physical activity. However, perceptions of accessibility might well be confounded with physical activity behavior, and it is therefore difficult to determine the true direction of causality. In terms of the size of effect, again the evidence is mixed and dependent on the study setting, measure used and degree to which potential confounders have been controlled for. In general, when an association is observed, its strength is modest.

Relationships between greater access to natural environments and e.g., socio-economic advantage make it difficult to draw firm conclusions as to whether natural or green spaces have an independent and causal association with physical activity rates. At this time, the literature cannot confirm a causal relationship. The few studies which do exist suggest that some forms of natural environment are more encouraging to physical activity than other forms of natural environments.

It does appear that different population subgroups have differing relationships with natural environments and thus to physical activity in them, but it is currently not possible to provide generalizations.

8.7.2 Walking and Cycling for Active Transport or for Recreation and Exercise

A basic prerequisite for active transport is that distances between origin and destinations are suitable. It is therefore not surprising that this type of physical activity appears to be related to residential density and land use mix in the neighborhood environment. Whether green elements affect the levels of active transport therefore needs to be studied while controlling for these other variables. To our knowledge, no such study exists. Correlation studies do however suggest that both walking and bicycling commuters' perceptions of levels of green elements along their individual active commuting routes are related to their perceptions of to what extent their route environments stimulate to active commuting.

The effect of the local supply of green and natural areas on *where* people go for a recreational walk is considerable. There are also some studies indicating that a low local accessibility and/or availability will lead to less walking for pleasure overall. Given the limited focus of most studies, it is not clear whether this also means a lower level of overall physical activity. Lower levels of walking may be compensated by other activities (elsewhere). On the other hand, a lot of greenery in the residential environments often goes together with a spacious design of the neighborhood. Among other things, this may imply good parking facilities and fewer destinations such as shops, banks, etc. nearby, thereby facilitating car use for transport purposes. So, factors promoting recreational activity may be negatively associated with factors promoting active transport, at least for adults (see e.g., Den Hertog et al. 2006). The net result may be negative. Moreover, besides their sheer presence also the attractiveness of the green areas and their (social) safety are of importance for their use.

General conclusions with regard to type and strength of the relationship are hard to draw. We still cannot answer questions such as: is there really a dose-response relationship, and if so, is it linear or is there for example a decrease in the marginal return of ever more nature? A wide variety of green environmental characteristics have been used. Sometimes these characteristic have only two levels, making it impossible to say something about the shape of the relationship. Also for physical activity, a wide variety of measures have been used. Furthermore, in several studies the environmental characteristics are the characteristics as perceived by the respondents that also self-reported their physical activity. This same-source bias may lead to an overestimation of the strength of the relationship between actual physical characteristics of the environment and physical activity.

A related question is how the dose should be defined in this case. Whereas on the effect side the measurement of physical activity has received quite a lot of attention, the development of measurements of environmental doses is still in a very early stage. The question of which green environmental characteristics are relevant and how they can be assessed objectively and reliably has only begun to be addressed. A next step would be to integrate the individual characteristics into an overall measure of the activity stimulating capacity of the green components of the environment. An early example of this type of study is that by Giles-Corti et al. (2005a), introducing a model in which size, distance and attractiveness of public open spaces are combined.

Given the nature of almost all studies that have been presented (cross-sectional, correlational) no firm conclusions regarding the direction of causality are possible. Intervention studies, when available, usually only deal with a small part of the local supply of green space and natural elements. Besides the resulting problem of location substitution, this makes it unrealistic to expect big effects.

Differences between population segments are also likely to exist. Neighborhood walking may be especially important for the elderly as a type of activity with a low threshold. At the same time, social and physical safety issues are likely to be more prominent for them.

8.7.3 Children's Outdoor Physical Activity

Relatively few studies focus on whether a green environment stimulates physical activity for children. The evidence shown in this chapter suggests that having a park in the neighborhood is often associated with elevated physical activity levels of children. For other types of natural environments the evidence is less convincing or available. This evidence mainly comes from studies outside Europe. Further research is needed to find out whether this relationship also exists in Europe.

Findings are mixed with dose-response relationships sometimes detected, and sometimes not. In terms of the size of effect, again the evidence is mixed and dependent on the study setting, measure used and degree to which potential confounders have been controlled for. In general, the association size is modest.

Because all reviewed studies are cross-sectional it is hard to draw conclusions regarding the causality of the relation. Furthermore, most studies do not investigate whether children are really physically active in the green environments, but investigate whether the availability of green environments is related to children's physical activity.

It does appear that there are differences between boys and girls and between different age groups in whether natural environments promote physical activity, but it is currently not possible to provide generalizations.

8.7.4 Benefits of Physical Activity in Green Space Versus Urban and Indoor Settings

Discussing emotional, cognitive and physiological benefits of physical activity in green space versus in urban and/or indoor settings implies two connotations. First, natural environments may provide the same benefits as other locations but at a different degree. Second, they may provide qualitatively different benefits. Most of the studies on running show similar benefits in natural and urban/indoor settings, but at a different degree. Obviously, quantity may sometimes turn into quality, and the most reliable result seems to be the presence or increase of positive emotions and absence or decrease of negative emotions after physical activity in natural environments. Less reliably, adults seem to perceive less fatigue and physical symptoms after their physical activities in green space vs. indoors or sports fields. Regarding walking, experiments indicate that natural environments (e.g., nature reserve area) in comparison to urban (e.g., office and retail development) provide lower levels of blood pressure after stress conditions.

In sum, the evidence regarding exercise in green space versus elsewhere seems to be limited, mixed and we note that the effects of the environment may differ according to the intensity of the exercise and level of the runners (e.g., competitive versus non-competitive; experienced versus less experienced runners). There are some studies comparing different types of outdoor environments but only a few studies comparing the effects of indoor and outdoor exercise environments. The contradictory results described above may be due to methodological differences and differing limitations of the studies. More accumulation of research results is needed. For example, because the studies are mostly experimental and the research settings have been selected by the researchers, it is not known whether attachments to particular exercise places or to types of places might influence the effects (cf. Korpela et al. 2001). It is not known whether regular runners choose their environments differently from irregular runners and whether familiarity of and habituation to the route is relevant.

Because the reported studies have used limited sample sizes and population groups, we cannot answer the question of individual and population group differences properly. Individual differences in training or individual exercise preferences and habits can mediate effects of physical activity in green space. It seems that physical activity in green space has beneficial emotional, cognitive, behavioral and physiological benefits effects on both adults and children. For children, the results of controlled experiments suggest more creative and explorative play and greater alleviation of attention deficit disorder (ADD) symptoms in natural settings.

8.7.5 Future Directions and Issues

The overall pattern and the majority of correlations between green elements and levels of physical activity speak in favor of the hypothesis of a connection between green elements and physical activity. However, there are a number of studies showing no relation and even a few showing a negative relationship.

The quality and quantity dimensions of green space need to be explored as separate entities in relation to possibly being determinants of physical activity. For example, the potentially stimulating effect of the green environment in urban settings may be neutralized by high levels of noise from traffic (cf., Schantz and Stigell 2007; Hornberg et al. 2007). On the other hand, a playground in the park may be the actual cause for higher levels of physical activity in children, rather than the green dimensions of the environment itself. The confounding of aesthetic quality and the greenness versus urbaneness of the setting is an understudied issue. The study by Pretty et al. (2005) suggests that both rural and urban pleasant scenes observed during physical activity may have similar effects on self-esteem. Thus, we have to more carefully differentiate between the aesthetic and natural features in studies comparing natural and non-natural physical activity settings.

Green elements as a destination and/or as part of a transportation route and their effect on physical activity are an important but complex research subject. Thus, future investigations should try to study environments where the physical activity/inactivity is undertaken but also the effects of environments along the route or adjacent to the environment where the activity takes place. For example, a basketball court in a green park versus besides a car park may attract people to physical activity in different ways.

The quantity and the optimal size of green space needs also further research: envision two extremes, both in urban settings, one a local pocket park, the other being a large urban park in center of an urban residential area, e.g., Central Park in New York City. It is immediately apparent that the pocket park will not be used as an arena for physical activity. A slightly larger park can be a destination point for e.g., dog owners and thereby be a determinant of physical activity for this subgroup. But still the park may be too small to attract adult joggers. Thus, the quantitative limits and qualitative features of green space positively effecting physical activity for different user groups are still relatively unknown. Furthermore, the potential substitution effects are not presently known, i.e., whether the total level of physical activity would remain the same if the desired green space did not exist.

Future studies should also conceptually clarify not only the independent variable, i.e., the green space and its dimensions but also the "dependent" variable, physical activity. This refers to types of physical activity as well as to the intensity of activity. If natural environments attract people to engage in physical activity, do we mean overall starting of physical activity (by people who previously were totally sedentary) at whatever frequency and intensity, achievement of recommended levels of physical activity, progression from irregular to regular physical activity, or regression from regular to irregular physical activity, or total regression from physical activity to a sedentary state? Attaining such types of more specific information on the physical activity and the individuals being active would enhance evaluations of health impacts on both the individual and the population level.

It is known that usage of green space for running and walking may vary substantially over the year (see e.g., Kardell 1998). In consequence, the relation between green space and levels of physical activity is rather weak during winter whereas it might play a substantial role in summer. Studies using spot data of physical activity can thereby miss important information depending on when the data is collected. To address these issues we therefore need a basic understanding of how green space is used over the year. It is also of interest to know whether the physical activity takes place at other locations during winter time (e.g., on a treadmill at a gym), i.e., is there a substitution effect regarding the place where the physical activity is going on, or whether people are less physically active during winter time?

The understanding of the basis for the possible relation between green space and physical activity is today to a great extent relying on psychological and psycho-physiological theories and findings. However on top of that basis, we are dealing with a behavior that to a certain extent very likely also is an effect of socialization and learning processes as well as trends that might undergo undulations. Studies in for example Sweden have revealed great secular changes in usage of the same green settings and running trail network (Kardell 1998). This points at the importance of studying these issues in different behavioral and cultural contexts and settings. For example, one might think of different ethnic, parental support and learning environments. Examples are nature-based pre-schools, physical education contents in schools and the influence of NGO's, such as the scout movement and other organizations which promote outdoor recreation.

An important issue for further studies is to increase our knowledge of the effect size. In one study presented in this chapter, the postulated effect of green space was about 6 min of physical activity per day. In relation to the recommended minimum levels of physical activity per day (= 30 min.), the 6 min per day amounts to 20%. Research on the effect size has to take moderating factors into account. For example, despite good environmental conditions physical activity may not occur, e.g., due to factors such as lack of leisure time. In other words, effect sizes might be highly conditional. Green space might be a necessary or optimal ingredient in stimulating to physical activity within the population, but it might not be a sufficient factor. To further the understanding of these matters, it would be favorable if the correlation approach used in many current studies can be supplemented with information on the preferences of different population groups for arenas and qualities of environments for physical activity. Indeed, there is a need for several different and complementary study designs.

The most important concern about the existing results relates to the potential selection effects, i.e., that people select their housing or other general living conditions in order to obtain certain conditions for e.g., physical activity. The results may then be relevant for subgroups of the population, rather than for a majority or the whole population. Longitudinal studies following changes in environment and/or in residence can be one way to circumvent this measurement issue. Experimental research might offer another avenue, when feasible.

8.7.6 Recommendations

In all, it is possible to speculate about some practical recommendations regarding planning and design of open (green) space based on the available empirical evidence. If access and the amount of green space near one's residence can be more reliably than now related to the meeting of recommended levels of moderate or vigorous physical activity, the conclusion could be that we need many but somewhat smaller parks rather than few large parks within the city structure. The point is that there should be a sufficient amount of green space close to everyone's residence. At the moment, however, there are no studies to show the sufficient size of, for example, a city park for physical activity. The same point would also speak for urban sprawl rather than densification. Studies on the effect of green space in the vicinity of children, disabled and the elderly, whose range of activity is usually more limited than adult 'normal' population support similar conclusions.

In this chapter we have dealt merely with the physical activity dimension in relation to green space. However it is obvious, that in physical planning more dimensions have to be integrated. As pointed out in other chapters in this book, studies showing that viewing green space has relaxing physiological and psychological effects (Chapters 5 and 6). This supports the need for private gardens or green yards in residential areas. Some of these elements may also stimulate physical activity through gardening, but the point is that there are also other merits of green space to be considered. On the basis of existing knowledge a wise policy might be to conserve whatever green space is there as a precaution, because in practice changing built-up areas back to green space has proven to be quite difficult.

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Chapter 9
Natural Elements and Physical Activity in Urban Green Space Planning and Design

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Abstract While studies on physical activity behavior are widely available, research on physical activity environments is relatively new, particularly when related to 'natural' environments. In this chapter planning issues and design elements that can influence the use of urban green areas for physical activity are discussed. Availability, features, conditions, safety, aesthetics and climatic comfort are the main characteristics of urban green areas considered in the discussion, particularly in relation to natural elements. In the first part of the chapter the current literature presenting scientific evidence is examined. Once this evidence is discussed examples of best practices and significant planning and design solutions concerning the most relevant attributes of the green spaces are presented.

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9.1 Introduction

The purpose of this chapter is to discuss how the quality and the features of the physical environment, deriving from urban and peri-urban green space planning and design, can influence physical activity. The chapter will first examine the literature presenting scientific evidence relating planning issues (such as availability of green spaces, accessibility and equitability) design features (such as size, layout, facilities, attractiveness, climatic comfort) and maintenance, to the physical activity levels of the users and/or more in general of the population living in the surrounding areas. Once this evidence is discussed examples of best practices and significant planning and design solutions concerning the most relevant attributes of the green spaces will be presented.

The definition of urban green space generally includes a variety of sites, characterized by the presence of vegetated land or water, within or adjacent to urban areas. A common classification of urban green space does not exist although many state or local agencies and governments have adopted their own for planning purposes. They include a variety of sites, such as parks and gardens, playgrounds for children or teenagers, amenity green space, outdoor sports facilities, cemeteries and churchyards, natural and semi-natural urban green space and green corridors.

Although the presence of accessible attractive green space is likely to engage residents in frequent physical activity, the current evidence does not provide a classification based on the characteristics of green space that encourage autonomous use for physical activity. Similarly, it is not possible to classify green space according to the psychological benefits it delivers (CSC Consulting 2005).

Humpel et al. (2002) suggested that "*while the measurement of physical activity behavior is now a well-established field, this is not the case for the measurement of physical activity environments*." The key attribute for classifying green space in relation to health is its functionality for physical activity. A number of studies have examined barriers and opportunities in the use of parks and green areas and their influence in physical activity levels for the population using them (Jackson and Scott 1999). Many of the barriers are related to demographic or social characteristics, such as age, gender, race/ethnicity, socio-economic status (Lee et al. 2001). Others are related to specific physical features of the green areas, and might be easier to be dealt with through planning and design solutions. While there are relatively many studies on factors that inhibit park and open space use, there is a need for more research regarding features that can promote the use of parks and green areas for physical activity (Bedimo-Rung et al. 2005). According to Sallis et al. (1997), physical environments are the least studied type of influence on physical activity and the existing studies are often restricted to specific user groups, limiting generalization. Recently, however, many studies are focusing on the development of comprehensive instrument to measure the physical environmental factors that may influence physical activity in the open spaces (Pikora et al. 2002, 2003; Brownson et al. 2004; Lee et al. 2005; Iamatrakul et al. 2005; Lawrence et al. 2005; Hoehner et al. 2005; Bedimo-Rung et al. 2006; Saelens et al. 2006; Kaczynski et al. 2008).

9.2 Physical Attributes of Green Space

Following the framework proposed by Bedimo-Rung et al. (2005), green space characteristics that can strongly influence their use for physical activity, and therefore should be considered in urban planning and green-space design, can be divided into six categories: *Accessibility, Features, Conditions, Safety, Policies and Aesthetics*. Policies, especially those specifically aimed at promoting and encouraging physical activities are well covered in other chapters of this book and therefore will not be addressed here. To the categories proposed in the framework we have added climate and microclimate, considering how they can influence physical activity in the outdoors (Chan et al. 2006; Merrill et al. 2005; Togo et al. 2005) and how they can be modified through design choices (Brown and Gillespie 1995; Plotcher et al. 2006).

9.2.1 Accessibility

Accessibility is defined as the ability of city dwellers to get to the green spaces. To gain health benefits from physical activity, but also from the green environment, regular exposure to influential factors seems to be needed. Research suggests that regular contact with the natural environment enhances physical health and mental well-being, and good accessibility to green areas helps to achieve this. Grahn and Stigsdotter (2003) identified a significant relationship between the number of visits to an urban open green space and the level of self-reported stress. Accessibility is directly influenced by how recreation areas and facilities are provided and managed. Accessibility is primarily a consequence of the availability of parks/forests within the geographic area (m^2 per capita, ha of open space per 1,000 population, etc.). However, it also relates to the distribution within the city and its neighborhoods, and to how the availability of parks is distributed between different ethnic and economic groups. Do all groups have equal access to parks? And are parks/forests in different areas equally maintained and supported? The distance from the dwellings as well as the transportation system available are also an important factors influencing accessibility for individual users, as is safety of access (safe pedestrian or bicycle routes to the park/forest), and the awareness of the existence of green open spaces.

In a Dutch study (De Vries et al. 2003), the relationship between residents' perceived health-status and the amount of green space in one's living environment was studied. This relationship was consistent after controlling for personal characteristics, such as age and socio-economic status. Furthermore, all socio-demographic groups expressed a similar need for using urban green spaces in a Swedish study (Grahn and Stigsdotter 2003). Humpel et al. (2002) reported that location and convenience, as well as perceptions of safety have a great influence on whether people visit parks and use them for physical activity. Sallis et al. (1998) found that a convenient location of parks was associated with vigorous physical activity. Strong evidence suggests that access to parks and activity programs is related to more activity for children and youth (Sallis et al. 2000).

Troped et al. (2001) found that the closer people lived to bike trails, the more likely they were to use them. However, in a recent study by Kaczynski et al. (2008), distance from home was not found to be a significant predictor of the use of neighborhood parks for physical activity.

Information regarding how far people are willing to travel to use destinations for different types of recreational physical activity behaviors is limited. A study by McCormack et al. (2006) examines the demographic characteristics, neighborhood opportunity and specific-physical activity behaviors associated with distances travelled to destinations used for recreational physical activity. Work by Giles-Corti et al. (2005), examined the association between access to public open space and physical activity using three accessibility models that progressively adjusted for distance to public open spaces, and its attractiveness and size. The study showed that the likelihood of using these spaces increased with increasing levels of access, but the effect was greater in the model that adjusted for distance, attractiveness and size. After adjustment, city dwellers with very good access to large, attractive public open spaces were 50% more likely to achieve high levels of walking. The availability of green spaces for physical activity may be particularly relevant for certain user groups. Several studies have shown that proximity to recreational facilities and parks is one of the most important predictors of physical activity for youth. Cohen et al. (2006) have found that adolescent girls who live near parks, particularly near parks with amenities that encourage walking and contain active features, engage in more non-school physical activity than those living in areas with fewer parks. In this study the presence of parks within a 1 mile radius from home was associated with higher levels of non-school moderate to vigorous physical activity among adolescent girls, and this relationship is also found for proximity, number, and the type of parks, as well as specific park amenities. Roemmich et al. (2006) have found that neighborhoods with greater proportion of park area are associated with greater physical activity amongst young children.

In a study by Grahn and Stigsdotter (2003), proximity to a green environment (distance travelled to a public urban green area, access to a garden) also appeared to be influential, in addition to the duration of the visit. An individual who lived 50 m or less from an urban open green space visited it three to four times weekly, but when the distance was 300 m, the number of visits reduced to an average of 2.7, and if the distance was 1,000 m, visits occurred only once a week. Also in a Finnish study, both a good amount of green areas and easy access (i.e. short distance) to a natural environment increased the number of visits to a green environment by Helsinki residents (Neuvonen et al. 2007), see Fig. 9.1. People who live closer to a park or trail use it more frequently, on average, than people who live farther from these facilities (Hoehner et al. 2005).

The findings presented here show that the distance to green areas is an important factor in explaining visitation to close-to-home recreation areas. The results from Scandinavia (Jensen and Skov-Petersen 2002; Grahn and Stigsdotter 2003; Nielsen and Hansen 2006; Neuvonen et al. 2007), show that the shorter the distance to open green space, the more often people use them. All these results are in line with findings which have shown that, on the other hand, physical inactivity is related to poor conditions for walking or cycling in residential areas (Lenthe et al. 2004). Also the

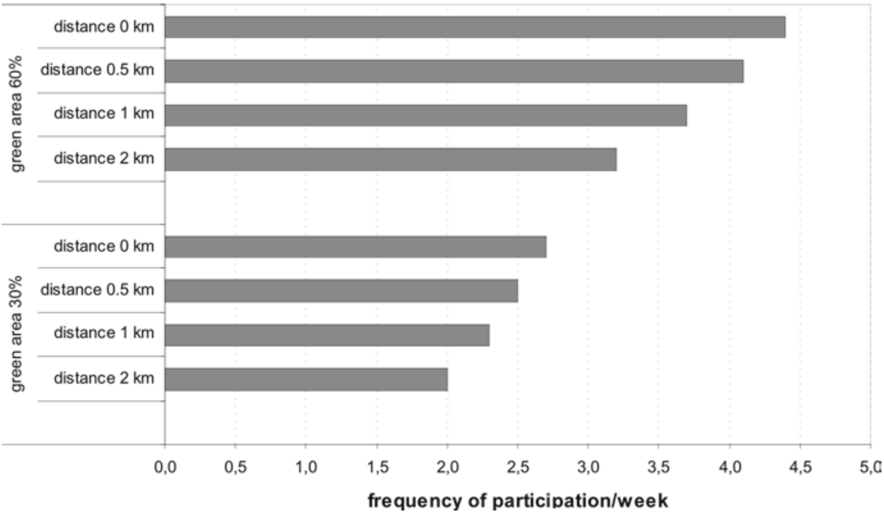

Fig. 9.1 Estimated frequency of participation in close-to-home outdoor recreation per week in two different recreation opportunity situations, with 30% respectively 60% of the total neighborhood area consisting of green space (Neuvonen et al. 2007)

amount of green areas in the residential areas as well as the landscape attractiveness affect the frequency of visits to green areas (Neuvonen et al. 2007; Giles-Corti et al. 2005; Roemmich et al. 2006). Recent data suggest that people who live near attractive, public open spaces may be almost twice more likely to walk at moderately active levels than were those who do not have access to public open spaces (Carnegie et al. 2002).

Different population groups are not equal in terms of ability to travel or to move to recreational areas. The distances adults travel to a recreational facility depends on the demographic characteristics, destination type, physical activity behavior undertaken at that destination, and number of neighborhood opportunities (McCormack et al. 2006). The selection of parks for a recreational visit is correlated to travel distance, travel time and travel cost (Iamatrakul et al. 2005). Accessibility is also related to the means of transportation available to reach the open space. In terms of available time during weekdays or weekend-days, most people have somewhat restricted possibilities to engage in recreation outside their own residential area during weekdays. Close-to-home recreation opportunities are, therefore, essential for fulfilling daily recreation needs. Proximity and a safe and attractive gateway to recreation areas have been found to be important quality factors in one's living environment. In one study, a short distance to recreation areas was important for 95% of the residents of a Swedish town (Lindhagen 1996). In another study, the frequency of visits and greater distance to recreation areas also had a negative relation (Roovers et al. 2002). According to the Swedish study, residents expressed that the maximum distance to a recreation area should not exceed 1 km (Hörnsten and Fredman 2000). According to the recommendations given by the Nordic Council of

Ministries, the maximum walking distance to recreation areas for daily use should be 250–300 m, but areas provided for weekend and vacation use may be located further away (Nordisk Ministerråd 1996).

Awareness of park existence has been found to be strongly related to distance, length of residence, and park age, which indicates the role of time and space in diffusing information about urban parks to residents of a community (Stynes et al. 1985). There is also evidence that the physical environment itself may be of limited importance to achieving the overall recommended levels of physical activity as such; in a prospective study of the building of a multi-use trail, for instance, Evenson et al. (2005) did not demonstrate an increase in physical activity among adults living near the trail. Nevertheless, in many other cases, accessible recreational facilities determined the use of those facilities, and thus good access is necessary to create a supportive environment (Giles-Corti and Donovan 2002).

Individual motivation is crucial as well. In Gobster's (2005) study of trail users, health-motivated trail users visited the trail more often and were more likely to walk or run on it than those people using the trail for pleasure or for other reasons. Proximity of the trail did not appear to be a differentiating factor between health or pleasure oriented users. The most frequent trail users were twice as likely to be health oriented than less frequent users. This implies that both good access and personal motivation is needed to achieve the level of physical activity required to obtain health benefits.

The health impacts of close-to-home outdoor recreation are remarkable. This leads to the conclusion that access to recreational areas in residential areas should be as easy and safe as possible. Recreational areas that are close to home are particularly important for children and families with small children, and also for elderly people in big cities (Maas et al. 2005). Developing a habit of going on daily outings to close-to-home green areas and engaging in physically active leisure activities in childhood is a good start for a physically active lifestyle later in life. When planning urban green areas and recreational services, much more attention should be paid to the outdoor recreational needs of families that include small children and their opportunities to experience nature. The needs of elderly people and those without access to a private car should also be known and considered more in order to provide attractive and inviting close-to-home recreation opportunities (Lehmuspuisto 2004). There is evidence that elderly women in all population groups face the most constraints and obstacles when it comes to participating in outdoor recreation (Neuvonen et al. 2004; Sievänen et al. 2005).

Green areas should be available to everyone, but those with some kind of disability often find themselves excluded from them (Lundell 2005). Physical barriers are key factors in this exclusion, since they create obstacles that don't allow full access and mobility to and within these sites, such as steps, slopes, surfaces, or inadequate dimensions of paths (Crosby 2003). Easily accessible and high quality recreation opportunities, which equally serve all population groups and inhabitants of different locations in the urban environment, are indicators of good living conditions and a healthy environment, as well as of quality of life as a whole.

9.2.2 Facilities

Green space facilities represent a variety of elements, structures and programs that can make green space suitable and attractive for different active uses. People are attracted to green space where they feel they may engage in specific activities and obtain certain benefits. Therefore the presence or absence of a variety of features can determine a park's ability to promote physically active leisure behavior. Facilities that support active use of the green spaces will be considered rather than facilities specifically designed for organized sport activities (sport fields, swimming pools, etc.). Access to facilities and opportunity for activities are described as factors that may be associated with physical activity among adults (Humpel et al. 2002), and the presence of facilities in the neighborhood can also be significant for youth's levels of activity (Cohen et al. 2006; Mota et al. 2005). Baker et al. (2008, p. 258) concluded that parks should offer "equipments and low levels of physical disorder" in order to increase their use for physical activity. A study conducted by Tinsley et al. (2002) revealed that the presence of facilities in the park such as cycling and foot paths, parking and toilets was important for a high percentage of those interviewed. In the literature, however, there is limited amount of information as to which facilities and park features encourage activity (Baker et al. 2008).

The presence or absence of specific features plays an important role in how green can be used for physical activities, but 'thoughtful design' can include multiple users: sports people, walkers and passive users (Giles-Corti 2006). According to Kaczynski et al. (2008), park facilities are more important than park amenities and trails and have the strongest relationship with park use for physical activity. In a recent Canadian study (Potwarka and Kaczynski 2008), children that had a park with a playground within 1 km were found to be almost five times more likely to have a normal weight rather than being overweight, compared to those children without playgrounds in nearby parks. In this study there were no significant relationships between the proximity-based park variables and normal weight among the children in the sample.

Green spaces do not provide the same level of activity for their users, and parks can be considered as 'active' if they provide sports facilities such as tennis courts or playground equipment. More 'passive' parks are characterized by the presence of lawn areas, trees, water features, lakes, picnic areas, and/or walking trails (Mertes and Hall 1996).

Since walking is one of the most common type of physical activity among adults (Godbey et al. 2005), the design of good path and trail networks in green space and good links between home and the outdoor spaces are essential in order to encourage physical activity. Foot and/or cycling paths can take advantage of the existing landform, creating paths with different gradients which can be used to promote different levels of physical activity (Sport England 2005). Appropriate lighting, surfacing and a careful design should be considered in order to plan aesthetical and safe foot and cycling networks (Sport England 2005). Based on their study on trails characteristics and urban greenways Lindsey et al. (2008) concluded that trails were used more often when they offered wide paths, open views, a diversity in land use, and when they where greener than the surrounding environment. In the same study a negative correlation between use and unpaved paths was found.

The position of features in the space needs to be logical, for example locating the seating points near a playground or drinking points near sports fields (Bedimo-Rung et al. 2005). The presence of playground equipment seems to attract a higher density of children, and for this reason playgrounds should include a variety of equipment in order to favor different types of physical activity such as climbing, running, swinging, etc. (Farley et al. 2008). Green space facilities should also, as much as possible, be free of physical barriers to enable their use by all population groups and inhabitants. Physical barriers are usually well-known and today there is a great awareness for this issue, although 'basic mistakes' still occur (Stoneham 2003). Guidelines for designing accessible outdoor spaces can be found in e.g., Bell (1991, 1997), Bell et al. (2006) and Price and Stoneham (2001). Open space layout and the availability of facilities can also have an effect on intra-activity conflicts. Few studies have examined the effect of intra-activity conflicts on urban park use for physical activity (Schneider 2000). Conflicts do not seem to detract from park experiences (Schneider 2000), but perceptions of conflict appear to vary by activity group. For example, Moore et al. (1998) found that a greater proportion of walkers and runners than skaters and bikers reported that their enjoyment was negatively affected by skaters and bikers than vice versa.

9.2.3 Conditions

Conditions are strictly related to the maintenance and to the proper or improper use of green space. The quality of the maintenance has an influence on aesthetics and on perceived and actual safety. Poorly maintained parks can be considered unsafe both due to the presence of broken, and thus dangerous, play equipment or hazardous trees and due to the fact that poor maintenance sends the message that breakdown is accepted civil behavior, inviting vandalism, and leading to unsafety. If the green space available is of poor quality people do not feel confident to use the area for recreational purposes. As a consequence increased vandalism or other means of damage and misuse occur. Ellaway et al. (2005) report in their study that higher levels of greenery and lower levels of graffiti and litter in residential environments are associated with being physically active and not being overweight or obese; efforts to promote activity and reduce weight should take environmental facilitators and constraints into account. There is a whole range of causes for damage and misuse, which strongly influences the use of parks and other urban green space for physical activity and recreation. The presence of litter and debris, as well as lack of apparent maintenance might be important detractors from using a physical activity resource for physical activity; especially since people who walk more frequently typically rate their environment more positively (Carnegie et al. 2002). In fact, a high proportion of incivilities might suggest lack of attention to an area, and might even encourage less desirable behavior, clearly not promoting favorable conditions for recreational physical activity (Brownson et al. 2001; Lee et al. 2005). The most common negative aspects as described by the Woodland Trust (2002) are vandalism (opportunistic or premeditated); litter and fly-tipping; antisocial behavior of certain groups; uncontrolled dogs and dog fouling; dumping of cars, motorbikes, refrigerators, etc.; and the use of unauthorized vehicles.

It is important to analyze the given damages and misuse in order to find adequate solutions that can mitigate the situation. Communication, education and working with authorities, and neighborhood engagement, are seen as general principles to deal with misuse issues. The more people are involved in maintaining green areas, the more they get a sense of ownership, and the more likely misuse and damage decrease. Thus public involvement is crucial for maintaining positive conditions of urban green areas (e.g., Van Herzele et al. 2005).

Maintenance can also have a direct influence on the opportunities for physical activity. Poorly maintained entrances, signs, paths, or thick vegetation can become physical obstacles or hazards for joggers, bicycles, and people just strolling through the parks. Guidelines recommend developing check-lists and stepping stones for the planning as well as the maintenance and further development of urban green spaces as spaces people tend to go to every day for recreational and sports reasons. Footpath and biking routes have to be checked frequently, damage has to be removed as soon as possible to avoid further damage (Bundesamt für Naturschutz 2008). If, for example, a certain part of a much frequented hiking path is in a bad condition, people will create new paths crossing meadows or woods which might have negative effects on the wildlife or raise conflicts with private owners. Urban dwellers tend to prefer green structures that are well kept and tidy. It is therefore crucial to develop effective maintenance routines, which includes regular control visits of the green areas. It is important to integrate the maintenance aspects into the planning process in order to calculate the financial and human resources needed to maintain green spaces. It is reported that the maintenance costs of green spaces are much higher in urban areas than in rural areas. For example, the Emscher Landscape Park is a regional park and its management involves a multitude of cities and counties (Dettmar and Rohler 2007). Maintenance aspects are closely linked with safety aspects as described in the next paragraph. Research and conclusions drawn from visitor studies have pointed out that people avoid green spaces that are neglected.

9.2.4 Safety

Both real and perceived safety can be a strong factor in favoring or inhibiting the use of green spaces, and consequently their use for physical activity. Safety can be related to the surrounding environment (crime rate in the neighborhood) but very often it originates from the park layout and features (openness, type of vegetation, lighting, entrances). Features that promote a variety of uses of the green areas, keeping the spaces alive throughout the day and evening, are important both for perceived and actual safety. Perceived safety is often analyzed by looking at how safe people feel their green spaces and neighborhoods are considering crime. A few studies found an association between neighborhood safety and physical activity levels (Hastert et al. 2005; Weir et al., 2006). The Center for Disease Control and Prevention (1999) found a significant association between perceived safety from crime and physical activity participation. In addition, Kirtland et al. (2003) found that people who were the least active were more concerned with safety issues.

Perceived safety in urban green spaces has been found to be related to park features and layout (Schroeder and Anderson 1984; Herzog and Chernick 2000). The authors of these studies found that some features that are perceived as enhancing the scenic quality, such as forest vegetation, were at the same time negatively influencing perceived safety. They discussed the management implications of their findings and conclude that the perception of both safety and aesthetics depends on specific manageable features of recreation sites, including vegetation and manmade features. Although perceived security and attractiveness may sometimes be difficult to achieve simultaneously, this is not necessarily always the case. According to the authors a compromise between perceived safety and scenic quality might be achieved by, for instance, reducing shrubs and raising tree canopies to improve visibility at ground level, while preserving a feeling of naturalness.

Perceived safety in urban parks is significant for promoting physical activity in specific urban settings (Hastert et al. 2005). According to the authors, having access to a safe park is particularly important for teens that live in neighborhoods in which people are afraid to go out at night. Among teens living in neighborhoods perceived as unsafe, 16.3% of those with no access to a park that is safe during the day get no physical activity, compared with 9% of those who have access to a park that is safe during the day. Suminski et al. (2005) reported that neighborhood safety is an important determinant of walking. Parents' concern for safety has also been found to be negatively correlated to children physical activity in poor neighborhoods (Weir et al. 2006). Some qualitative studies indicate that criminal activity such as the sale and use of drugs deters use of parks by children and adults (Gobster 2002; Outley and Floyd 2002). Use of urban parks can also be affected by having to traverse 'gang territory' (West 1993). We could only find one study that has used an objective measure of safety, by looking at the reported incidents of serious crime in the neighborhood, and found an association with physical activity (Gordon-Larsen et al. 2000).

9.2.5 Aesthetics

According to Giles-Corti (2006, p. 3) a "*Well designed public open space is an important component of the recreational mix providing opportunities for physical activity, social interaction and potentially a restorative environment providing* *some relief from the rush of life in the 21st century*." However, the design of a space is a complex process since many variables are used in order to create a well-designed, appealing and balanced space that is aesthetically pleasing. Hoehner et al. (2003) propose that recreational activities are positively related with objective measures of attractive features. This category includes all the elements and features that can enhance the attractiveness and appeal of a park or a forest and especially those that stimulate the desire of being physically active. These elements are strictly related to design choices that can influence the perception of the environment through the different senses. Overall scenery, visual appeal of features, vegetation type, density, colors, scents and sounds.

Aesthetic principals have been studied by researchers in different fields of knowledge, from philosophy and psychology to architecture and planning. When related to the environment the aesthetic attributes refer to the perceived design elements of an environment that make it attractive and appealing, and they are very much associated with the notion of perception and aesthetic quality of the landscape. According to Gobster and Westphal (2004), people's response to the environment is often 'aesthetic in nature' and as noted by Nasar (1988) the aesthetic qualities of the environment may influence the experience, the behavior and the responses towards the surrounding environment. Humpel et al. (2002) pointed out the 'aesthetic attributes' of the environment as one of the factors that influences the use of outdoor spaces for physical activity. Titze et al. (2007) found a positive relation between the perception of an attractive environment and cycling, particularly for those who cycle on an irregular basis. Increased levels of walking for exercising are positively correlated with the perception of an aesthetically pleasing neighborhood (Ball et al. 2001). When neighborhoods present good aesthetic qualities, adolescents are more likely to have higher levels of physical activity (Mota et al. 2005). The presence of hills and enjoyable scenery in the neighborhood has been associated positively with the practice of physical activities among women belonging to different racial-ethnic minorities in the US (King et al. 2000). Wilcox et al. (2000) in their study regarding levels of physical activity among women living in rural areas implied that the absence of enjoyable scenery could act as a constraint for exercise, suggesting that green spaces may be important to increase the levels of activity. Wright et al. (1996) found that the presence of street trees, along with green borders, may be considered as attributes that create attractive environments, and may contribute to increased exercise. Pikora et al. (2003) suggested that walking in the neighborhood is also influenced by the presence of diverse views.

Although the presence of high aesthetic quality can motivate people to use and be active in parks (Bedimo-Rung et al. 2005), research regarding green space attributes, particularly park characteristics that might influence the levels of physical activity is sparse (Baker et al. 2008; Bedimo-Rung et al. 2005). The presence of water, trees and woody vegetation in parks seem to have a positive impact on a park's high scenic quality (Schroeder and Anderson 1984). Examples of paths bordered by trees and shrubs allowing wide views and water features (Giles-Corti et al. 2005) are described as elements preferred by individuals, which can promote active use of public open space, and seasonal variation of trees' color, especially in autumn, can also contribute to the enjoyment of outdoor physical activities (Krenichyn 2006). The design of endowing green spaces with high aesthetic qualities is also deeply linked to the layout, materials, textures and colors of the different features chosen for a particular space. For instance, multicolored markings on playground structures have been shown to increase physical activity in children (Stratton and Mullan 2005; Ridgers et al. 2007).

9.2.6 Climate and Microclimate

The planning and design of urban and peri-urban green spaces can influence microclimatic condition and climatic comfort (Brown and Gillespie 1995; Plotcher et al. 2006). Climate and microclimate can be important factors in promoting physical activity in the open spaces. Many studies relate physical activity levels in the population with meteorological and climatic conditions. Physical activity has been found to be correlated to ambient and apparent temperature, relative humidity, wind speed, rainfall and day length (Chan et al. 2006; Merrill et al. 2005; Togo et al. 2005). Other studies have looked at thermal comfort in open spaces (Nikolopoulou and Lykoudis 2006; Oliveira and Andrade 2007; Stathopoulos et al. 2004; Thorsson et al. 2004). The findings confirm a strong relationship between microclimate and comfort conditions, with air temperature and solar radiation being important determinants of comfort. The perception of air temperature is difficult to separate from the perception of the thermal environment and it is modified by other parameters, particularly wind. The perception of solar radiation is related to the intensity of fluxes from various directions (i.e. falling upon both vertical and horizontal surfaces), weighted by the coefficients of incidence upon the human body. Wind was found to be the most intensely perceived variable, usually negatively. Wind perception depends largely on the extreme values of wind speed and wind variability (Nikolopoulou and Lykoudis 2006). The strong relationship between microclimatic and comfort conditions suggest that careful design can allow for the use of open spaces, even at relative harsh microclimatic conditions balancing exposure and protection to the different climatic elements, depending on the geographical region, season and user preferences. However, this can only be feasible if great care is taken to include microclimatic concerns at the design phase. Solar radiation and wind can be influenced by the design of planting and other features in green open spaces to create more favorable conditions for physical activity (Brown and Gillespie 1995)

9.3 Designing Parks for Physical Activity: Examples Throughout Europe

In Europe many interesting projects have been implemented at different scales, regional, metropolitan and local, specifically to offer opportunities for physical activity in a natural environment. In other cases newly designed public open spaces have included design solutions and programs to encourage active use. In this section a limited but diverse selection of such projects his presented. The projects were selected to cover different scales, different geographic and climatic regions, and different typology, ranging from designed urban parks to regional trail systems. The Emscher Landscape Park in Germany is an example of a regional scale project, serving a very large population and involving many municipalities and agencies. The Helsinki Recreational Trail System and the Padua Green U are different, yet related, examples of urban scale projects, specifically aimed to promote outdoor physical activity. The two examples from Lisbon (Portugal) describe different approaches in promoting physical activity with green open space design: in a well established peri urban forest such as the Alameda Keil do Amaral and in a recently developed waterfront urban park (Parque Tejo e Trancão). An example of open space design for specific user groups is provided by the Maunula trail in Helsinki.

9.3.1 Regional Project: The Emscher Landscape Park

9.3.1.1 Emscher Park Cycle Track and Industrial Heritage Bike Trail in the Ruhr Area

The Ruhr Area is the largest economic area in Europe and was once the industrial heart of Germany depending mainly on coal mining, steel industries and chemical industry. Its name stems from the river Ruhr, which marks the southern boundaries of the area. The Ruhr Area of today is a landscape full of contrasts: a still visible industrial past and a new infrastructure are intertwined and visible side by side. For decades the rhythm of life was dictated by machinery, noise and shift work. Life-styles and attitudes grew out of coal dust and working-class housing estates. But then the blast furnaces and collieries started to be closed down but nevertheless even today blast furnaces, gas meters and pithead towers continue to give the Ruhr Area its own unique features. They are important witnesses to 150 years of industrial history in the region, and also to the process of structural transformation which has been taking place here for several decades. The now silent factory sites – many of which are under an industrial heritage conservation scheme – are not sites of nostalgia and regret. They have long been transformed into lively industrial venues and attractive centers for cultural and tourist events. And only when people looked back on the now silent plants did they see the peculiar beauty inherent in the gigantic and ornamented industrial buildings. The Ruhr Area is roughly 13% of the surface of North Rhine-Westfalia. From east to west it measures 116 km, from north to south 67 km. More than 5.3 million people live in the area, the population density being 1,203 inhabitants per square kilometer.

In 1989 the government of North Rhine-Westfalia started the International Building Exhibition to prepare a strategy for the economic, ecological and social development of the Emscher Region. In former times the ‘Emscher’ was a small river, which became the open sewage canal for the whole Ruhr Area during the last

100 years of mining. Within the framework of IBA the Emscher Landscape Park (ELP) is a consequence and the central component of an integrated development strategy for the former industrial region. It is the most ambitious landscape project in Europe in the last decades.

The Emscher Landscape Park is designed as a leisure park for more than two million people living in the main zone of the river Emscher and for the above mentioned 5.3 million people living in the greater Ruhr area. The Emscher Landscape Park represents the largest and most developed regional urban park in Europe with its 45,754 ha and almost 180 realized and approx. 250 planned projects. Within the ELP 20 cities, two counties, 20 municipalities, the regional government as well as the state of North Rhine-Westfalia, the Emscher Waste Water Association (EG) and the Ruhr Regional Association (RVR) are cooperating. The Ruhr Regional Association – RVR is the main actor to develop and manage the ELP. Its responsibilities and duties are described in a special law. The main duties are: coordination and planning; public relations; building and realizing projects; maintenance and care; and financial management.

From the beginning one of the main major projects has been to establish a regional Cycle track system, which covers on one hand the whole Ruhr Area. This Cycle track is called 'Rundkurs Ruhrgebiet' which extends over more than 700 km. Within this greater cycle track the Emscher Park Radweg (cycle track) has been created, planned and designed as an important infrastructure to explore the park but also to be used as a day-by-day transportation system for work and leisure. The cycle track consists of a 230 km circular course running through the Emscher Landscape Park connecting anchor points of industrial heritage sites 70 km are newly built using old industrial railway tracks. The tracks have a width of 3.5 m.

9.3.1.2 Project Elements that Contribute to the Promotion of Physical Activity

Access and safety issues: Together both cycle tracks cover a vast amount of the different facets of industrial heritage along the rivers Emscher, Lippe, Rhine and Ruhr. Parts of the cycle route are created on former railway tracks. In order to create an attractive and safe circular track system it was inevitable to cross main routes, rivers or canals in the area. Therefore new bridges for cyclists as well as pedestrians were constructed. These bridges represent outstanding examples of technology and beauty, designed by well-known architects like Polonyi, Schlaich and Frei Otto (see Photo 9.1 for an example). Further access is possible through smaller local cycle routes which connect with the main cycle tracks.

Features: While underway bike tourism service stations are available for information, maps and other written documents, luggage transport, break-down assistance as well as the lending of off-road bikes. If visitors do not want or have the opportunity to take their own bikes it is possible to hire them at the service stations. Stations are inter-connected and rented bikes can be returned at other stations.

Photo 9.1 Bridge 'Erzbahnschwinge' in Emscher Park Radweg cycle track (Photo: Harald Spiering, RVR) (*See Color Plates*)

The 'RevierRad' is a high-quality bike service ideal for individual bikers but also for groups. It is possible to book a large contingent of bikes. The following are available for hire: city and trekking bikes for adults, children's bikes, trailer bikes, tandems, recumbent tricycles, rickshaws and electric bikes. People with moving disabilities do also have the possibility to hire bikes. The cycle route is improving year by year with growing facilities like bed and breakfast for overnight stay, toilets, restaurants and bars open for bikers. There is a huge amount of maps and other items of publicity. In 2007 a completely revised and updated guide for cyclist has been edited, containing a comprehensive series of maps (scale 1:50,000 as well as enlarged maps of 1:20,000 for inner city areas). The richly illustrated text sections describe the history of the industrial locations along the trail.

Conditions, Maintenance and Cooperation: To maintain this huge cycle track is a big challenge. The RVR as holding organization responsible for the whole route divided the 700 km of Ruhr area cycle track into 17 smaller parts. For every part people interested in biking and living in the region could apply as local stewards. Out of a greater number 17 persons were chosen who are responsible for 'their' part of the track. They regularly visit their parts of the track and control maintenance issues like quality of the track itself, the signs, signposts and bridges. Every 3 month during the season they report to RVR about the conditions of the track concerning sign posts, maintenance and other items. There are regular meetings of all cycle track stewards where issues like the enhancement of the tracks and quality management issues are discussed. It is known that the regular users as well as visitors find the sign system of the cycle tracks very attractive and respond mainly positive. One of the major issues within the responsibility of every local municipality is the waste management. There is also a multitude of institutions responsible for the technical maintenance of the cycle tracks. One of the outstanding responsibilities of the Regional Ruhr associations is to coordinate this multitude of local and regional actors together with involving the civil society actors.

Future Perspectives: The Emscher Park cycle track will be developed in the next years continuously as artery of the network of Industrial Heritage Trail by bike. To achieve this goal further railway tracks will be purchased and developed by the RVR. Furthermore sections leading through the different cities and maintained by the local municipalities will be modified and maintained. Another important goal is to intensify the quality management system. In 2010 the Ruhr Area is the European Capital of Culture. The Ruhr Metropolis lies in the midst of the most populated area of Europe. Twenty five million Europeans can reach the region by rail or car in 2–3 h. The Capital of culture therefore is seen as a unique chance to establish the area as an attractive tourist destination. In this context of Ruhr 2010 a section of the Emscher Park Cycle Track is put particularly into scene as a cultural cycle track 2010.

9.3.2 Municipal Projects

9.3.2.1 Helsinki, Finland[1]

The Recreational Trail System for Bicycling and Cross-Country Skiing

Helsinki is the capital of Finland with 560,000 inhabitants, and a land area of 185 km^2. The Helsinki Metropolitan area has about one million people, three neighboring municipalities included. Nearly all (97% of 15–74 years old) of Helsinki's inhabitants participate in outdoor and/or physical exercise activities. The average number of close-to-home recreational visits among Helsinki residents is 160 during 1 year. Walking for fitness or pleasure is the most popular type of outdoor activity. Other popular activities are cycling, dog walking, jogging and outdoor activities with children. Physical or fitness activities represented about 90% of all close-to-home outdoor activities: walking, skiing, bicycling (Neuvonen et al. 2007). In Helsinki, 55% of all inhabitants exercise enough for health status based on the standard of three times a week with intensity of sweating and getting out of breath to some extent (Kansallinen liikuntatutkimus 2005–2006, 2006).

The average distance from a residence to a park is 600 m in Helsinki. There are about 1,050 ha of managed parks (parks consist 6% of land area) and more than 4,500 ha of urban forest in Helsinki (25% of land area; 37% of green area of total

[1]Acknowledgements to Mr. Antero Naskila, City of Helsinki, for his contribution

land area) (Helsingin kaupungin tietokeskus 2003). The recreational trail system consists of 450 km multiple use routes and about 730 km of bicycling routes (see Photos 9.2 and 9.3). In addition, for walking and running there is more than 50 km of fitness trails. In winter, majority of the trails are kept clean of snow for walking.

The Bicycle Route Network

In Helsinki Metropolitan Region, all bicycle trails and other recreational paths suitable for bicycling provide about 2,600 km of trails or street side bicycle tracks; and from those about 1,200 km are in the City of Helsinki. Helsinki has a special plan for a 'city level' main recreational route network. This 'core' trail system is almost 500 km long, and about 85% of the planned core network is completed. Almost all the links of this network are provided for both pedestrians and cyclists. The paths are located in and between recreational areas and also make connections to housing areas. About three-quarters of the network are in a recreational environment, but commuters also use it. Now, a similar network plan is completed for the whole Helsinki metropolitan area. Seaside routes are of great value for recreation and there are altogether 90 km of seaside or riverside bicycle paths in Helsinki.

There are three designated landscape routes, which are marked on a bicycle map, and 27 special 'neighborhood district bicycling routes', some of which are themed and have special signage. These routes are 12–27 km long, and run past historical, architectural and other cultural attractions as well as nature attractions. One can get the A4 brochures of these routes from the libraries and from the Internet.

Photo 9.2 Hiking trail in Helsinki – in forested areas, the same trail network is used for several activities including walking, hiking, running and bicycling (Photo: Metla/Erkki Oksanen) (*See Color Plates*)

Photo 9.3 The majority of hiking trails are located in urban forest areas in Helsinki, Finland (Photo: Metla/Erkki Oksanen) (*See Color Plates*)

Project Elements that Contribute to the Promotion of Physical Activity

Access: The core bicycle trail network is located in recreational areas within green corridors, meaning in the urban forest or in other green spaces. They are well connected to housing areas.

Safety: The majority of crossings with major streets or roads are facilitated with bridges or road tunnels.

Conditions: The majority of the bicycle trail network is facilitated with lightning in the dark season. In winter time, some parts are managed for bicycle use; some parts are converted into skiing tracks (see below).

Features related to green space: About three-quarters of the core network are in a recreational environment (in green space).

The Cross-Country Skiing Trail Network

In the winter time, the City of Helsinki maintains a trail network for cross-country skiing. When the snow conditions allow, about 200 km of ski trails are prepared. It is possible to follow the ski trail network for 11 km from a downtown entrance point, to the northern end of the Helsinki Central Park (Photo 9.4). In addition, many other recreational areas have a groomed ski trail network. When ice-conditions allow, also ski trails are groomed along the coastline on the ice. Early in the season,

Photo 9.4 Skiing trail in Helsinki – Ski tracks are groomed on part of the trail network when the snow conditions allow (Photo: Metla/Erkki Oksanen) (*See Color Plates*)

and in winters with poor snow cover, Helsinki provides a shorter ski track, which is maintained with an ice shavings coming from ice-hockey (ice skating) halls. This 'artificial' ski trail is a service for the most enthusiastic skiers. Also, one commercial ski hall provides skiing opportunities based on artificial snow.

Project elements that contribute to the promotion of physical activity

Access: The ski trail network is relatively close to residents, free of charge

Safety: The majority of ski trails are in recreational areas; crossings with major streets or roads are facilitated with bridges or under road tunnels in most cases, and with lightning in the dark hours of the ski season.

Conditions: Regularly groomed during the season.

Features/facilities: Outdoor Recreation Centers have rooms for changing clothes, showers and saunas.

Promoting the Trail Network in Helsinki

A Helsinki Metropolitan Cycling and Outdoor Map is published every third year in the Helsinki metropolitan area. The first map was published in Helsinki in 1975. The 2008 edition was printed in 525,000 copies. The scale for bicycling map is 1:35,000 and for other outdoor activities 1:40,000. The map is distributed free of charge at sports centers, libraries, at the tourist office, and in some other places. It is targeted primarily at all city residents, but also at tourists. Helsinki also provides brochures of the above mentioned 'neighborhood district bicycling routes'. Outdoor maps are also available in the Internet and there is a special journey planner for bicycling and other trail activities in the Helsinki Metropolitan Area, where you can choose your route for instance according to the type of pavement and by interest points. The outdoor recreation and bicycling map shows all parks, recreational areas and green corridors. Trails are marked with different marking: multiple use trails for walking and bicycling, riding trail and skiing trails. On the back side of the map, different types of services are located and described. Also attractions of cultural and natural interests are included.

9.3.2.2 Lisbon, Portugal

Alameda Keil do Amaral (Keil do Amaral Promenade), Parque Florestal de Monsanto

Alameda Keil do Amaral is part of Parque Florestal de Monsanto and was designed by Keil do Amaral, in 1946. Parque Florestal de Monsanto, located on the hill of the same name, is deemed the city's 'green lung', due to its natural elements, size and scale, which is approximately 900 ha. As a consequence of this urban forest's large extension, the planner created several smaller pocket green areas within the forest which are connected by roads. During the 1980s, this area was seen as an unsuitable area for use, due to a lack of control, as well as poor maintenance. From the 1990s on, the Municipality of Lisbon has again been investing in the Parque Florestal de Monsanto and in order to promote its active use and recreation in the smaller green areas, several action were taken to renew the design and environment: preparing circuits, improving road surfaces, spreading the recreational options and providing users with greater security.

Located in the southern part of Parque Florestal de Monsanto, with extraordinary views of the River Tagus, Alameda Keil do Amaral (Photo 9.5) consists of a 1,300 m long promenade surrounded by green areas, which include barbecue areas, an amphitheatre, viewpoints, sports fields and parking facilities. In 2003 this promenade was permanently closed to traffic, resulting in one of the most important places for physical activity, such as walking, jogging and cycling, mainly during the weekends. A study conducted in 2004 (Soares et al. 2005; Almeida 2006) revealed that Parque Florestal de Monsanto was one of the public green spaces most frequently visited and used by Lisbon residents at weekends.

Project's Elements that Encourage and Promote Physical Activity

Three important components make Alameda Keil do Amaral an attractive area to visitors: the trees, the trails and the views. The trees, and all other vegetation present in the park, are of an exceptional size and shape and have a pleasing appearance, making them the most valuable component in these environments. They create an extraordinary visual frame and natural scenery for the trails and other recreational areas. The trees and vegetation, not only provide high aesthetic value, but also fulfill an important role in terms of bioclimatic comfort. The seasons are marked by the

Photo 9.5 Alameda Keil do Amaral, Monsanto (Photo: Ana Luisa Soares) (*See Color Plates*)

vegetation's different color schemes and the area offers mystery and pleasant views. Throughout the area, while strolling on the curved paths and enjoying the resting areas between the dense areas of vegetation, it is possible to experience moments of mystery, contrasted with the extraordinary open views over the river.

Access: The area can be easily accessed by public or private transport and while not located in Lisbon's city centre, it is served by a good road network and can be used by the urban population of Lisbon and the surrounding cities. Due to its natural topography, there are different levels of circulation and some of the paths have a high gradient which may exclude users with mobility restrictions. Nevertheless there are alternative roads that guarantee access for people with disabilities, children and elderly people. This green space's main promenade is paved with asphalt and has a small gradient allowing activities such as roller skating, cycling, walking and running. The secondary level of paths is paved with loose materials such as gravel and soil, offering the possibility to engage in more radical activities, for example mountain biking.

Features: For the older population there is a special trail, 'the Life Trail', composed by ten bases, each equipped with different physical activity equipment. There is also a natural amphitheatre, designed with grass and stone, which offers the possibility for passive recreation and resting from physical activity. This area is one of the few parks in Lisbon where it is possible to hold a barbecue, which turns it into a very attractive area for Lisbon residents, including minorities (immigrants), as it combines gathering for physical and social activities. The park is fully equipped with facilities such as benches, bins, picnic tables and parking facilities.

Maintenance and conditions: This space requires low levels of maintenance, mainly due to its natural characteristics. Most of the vegetation (trees, shrubs, herbs and grass) is natural, well adapted to the soil and the climatic conditions. In terms of materials used, most are rustic (wood, stone, gravel, soil, etc.). Regular maintenance such as garbage collection and maintenance of the barbecue areas is provided by the local authority, which keeps them in extraordinarily good condition.

Safety: The park is located in the vast urban forest, outside the city centre, and it is surrounded by dense areas of vegetation, mainly Pine (*Pinus pinea*). Due to the dense vegetation and the curved paths, that do not always provide clear and open views, the sense of safety can be affected. However, over recent years, the Municipality of Lisbon has invested in the park's security, using police patrols to undertake the surveillance, either on horseback or by car. Consequently, safety has been re-established and the use of the park has increased.

9.3.2.3 Padua, Italy

The Green U Project – Riparian Green Spaces as the Foundation of the Urban Green System

In many countries in southern Europe the spatial organization of cities, deriving from ancient settlements and often from walled medieval cities, allows for very little room for parks and other green spaces. Most Italian cities are far from satisfying the minimum standard requirement of green public space per inhabitant, and furthermore the quality and accessibility of the existing green spaces for physical activity is questionable (ISTAT 2005). Italian cities are tackling the problem of lack of urban green spaces in different ways, depending on the specific urban and suburban structure (Sanesi 2002). The City of Padua has developed a green network of existing and new parks and green corridors that seems particularly fit to provide opportunities for physical activity. Creating spaces and motivations to get people of different ages and social status to exercise has indeed been one of the major objectives of the project.

The City of Padua has a population of 210,301 people of which approximately 20,000 immigrants mainly from North Africa and eastern European countries. It also has a large student population of about 70,000 students. The public open space system covers an area of about 250 ha m, approximately 11 m^2 per inhabitant. The public green network of the City of Padua includes the historical green spaces of the city centre, mainly located next to the 15 century walls, the semi-natural riparian areas of the river network that characterizes the city, and of the many new neighborhood parks included in the suburban areas of new development. The primary role of the riparian corridors in the development of a green system in Padua has been recognized since the 1980s and early 90s when a preliminary plan was developed by Roberto Gambino, from the University of Turin. In the plan two main corridors were identified along the major rivers, Brenta and Bacchiglione, and these corridors represent the most natural section of the green system. The two main corridors are connected through three secondary corridors along the inner channels that cross the city and adjacent to the city walls. The main existing parks and green spaces are connected with the corridors and the new park development takes place in areas that have direct access to the corridors.

Based on this preliminary scheme, the Green U system was developed since 2004. The project started with the creation of a walking and cycling trail on the river levees (See Photos 9.6 and 9.7). A surface of crushed granite was put in place, a lighting system was established, and a bike and pedestrian bridge was constructed in an area of possible conflict with heavy road traffic. An agreement was reached with the Water Authority to plant trees on the levees and in the riparian areas, without endangering the hydrological stability of the river system, in order to provide a shady, more natural and pleasant environment for the user. New planting has taken place since 2005. To create further opportunities for exercise some gym trails have been developed with the advice of specialists in physical training and fitness. To attract people to the linear park some facilities have been developed. Two artificial beaches, for sunbathing, were built along the rivers and given in concession to private enterprises, also to provide better surveillance. The direct connection of the green corridors to free sport fields (soccer, basketball) and to playgrounds in the neighborhood parks creates further active recreation opportunities.

The Green U system, which will in the future be connected with a larger green space system surrounding the entire city, includes today a 14 km continuous walking

Photo 9.6 Padua Green U – existing riparian vegetation helps creating 'natural' views from the trails, in close proximity to a densely populated city (Photo: Paolo Semenzato) (*See Color Plates*)

Photo 9.7 Padova Green U – joggers on river levee; new planting and night lighting has been provided along the path (Photo: Paolo Semenzato) (*See Color Plates*)

and cycling trail, and takes approximately 60 min to complete by bike and 3 h on foot. The connection with the city's bike route system, with appropriately located parking lots and with public transportation, makes the system accessible at many locations and allows a choice of short or long walks and rides.

The city's 'Parks and Gardens' and 'Sport' departments are promoting many activities to publicize the existence of the park system and to encourage its active use. A pamphlet 'Naturalmente Padova' (Padua naturally) is available on the City's website and provides a description of the system with maps and relevant information for its use. Another leaflet has been published to propose appropriate, self instructed, physical activities and exercises for adult users of the park system In the summer months, organized activities take place in the parks under the city's sponsorship. A special event called 'Gustando il verde' (Tasting the green) has been particularly successful in bringing more people to the parks with their bikes and getting them involved in physical activity. The event takes place three times a year, and is a 20 km bike ride through the Green U and some of the city parks, with traditional food tasting stations located along the route.

Project Elements that Contribute to the Promotion of Physical Activity

Access: Because of its shape and location, the Green U is easily accessible from most residential areas of the city. The system can be accessed from many of the public parks and connects many of them to one another. The Green U is linked to the urban and regional bike routes system (still under development). Access to the Green U is well served by local public transport, including the newly implemented surface metro-bus line. Access is free.

Safety: The trails are isolated from car traffic and new bridges for cyclists as well as pedestrians have been constructed when necessary to avoid safety issues in the use of existing crossings. Trail and surrounding areas are well lit at night. The design of the new planting allows the preservation of views to the surroundings and avoids the creation of potential concealment areas and hiding places. The presence of organized activities and private concessions improves surveillance, both directly and indirectly by promoting use throughout the day. The presence of many access points also provides many escape routes, generally avoiding the risk of entrapment. The elevated position of the trails (most of them are located on the top of the river levees) allows ample views to the surroundings increasing the perceived safety of the users.

Conditions: The system is characterized by a low maintenance landscape and the maintenance can easily be provided by the City. Areas with higher maintenance requirements are part of private concessions. The relatively intensive use of the trail seems to have reduced problems of vandalism and garbage dumping that was much more frequent before the implementation of the project. A sense of ownership of the users and surrounding residents appears to have been created.

Features/facilities and programs: The combination of the 14 km trail, access to sport fields and playgrounds, the presence of sunbathing beaches that have to be accessed by bike or on foot, all provide attractive opportunities for recreational use of the green system in an active manner. Public and private (non profit) programs tailored to attract specific users groups have been successful in promoting active use of the Green U.

Aesthetics: The Green U partially surrounds the entire city, providing changing views over a diverse urban, suburban and agricultural landscape. The existing vegetation and the new plantings create in many areas a sense of being in a natural environment, enhancing the recreational experience. Some of the linked public parks offer an even greater immersion in a ‘natural’ environment. The new bicycle and pedestrian bridges offer attractive examples of modern architecture and technology, contrasting with the otherwise ‘natural’ aspects of the trails. The new plantings will in the future provide protection from direct radiation and glare, making the walking and biking experience more pleasant in the heat of the summer months.

9.3.3 *Local Projects*

9.3.3.1 Lisbon/Loures, Portugal

Parque Tejo e Trancão (Tagus and Trancão Urban Park), Parque das Nações

Parque Tejo e Trancão (Photos 9.8–9.10) is an example of a highly successful urban park in Lisbon. This park is one of the green spaces designed during the construction of Parque das Nações, a new urban and environmental development project in a valuable, but inactive industrial area, located on the riverfront. Parque das Nações was designed by PROAP practice (Estudos e Projectos de Arquitectura Paisagista, Lda) in association with Hargreaves Associates. Parque das Nações is located in West Lisbon and is surrounded by the River Trancão and by the River Tagus. Parque das Nações has a total area of 340 ha, of which 110 ha are green space. One of the most attractive natural features in this area is the River Tagus, a vast water surface, which offers a high visual quality along the 5 km of riverfront. Parque das Nações was from the beginning designed to have two uses: to host the Lisbon World Fair 1998 (Expo'98), and act as the driving force for the development of a new city (Castel-Branco 1998, p. 36). This project was part of an attempt at environmental urban renewal, in which planners aimed to create an ideal city with green spaces, residential areas, services and infrastructures contributing to a well-balanced life style for the inhabitants. Based on the initial analysis of the area, and in order to achieve high quality and highly innovative urban planning concepts and designs,

Photo 9.8 Parque do Tejo e Trancão (Photo: Ana Luisa Soares) (*See Color Plates*)

Photo 9.9 Parque do Tejo e Trancão (Photo: Ana Luisa Soares) (*See Color Plates*)

Photo 9.10 Parque do Tejo e Trancão (Photo: Ana Luisa Soares) (*See Color Plates*)

four important recommendations were made to the planners and designers: (1) to create landmarks in the predominantly flat urban space, and to break the barriers, specially the railroad line; (2) to value the river and the riverfront; (3) to improve accessibility and to promote circulation; (4) to recover the environmental quality and to define a strategy for tree planting (Castel-Branco 1998, p. 33).

Initially the Parque Tejo e Trancão project was expected to cover approximately 90 ha of riverside area, however so far only 50 ha have been completed. As part of guidelines and recommendations for the overall planning, and among the ecological principals that riverside ecosystems require, five major objectives were defined for Parque Tejo e Trancão, (Walker and Castel-Branco 1998, p. 48): (1) areas for leisure/informal sports such as bike trails, fishing piers and pedestrian walks designed for multiple uses; (2) areas for competitive sports including tennis courts and other fields sports; (3) areas for passive activities; (4) areas for cultural activities; (5) areas for environmental and artistic education.

The park area was characterized by generally poor environmental quality, dominated by old and dismantled industrial units from the sanitary landfill site and Sewage Treatment Plant, the presence of waste and high levels of pollution in the River Trancão. On the other hand, the proximity to the River Tagus Estuary demonstrates the environmental, ecological and visual potential of this landscape. Eight years after completion, it is possible to verify that the objectives were successfully achieved, as can be seen from the daily flow of people engaging in different types of activities, including physical activities such as: walking and/or running, cycling, skating, a variety of sports, etc.

Project's Elements that Encourage and Promote Physical Activity

This project's design concept was inspired by the idea of bringing the rivers' 'waves' into the flat area, "*evoking the meeting of the wind and the surface of the water*" (Walker and Castel-Branco 1998, p. 52). This was achieved by introducing green slopes/landforms, creating movement and linking the green areas and the surrounding buildings. By using this concept, the design set out to establish a strong visual and aesthetic appeal which was achieved by the spatial structure of the design layout, so as to create unity. This structure emerged from the combination of three complementary systems: the green structures; the network of trails and paths; and the landforms produced by a complex topographic solution. The landforms' structure creates a sense of diversity of spaces and rhythm throughout the park, where users are able to engage with two different views, a panorama across the river and the vast, flat lawns, and an enclosed view between the green slopes.

In order to create an appealing green area, detailed attention was given to the planting scheme, balancing its aesthetic values with the specific ecological nature of the area. The vegetation offers different colors and textures, through the flowers, leaves and fruits which vary along the different seasons, creating a multiplicity of scenarios. Another important role of the vegetation is expressed by the shape of the trees, especially by the umbrella shape of the Pines (*Pinus pinea*). This type of tree works as a sculpture on its own, punctuating the space, giving the notion of coherence and unity among the green elements. The vegetation scheme along with the topographic solutions provided by the green slopes, balance the most adverse climacteric situations to generate a micro climate. The trees provide shade during the hot summer days, and the landforms protect against the strong, breezy winds.

Access: The park is surrounded by residential and commercial areas (hotels, shopping centers, offices, etc.), providing straightforward and easy access to local residents. The area is also served by a good public transportation network (buses, train station, underground), and there is a wide range of parking spaces. For this reason, this park is also used by non-residents from other parts of the city who travel there to take part in different activities (passive and physically active) especially at weekends. Apart from the roads, there are no physical barriers between the green space and the built environment, allowing good pedestrian circulation. This proximity plus the way the green area and built environment are integrated encourage people to visit a green space on a more regular basis. Also, unlike Lisbon's hilly topography, this area is predominantly flat, being the perfect place for cycling, running and walking for recreational purposes or physical activity. It also caters for different types of users, such as older people, people with disabilities and children, who can interact with the environment and take part in physical activities.

Features/facilities: In terms of features, there are three different levels of circulation, which translate into three types of paths, defined by the use of different materials and dimensions. These paths create diversity in the space by breaking the monotony of the flat environment, allowing a multiplicity of different routes, as well as different visual corridors. There is a promenade along the riverfront which allows the users to choose between a 5 km linear trail along the river or to do smaller circuits between the green space and the residential area. The park is characterized by vast lawns which create informal areas that make the park appealing for different types of physical activities. The users are free to use the space according to their preferences, and the same lawn can used for football, tai-chi, volleyball, etc. The whole area has facilities such as benches, drinking fountains, bins, small cafes, and parking facilities.

Conditions: The park has a high level of maintenance and the entire environment is extremely appealing. The extensive areas of lawns and the other types of vegetation are all well kept throughout the year. Not only the fact that this project is located along the river, but also the high levels of use, led to a specific choice of vegetation adapted to the soil and climate conditions, and consequently requiring lower levels of maintenance. During the design phase many studies were conducted regarding the selection of plants, lawns and trees for this area, in order to find the best ecological solution. Most of the trees chosen for the project were planted experimentally in order to determine the feasibility and adaptability of the vegetation to the local conditions and constraints (Walker and Castel-Branco 1998, p. 63). In terms of inert materials, specific design details and materials were chosen in order to construct durable project solutions and avoid pavement drainage problems and vandalism. The overall high level of maintenance allows users to explore the environment and to be physically active without worrying about possible obstacles or hazards.

Safety: The safety of this park is perceived as high. The park's layout combines open areas with more enclosed ones. Although the enclosed areas have a dense vegetation scheme linked to the green topographic conceptual design, the perceived safety is given by the wide paths and the strong lightning scheme. The crime rate in the surrounding neighborhood is low, contributing to a high level of objective safety.

9.3.3.2 Helsinki, Finland

Maunula Trail

A special trail is available for elderly and physically disabled people in Helsinki. It is located in a small park next to several social and health service units such as a hospital, a health care centre, a social service centre and two nursing homes for elderly people. There are plenty of elderly and disabled trail users living in the nursing homes. The park where the trail is located is a small forest with natural vegetation. The design and construction of the trail is adapted for people moving with wheel chairs, walkers and other types of supporting equipment, for blind people as well as for people with memory problems. The trail is easy and safe to walk. The trail was opened in 2004.

The main trail is 250 m long, with an additional link of 50 m connecting the main trail to the health care centre. There are several sites for resting and just spending time, where there are opportunities to enjoy the nature. The track is 3 m wide and covered by firm sand/gravel. The whole trail is flat, and there is a rail at the inner rim of the trail. The rail helps, for example, elderly with a memory disorder to keep track back to the starting point. On the other rim of the trail there is a 30 cm wide stone edge, which also helps people to keep on track. The whole trail is well-lit. The resting sites, with benches of different heights and shapes, are situated about 50 m apart. The benches are in bright colors, yellow and orange. Plenty of traditional garden plants, which are suitable for the natural forest environment, were also planted along the trail to bring back memories of former homes and gardens. There is also a feeding place for birds.

This is a unique trail in Finland at the moment, also because it is a result of close cooperation with local residents. One local individual, Salme Kurki, took the initiative, and participated in the planning process throughout the whole project. The trail is also a pilot project for building suitable green environments for disabled people. The project was completed together with City of Helsinki (agencies for construction and social work for elderly and disabled) and the local resident forum. In the planning process, residents and staff in the nursing homes, as well as other elderly people living close by, were interviewed and their local knowledge and needs were considered.

Project Elements that Contribute to the Promotion of Physical Activity

Access: The trail is located in a small recreational area with easy access and short distance from public and private nursing homes and a hospital for elderly and disabled people.

Safety: The trail design has paid special attention to the safety issues such as flat terrain and pavement, and rails along the trail.

Conditions: The trail is facilitated with lightning and benches for resting.

Features related to green space: The trail is located in a small forest park.

9.4 Conclusion and Planning and Design Guidelines

Accessible and aesthetically attractive green spaces are positively correlated with physical activity. There is evidence that people are more likely to engage in frequent physical activity when high quality green space and a well maintained outdoor environments are available close by. The value of green spaces as physical activity resources is correlated to frequent use by a high number of people. Some physical attributes of parks and other green spaces can influence their use for physically active recreation, and attract users. Evidence on the effects of accessibility, attractiveness, the presence of facilities, and real and perceived safety, has been presented in this chapter. Although, with the current evidence base it is not possible to give a complete answer on how the quality of the physical attributes of green space affects use, and how people incorporate green space within the variety of strategies they use to maintain physical and psychological health (CSC Consulting 2005), it is nonetheless possible to suggest some guidelines for the planning and design of urban green spaces.

9.4.1 Planning and Design Guidelines

9.4.1.1 Accessibility

- Parks and other public spaces should be connected to one another as much as possible
- Park locations should take advantage of utility corridors, or multilevel trail corridors were possible
- Link parks, trails, and greenways to local destinations of interest to ensure that walking trips are as convenient, or more expedient, than using a car.
- Park and open spaces should be central to the population they serve and possibly access to parks should be within 500 m or 10 min walking from users dwellings
- Within settlements there should be spaces that can be used by everyone, regardless of age, gender or disability
- Develop neighborhood park and recreation facilities in new subdivisions and in currently underserved residential areas
- Locate neighborhood park and recreation facilities to be easily and safely accessed by most people, especially children

- Utilize smaller sites for youth sport activities (versus large scale, regional facilities to which people must drive)
- Utilize public facilities, such as schools, as multi-purpose facilities, especially for recreation services
- Develop a system of trails that is readily accessible to most people
- The design of green spaces should take the needs of the disabled into account, avoiding physical and sensory barriers

9.4.1.2 Features

- Make park layouts easily understandable from for new users, through easily locatable entrances and exits, appropriate signage, clear connections and destinations of walkways and bicycle routes
- Offer features for passive use such as benches, picnic tables, and barbecues
- Design a good trail and path network with different attributes in order to increase the active use by promoting different activities for different types of users
- Create areas (green or non green) for informal uses and different activities
- If possible, offer a café or restaurant, toilets, and car and bicycle parking facilities
- Provide lighting that helps direct movement between destinations at night

9.4.1.3 Safety

- Consider measures to lessen the impact of vacant, derelict or problematic land uses nearby a park site
- Make sure the edges of a park are open enough to allow views in and out of the park
- If possible, locate at least one activity or facility at the perimeter of the park to create an 'active' edge visible from the street
- Avoid the use of dense vegetation, walls or other feature that can block views or signage along the primary routes
- Avoid use of dense vegetation close to pathways to maintain a feeling of openness and clear visibility and limit potential entrapment areas
- Design pathways to concentrate night movement along well lit routes
- Encourage, through planning and design of facilities and programs, evening and nighttime activities to ensure user surveillance throughout the day
- Locate activity areas to encourage surveillance of access and major routes in the parks
- Design lighting to enhance real and perceived safety through sensible choices relating to visibility of others and visibility by others
- Use lighting to illuminate potential concealment areas and hiding places
- Design a clear hierarchy of car, bike and pedestrian routes within the parks to ensure safety for users. Use vegetation, topography and structures to provide adequate separation

- Employ car speed reduction and traffic calming measures near park entrances, trails and greenways to provide safer access

9.4.1.4 Conditions

- Create active and well used spaces so that undesirable activities or vandalism would be less likely to take place
- Locate park facilities to avoid potentially conflicting uses
- Provide adequate access to park and park features to avoid shortcuts, damage to structure and vegetation, excessive wear of turf grass
- Designate a dog running area in the park big enough to appropriately serve the dog owner population in the area served by the park
- Provide trash cans in convenient locations to encourage use
- When developing new parks, consider maintenance as an element of the open space from the assessment of the preliminary proposals to the final design, to ensure appropriate choices for long term management
- Ensure, through adequate long term planning and funding, that parks, trails, and greenways are constantly maintained and receive the necessary infrastructure improvements
- Design parks, trails, and greenways with multiple users in mind and solicit community participation and feedback to assess community needs and interests, and to create sense of ownership
- Inspect and maintain trees and vegetation with appropriate arboricultural practices to prevent hazard for park users

9.4.1.5 Aesthetics

- Apply conceptual approach to design a balanced, attractive and functional space
- Use combination of different materials, vegetation and path layouts
- Employ attractive planting scheme – combining textures, colors and shapes
- Create an appealing scenery with interesting views
- Create interest during different times of the day and of the year

9.4.1.6 Climate and Microclimate

- Consider local climate and microclimate in the design process
- Provide shade or maintain solar access through use of vegetation to provide comfort conditions for different activities and users
- Use water bodies and vegetation to influence temperature, relative humidity and breezes to provide climatic comfort

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Chapter 10
Motivating People to Be Physically Active in Green Spaces

Amalia Drakou, Rik De Vreese, Tove Lofthus, and Jo Muscat

Abstract Studies have found that the two main constraints to outdoor physical activity are reported to be 'lack of time' and 'lack of information'. Constraints may be specific to particular target groups on the basis of gender, ethnicity/race, age group, ability and socio-economic status. Strategies aimed at promoting physical activity should aim at removing or mitigating as many target group related constraints as possible. Successful promotional messages need to be tailored to the specific group being targeted. Sustainable programs involve stakeholders in the decision-making process. The examples of physical activity programs from Europe featured in this chapter encompass a mix of good practice factors which include: good organization and structure (Walking the Way to Health, England); innovation and added-value information (Calorie maps, Wales); focus outside the physical exercise (Kjenmann Stjordal, Norway); socialization, play and fun (Children's Trekking Club, Norway).

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10.1 What Motivates People to Participate in Physical Activity?

To be physically active is today one of the characteristics of a healthy way of living. A vast amount of scientific papers agree that physical activity can create a shield of protection against various diseases, such as cardiovascular disease, high blood pressure, diabetes and obesity (U.S. Department of Health and Human Services 2000; Kohl 2001; Dishman et al. 2004). Physical activity can also create social and psychological benefits which could elevate a person's quality of life (World Health Organization 2007).

In order to be able to identify effective and appropriate measures to promote active lifestyles and their associated health benefits it is essential to understand what motivates people to engage in physical activities (Davison and Lawson 2006) and also what hinders them from doing so.

Over the past 30 years, research in motivation and physical activity has adopted a social cognitive approach (Duda and Whitehead 1998; Roberts 1982; Roberts et al. 1997). Thereby, motivation is considered as a social cognitive process, whereby the individual assesses his/her competencies within an achievement context. He/she then becomes either motivated or de-motivated to participate in physical activities. There are three psychological constructs that energize and direct achievement behavior in physical activity: personal goals, emotional arousal and personal agency beliefs (Ford 1992). A goal is defined as that which the individual is trying to accomplish: it reflects the aim of a particular action (Locke and Latham 1990). Emotional arousal is what happens after stimulation of the emotions and it creates physical agitation and readiness for action. Personal agency beliefs refer to what the individual believes about his/her capacities, the effort that needs to be put in physical activity and the value of the outcomes. Analyzing this process is not within the scope of this chapter. The critical question that remains is '*what do people want to achieve by being physically active?*'

Generally speaking, there are various reasons which may lead an individual to be physically active:

Health benefits: "*Physically active people have lower risk of coronary heart disease, type II diabetes, hypertension and colon cancer*" (Pretty et al. 2005, p. 320). People are generally aware of the health benefits of regular exercise but may not be as aware of the correct type and amount of exercise they have to take in order to avoid ill-health (Crombie et al. 2004).

Psychological benefits: People participate in physical activities because this gives them an opportunity to have fun, to escape from their daytime routine and to satisfy their need for achievement (Yoshioka et al. 2002). Furthermore, older people may retain their health and thus their independence for longer – a fact which elevates the quality of their lives.

Cognitive benefits: Children cultivate important social and negotiation skills while participating in team activities. Furthermore, it has been found that low levels of physical activity are a risk factor for cognitive functioning in adults (Singh-Manoux et al. 2005).

Social benefits: Physical activity may contribute to increased social contact (meeting people in the park, going out in small groups to participate in a common activity, cycling and avoiding driving a car) and this helps communities to develop in a healthy and inclusive way.

When physical activities take place in green spaces additional motivators and benefits come to bear such as a person's love of nature, the solitude and calm offered by green spaces and the sense of escaping from the urban environment.

10.2 Why Aren't People Physically Active?

An individual's decision to participate in a physical activity is the outcome of a complicated process which necessarily takes into account the constraints to participating in such an activity as well as the benefits. Constraints are the factors that "*are assumed by researchers and/or perceived or experienced by individuals to limit the formation of leisure preferences and/or to inhibit or to prohibit participation and enjoyment to leisure*" (Jackson 2000, p. 62). Leisure research authors have focused on constraints posed by ability and skill levels, income/pricing of the activity, perspectives based on age, gender and ethnicity, fear of crime and inter-user group conflicts (Parker 2007). However, time and cost-related constraints most often rank highest among the constraints experienced by individuals in leisure activities in general (Jackson 2005).

Crawford et al. (1991) list three categories of constraints: (a) intrapersonal constraints – individual psychological traits that affect the development of leisure preferences, such as anxiety and perceived lack of skill; (b) interpersonal constraints – social factors that affect the development of leisure preferences such as lack of partners; (c) structural constraints – factors that take place after the development of leisure preferences, such as lack of time.

Figure 10.1 depicts the process by which a decision to participate in physical activity is made. This model is based on the leisure constraints model devised by Walker and Virden (2005) which describes the mechanism which leads an individual to participate in leisure activities in general. It can also be applied to physical activities in green spaces.

As seen in Fig. 10.1, leisure preferences are affected by some individually oriented factors such as personality traits, human needs, attitudes and beliefs. All these are described as micro-level factors. Similarly, leisure preferences are affected by some socio-economic and socio-cultural factors such as ethnicity, gender, socio-economical forces. All these are described as macro-level factors. Micro-level and macro-level factors have a direct effect on both motivation and constraints. However, it is important to understand that both motivation and constraints (intrapersonal and interpersonal) have a cumulative effect on leisure preferences. Structural constraints function later in the process, and have an effect on the decision to participate and the actual participation.

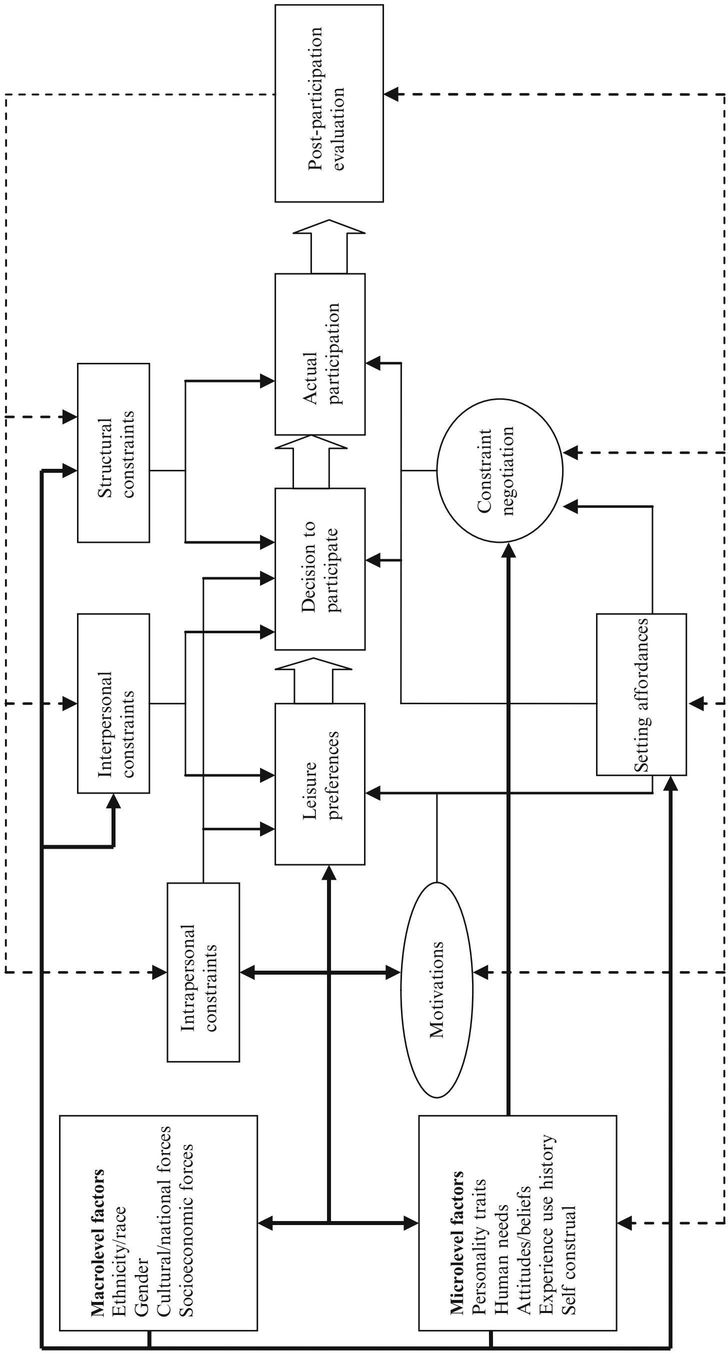

Fig. 10.1 Revised leisure constraints model (Walker and Virden 2005)

10.2.1 The Formation of Outdoor Physical Activity Preferences

Outdoor physical activities involve an interaction with the environment, and the preferences may be affected by the micro-level factor 'attitudes and beliefs' towards the activity and the natural environment (see Fig. 10.1). Bixler and Floyd (1997) highlighted the important role that perception of the physical environment plays forming outdoor physical activities preferences. They suggest three types of negative reactions to natural environments: (a) fear expectancy (getting lost, getting bitten by insects); (b) disgust sensitivity (getting itchy from insect bites or accidentally stepping in animal waste) and; (c) being outside the normal comfort range (having the appropriate equipment for outdoor activities).

On the positive reaction side, the concept of place attachment (Williams and Stewart 1998), where an individual gives a special meaning to the place he/she visits, gives importance to the environmental setting for a physical activity. It has been found that aesthetic attributes, opportunities and accessibility have significant associations with physical activity in terms of participation (Humpel et al. 2002).

In summary, it is the value placed on the natural setting that makes outdoor activities unique. Thus, and no matter what the constraints may be, individuals negotiate and adopt personal strategies which lead them to participation or non-participation, according to their attitudes and beliefs relating to the activity and the environment within which it will happen.

10.2.2 Constraints to Outdoor Physical Activities

The main constraints to leisure activities identified by Walker and Virden (2005) were 'lack of time' and 'busy with other activities'. Other high ranking constraints included: 'Outdoor recreation areas are too far from home', 'Recreation areas are too crowded', 'Lack of information', 'Recreation activity is too expensive', 'Family commitments', 'Family members in poor health', and 'Partners prefer other activities'. Mid-ranking constraints included: 'Ignorance of the location of parks', 'Lack of equipment', 'Poorly maintained areas and facilities', 'Fear of violence', 'Weather conditions', 'High admission fees'.

Four categories of constraints specific to outdoor activities, and that may affect participation in outdoor physical activities, are suggested by Walker and Virden (2005). '*Natural environment structural constraints*' refer to weather conditions, flash floods, avalanches, uncrossable rivers, lack of trails, the presence or absence of water features, type or size of water bodies, lack of accurate maps. '*Social environment structural constraints*' refer to crowding, loud music, fear of other people, and presence of motorized vehicles. '*Territorial structural constraints*' refer to constraints created by the planning and managing process which determines who gets access to outdoor recreation areas. Even though these areas are often assumed to be value-free, ethnicity and social class may restrict the access to certain groups of people. '*Institutional structural constraints*' refer to either intentional management constraints (no access to motorized users) or unintentional management constraints (chronic user conflicts, visual resource degradation, and low quality of recreation experience).

Particular target groups (such as children, women, and elderly) may experience some constraints more explicitly than other groups. For example, 'lack of time' and 'existence of a relative in poor health' are perceived by women to be stronger constraints for participation in physical activity than by men (Jackson 2005). With regard to outdoor activities, women perceive 'fear of violence in public spaces' and 'inadequate facilities' more strongly than men do (Bialeschki 2002; Johnson et al. 2001).

Differences in perceived constraints and expectations from outdoor activities are also revealed in relevant cross-cultural studies (Johnson et al. 2001; Virden and Walker 1999; Yoshioka et al. 2002). In a literature review about urban park and forest participation and preference among 'blacks' and 'whites' in the U.S.A., Elmendorf and Willits (2005) concluded that blacks expressed a lower level of satisfaction with parks in their neighborhoods, more fear of nature and lower participation in solitary activities (e.g. jogging, walking, hiking) than whites did. People with disabilities experience stronger constraints of 'transportation' and 'programming issues' (Jackson 2005).

Children may be constrained from leisure activities by restrictions placed on them by adults (parents, guardians and important others) (Krizek et al. 2004). Furthermore, there is a considerable amount of work highlighting the relationship between children's physical activity in general (including outdoor activities) and environmental features (Photo 10.1). Transport infrastructure such as the presence and condition of pavements, controlled crossings and bike lanes, seem to be positively associated with children's physical activity (Braza et al. 2004; Timperio et al. 2004). Local conditions such as neighborhood safety, crime rates, stranger danger and neighborhood aesthetics also seem to be associated with children's physical activity. More precisely, where negative local conditions exist, children's physical activity seems to be constrained (Gomez et al. 2004; Molnar et al. 2004; Carver et al. 2005). For more information about children and physical activity see Chapter 8.

With regard to people with low socioeconomic position (SEP), Pitson (2000) found that there is a positive relation between little or no overall physical activity and low SEP. Similarly, Popham and Mitchell (2007), who investigated the relation of employment status to SEP and physical activity types, found that people of low SEP were more likely to have low rates of participation in brisk walking, sport and exercise.

Table 10.1 summarizes the most important constraints experienced by individuals grouped by gender, ethnicity/race, ability, age group and socio-economic status.

Since changes of behavior need time to be achieved, it seems that structural constraints such as transport infrastructure, local conditions, accessibility, programming issues and lack of information, could be the easiest' constraints to be removed, by implementing and financially supporting a well designed promoting campaign for adopting healthy habits.

Removing the structural constraints, might be translated in increasing the possibilities of removing some interpersonal and/or intrapersonal constraints. For example,

Photo 10.1 A big challenge on a small rock (Photo: Tor Brekke) (*See Color Plates*)

Table 10.1 Identification of constraints experienced by specific target groups

Target groups	Most important constraints
Children	Restrictions placed by adults
	Transport infrastructure
	Local conditions
Women	Lack of time
	Existence of a relative in poor health
Third age	Accessibility
	Fear expectancy
People with disabilities	Transportation
	Programming issues
Immigrants	Fear of nature
	Avoidance of solitary activities
People of low socio-economic status	Lack of information/knowledge/awareness
	Budget constraints

improvement of local conditions by constructing wider pavements and pedestrian zones so that access to the local park is easier, might decrease the restrictions placed by parents to their children's desire to '*walk and meet their friends at the local park*'.

10.2.3 The Negotiation of Constraints

As Table 10.1 demonstrates, an individual may be inherently motivated to participate in outdoor physical activities but will need to negotiate various constraints in order to do so. Negotiating constraints is the process which goes on in individuals' minds in order to shape their final decision on whether or not to participate in outdoor physical activities. This decision making process could be influenced by strategies adopted by government and private organizations aiming to promote physical activities in green spaces. The importance of friendly and safe settings is presented in Chapter 9.

The physical activity constraint model presents significant similarities to the ecological approaches of physical activity promotion, which have lately gained a great deal of support (Spence and Lee 2003). An ecological approach supports the idea that physical activity (as well as any behavior) is influenced by various facets of different environments. So, psychological and biological variables which belong to the intrapersonal environment, friends and family which belong to the interpersonal environment and rules and regulations which belong to the legislative environment, may all have an impact on the physical activity (Gorely 2005). In simpler terms, in order to promote physical activity, we should take into consideration that individuals shape their preferences according to their needs and character, according to their close social environment and according to the policies related to participation in physical activities.

10.3 Strategies to Promote Physical Activity in Green Spaces

10.3.1 Correlation Between Opportunity and Motivation

Figure 10.2 depicts the correlation between motivation and opportunity for physical activity. It is based on a model developed by Ohlsson et al. (1997) to describe the connection between different user groups' motivation and participation in cultural activities which can easily be adapted to participation in physical activities in green areas.

The opportunity to participate in physical activity may be defined by how high the threshold for participation is in relation to access to facilities, cost, time, etc. Motivation is connected to interest in the perceived personal benefit arising from the activity. According to this model people can be divided into four categories:

Committed (high opportunity/strong motivation) – This group participates in physical activity on a regular basis. People belonging to this category can afford the time and money to use the facilities and opportunities which are available, and are willing to put some effort into finding out about opportunities to participate in physical activity. Examples of people who fall within this category are: a person who jogs daily in a park; a family which goes trekking in the wilderness every weekend.

Ambivalent (high opportunity/weak motivation) – People who fall into this category have the opportunity to participate in physical activity but do so only out of necessity or to fit in due to peer pressure. Examples of people who fall within this

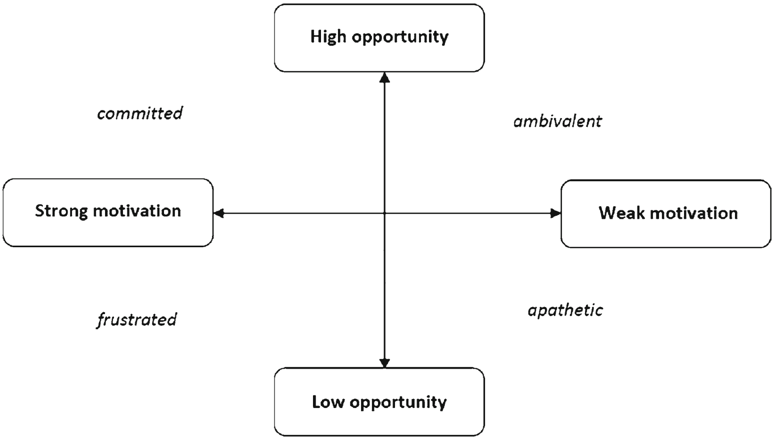

Fig. 10.2 Correlation between opportunity and motivation (Adapted from Ohlsson et al. [1997])

category are: a person who has no alternative but to walk/cycle to work; an employee who is obliged to participate in an outdoor activity organized by his employers.

Frustrated (low opportunity/strong motivation) – This category of people is highly motivated to participate in physical activity but lack money, time and/or access to facilities and opportunities. Examples of people who fall within this category are students and other persons of low income; people living in a highly urbanized area without easy access to green areas.

Apathetic (low opportunity/weak motivation) – People within this category lack opportunities to participate in physical activity but also have no real interest in participating. Examples of people who fall within this category are: people who live in a highly urbanized area with no green spaces nearby and who would anyhow prefer to spend their leisure time doing sedentary activities; people who lack the time and money to participate in physical activities but also have no interest in participating.

It is evident that the main focus of strategies for motivating people to participate in physical activities in green areas should be on the categories where motivation is weak (ambivalent and apathetic people) and opportunity is low (frustrated people). Committed people's participation should however not be neglected or taken for granted. Planning strategies should ensure that the opportunities enjoyed by this category are maintained and even enhanced.

Successful strategies generally target specific groups' needs and seek to mitigate their perceived or actual constraints. The target groups which have most been the subject of study in the context of healthy behaviors (including being physically active) include children, women, seniors, people with disabilities, immigrants and people of low socioeconomic status (Cale and Harris 2006; Carr 2000; Rimal 2002). Table 10.1 earlier in this chapter presented the most common constraints experienced by each of these target groups.

Motivation factors, which are actually the perceived benefits of what an individual gets from the physical activity and the meaning he/she gives to them, could be promoted through an information campaign or (if children are the target group) through the educational system. Constraints, particularly structural constraints, need to be addressed in a more practical way. For instance, the constraint 'fear of getting lost' in an outdoor space while participating in a physical activity can be addressed by providing accurate maps and signage throughout the area.

For some of the more universal constraints, widespread mitigation strategies can be seen. For the constraint 'lack of information', providing easily accessible information on possibilities for physical activities (information fairs, websites, TV/radio, newspapers, leaflets), organizing events on a regular basis (weekly or monthly, keeping the same meeting point, the same day and hour), and providing information regarding physical activity opportunities to immigrants in their own language, are commonly used strategies. For the constraint 'outdoor recreation areas are too far', providing regular, cheap transport to recreation areas and providing local green spaces and infrastructure such as trails and bike lanes, are frequently used. For the constraint 'high admission fees', commonly used mitigation strategies include encouraging employers to subsidize physical exercise opportunities and providing access to facilities outside peak hours at cheaper rates. For the constraint 'lack of equipment', strategies that help provide low income people with gear/equipment at no cost or subsidized rates, and encouraging organizations to invest in equipment for specific target groups, are often seen as successful. For territorial structural constraints, promoting flexible use for areas/facilities for specific target groups, and training target groups in networks are commonly used. Finally, some general ideas for strategies aimed at motivating people to participate in physical activities may include using celebrities as role models to promote activities; introducing the element of competition to promote an activity; interspersing physical activity spaces with interesting features (see Photos 10.2 and 10.3) e.g. land art, historical features, culture, music, animals; and encouraging doctors/health workers to give green prescriptions i.e. to prescribe specific exercise to patients with minor ailments instead of medicines.

10.3.2 Step by Step Strategies

Strategies to motivate people to take part in physical activities are effective only when they are built upon a sound understanding of the target groups they are aimed at and what motivates and constrains each group from participating (as outlined above). Motivators such as enjoyment and socializing with friends and constraints such as lack of time and negative pressure from peers, for instance, are important factors in determining the level of participation in a physical activity (Allender et al. 2006; O'Dea 2003). In addition, successful strategies and programs often gain from insights provided by research in related fields of study, such as perception studies, healthism and biomedical discourse analysis and health communication

Photo 10.2 Adults enjoy playing too! (Photo: Amalia Drakou) (*See Color Plates*)

Photo 10.3 So close to the city, so close to nature (Photo: Amalia Drakou) (*See Color Plates*)

and promotion and age-specific studies. A few of these insights are provided below.

Perception studies: Thurston and Green (2004) place enjoyment and satisfaction through social interaction and learning of skills centre stage, such that physical activity becomes the vehicle through which such experiences are generated. It is suggested that strategies and programs to promote physical activities should aim to enhance participants' perceptions: positive changes in 'perceived good health' and 'perceived benefits of exercise' over time is essential for a stable change in exercise behavior (e.g., Marcus et al. 1994; Wagner 2000).

Healthism and biomedical discourse analysis: This discourse argues that (young) people need to increase their physical activity levels to alleviate the health problems that may arise as a result of inactive lifestyle. This discourse is based on the assumption that individuals possess the capacity to make healthy lifestyle choices and that they are responsible for their physical and mental well-being (Calea and Harissa 2006). Tinning and Fitzclarence (1992) suggest that the ideology of healthism is unlikely to be approved by teenagers who perceive it as irrelevant to their life projects and associate it with sickness, incapacity, toil and the drudgery of exercise. Cale and Harris (2005) note the limitations of healthism which targets only the individual, tends to hold the individual responsible for their activity behavior, and fails to acknowledge other factors in the physical and social environment which influence physical activity.

Health promotion research: Judd et al. (2001) describe what they see as the most important values and issues within health promotion. These values have to be taken into account when developing physical activity programs. The first value is the empowerment of all stakeholders within the decision-making process on health promotion. Empowerment encompasses participation, multidisciplinary collaboration, equity, capacity building, and social and sustainable development (Hawe 1994). Empowerment is usually described as a process, but can also be considered as an outcome of when health promotion is focusing on capacity building. The second value is the people-centered and collectivist nature of health promotion. Health promotion has to include social, cultural, economic and environmental determinants of health (see also the ecological approach described above). Participation and ownership of the program by the community facilitates problem solving, builds community competence and creates successful, sustainable programs, rather than programs which are imposed by outsiders. Thirdly, Judd et al. (2001) state that health promotion's emphasis is on equity, rather than on productivity.

Health communication studies: Neuhauser and Kreps (2003) describe five lessons on health communication interventions and models, which can improve behavioral outcomes. (1) Providing emotions and rationale. Health communication is more effective when it reaches people on an emotional as well as a rational level. 'Self-efficacy' and 'perceptions of control' are emerging as the strongest mediators of behavior change (Bull et al. 2001; Institute of Medicine 2001; Syme 1990). These mediating factors are thought to be enhanced by communication that evokes empathy and other emotions typical of interpersonal discourse (Kreps and Kunimoto 1994; Northouse and Northouse 1998). (2) Promoting interactivity and participation. Health communication is more effective when it relates to people's social or 'life' context. Messages alone are not sufficient to help people make and sustain a life change. The contextual approach is likely to be more effective at strengthening the mediators of change: people's sense of efficacy and control to make actual changes. (3) Expanding the mix of media channels. A combination of the effectiveness of inter-personal communication and the reach of mass media communication is needed to change population behavior. Interpersonal approaches are more effective in changing individual behavior, but they are too expensive and too limited in reach to have a population effect. Mass media approaches reach more people for a lower cost, but are less effective in changing behavior. However, both approaches are important and interrelated. Therefore a range of techniques on the continuum between interpersonal and mass approaches should be implemented to increase the impact (e.g. through Internet). (Backer et al. 1992; Cassel et al. 1998; Johnson et al. 1992; Napoli 2001). (4) Providing customized and contextualized information. Tailored communication is more effective than generic messages (Kreps 2000; Marcus et al. 2000; Rimmer and Glassman 1997). Apart from customizing information to the needs of the recipients, many people lack access to information due to language, literacy, disability or other barriers. (5) Interactive communication is more effective than one-way communication. Messages from experts about people's needs to improve; may provoke negative feelings of fear, embarrassment and guilt, rather than empowerment (Kline 1999). To conclude, health communication approaches that are set within multiple social contexts and that engage people interactively and personally are more effective (Emmons 2000).

Neuhauser and Kreps (2003) evaluate the (possible) role of E-health in health communication, using the five lessons on health communication as evaluation criteria. E-health is defined as the use of emerging information and communication technology, especially the Internet, to improve or enable health and health care (Eng 2001) and includes online health information, online support groups and e-mail contacts. E-health is expected to address some of the limitations of traditional health communication. Information can easily be customized and/or adapted to the target group and audience; more personal engagement, interaction and participation is possible; the information is continuously available and can be distributed widely; linkages with others are possible through forums and social networks; etc. (Caplan 2001; Emmons 2000; Eysenbach and Diepgen 2001; Ferguson 1996; Institute of Medicine 2001; Marcus et al. 2000; Rubin and Rubin 2001; USDHHS 2000). Neuhauser and Kreps (2003) conclude there are indications multimedia health communication can improve behavior outcomes through features of mass customization, interactivity and convenience. But, will this result in long-term behavior changes? Based on a discussion of four analytical reviews, Neuhauser and Kreps (2003) conclude the results are uneven. There is little evidence of the sustainability of behavior changes facilitated by e-health interventions and there is no robust e-health communication model to explain or predict the outcomes. Furthermore, barriers such as the broadband divide, literacy, lack of access, and linguistic, cultural and disability barriers prevent many people from benefitting from E-health.

Age-specific studies (50+): Based on focus group discussions, interviews and surveys Ory et al. (2003) identified concepts, messages and tonalities that are likely to be successful in motivating people aged 50–79 to adopt regular physical activity in a sustainable manner. They found that to be effective, promotional messages for physical activity must assume that the target audience (in their case people aged 50+) already knows the health benefits of exercise. Messages must go beyond conveying basic health benefits, and focus on encouraging and inspiring the audience to get moving, being careful not to alienate or turn them off. They stress the importance of the 'right' visual imagery, as imagery can inspire future participants or turn them off. Images showing men and women together, older and younger generations together, people in groups and people enjoying themselves were more appreciated by focus groups. Messages that motivate 50+ to be physically active feature ordinary people doing ordinary things ('real people like us') or feature older people being physical active with their (grand)children. The obstacles people face (time, family, business commitments) should be recognized. Furthermore, Ory et al. (2003) recommend providing people with concrete information (websites, telephone numbers) where they can find further details on physical activity and being specific when giving advice ('get your heart rate up, at least 30 min a day, at least 5 days a week' was preferred to 'get your heart rate up, at least 30 min a day, most days'.) Messages which were not found to motivate include those which make exercises look like work (i.e. the fun and social character of the activity should be stressed), those which call the activities 'exercises' or 'fitness' (i.e. use 'physical activity' instead), and those which are confrontational ('get off the couch') or refer to age.

10.3.3 Recommendations for Strategies Aimed at Promoting Physical Activity

Allender et al. (2006), Cale and Harris (2001), Calea and Harissa (2006), Christodoulos et al. (2006), Gillis and Perry (1991), O'Dea (2003), Thurston and Green (2004) propose the following recommendations for physical activity programs, initiatives and interventions:

1. Tailor programs to specific target groups.
2. Ensure that program design and content addresses the target group's needs, interests, preferences, capabilities and abilities. The program should be fun and joyful. Avoid a too intensive start.
3. Empower people with decision-making on the program design and create a sense of ownership in the community.
4. Design realistic program outcomes.
5. Provide a range of choices: include also non-competitive, more individually oriented and unstructured activities. Include fun and joyful activities in the program, which generate feelings of enjoyment and satisfaction.
6. Avoid prescriptive delivery and organization of the program.
7. Timing: be flexible in the timing of the program; schedule sessions to accommodate variation in participant's availability (times of the day and days in the week); offer participants the possibility to attend the gathering of their choice, depending on their weekly schedule; accommodate periods of non-attendance.

8. Duration and intensity: implement the program for a sufficient period of time, to enable the development of social networks, as well as to have an impact on the physical activity levels and physical performance of the body. The typical length of physical activity programs (3–4 months) is insufficient to allow the participants to feel 'locked into' participation by routinization of the behavior, the development of skills and the generation of social networks.
9. Try to establish patterns of regular participation.
10. Focus on behavioral (physical activity levels), cognitive (knowledge and understanding) and affective (attitude) changes.
11. Adopt an ecological approach to the design (take into account the various facets of different environments supports that influence physical activity and behavior) and try to develop a multi-component design (participants encourage non-participants to implement the program's exercises).
12. Provide low-cost programs for the participants at easily accessible places.
13. Evaluate the effectiveness of the program before, during and at the end of the program and, where possible, conduct follow-up evaluations over the longer term.

Group homogeneity (both in terms of age and of fitness level) is an important factor which determines whether people stay in the program or not (Gillis and Perry 1991). It is therefore important to accommodate group preferences (Thurston and Green 2004).

10.4 Good Practice: Examples from Europe

This section presents some of the good practices to motivate people to get physically active in a natural and/or green environment, found in the submitted country reports within the framework of the COST E39-action.

10.4.1 Walking the Way to Health (WHI) – England

Aim: This initiative aims to motivate people, particularly those who are physically inactive, to do regular short walks in their communities.

Partners: This is a joint initiative between Natural England (public body committed to the conservation and enhancement of the natural environment) and the British Heart Foundation.

Description: Walking the way to Health (WHI) supports local health walk schemes all over England by providing training to potential walk leaders and an accreditation to any walking scheme that achieves certain criteria. The main criteria that need to be obtained in order for a scheme to be accredited are:

1. To offer led health walks for beginners (of under 1 h duration, in reasonably flat paths with no stiles)
2. To meet WHI safety and insurance standards for all walks
3. To collect basic monitoring information

The accreditation program has set and maintains high standards for health walks. Users are reassured that the walks in their area are of good quality and all the people involved benefit from increased sense of achievement and confidence (participants, partners and funders add confidence). The main benefits of being accredited in WHI include the credibility associated with being part of an evaluated scheme at a national level; a page on the WHI website; recognition by health professionals; permission to use the accreditation logo and a WHI certificate.

WHI provides a 1 day course to anyone wishing to lead walks in an existing or potential 'walking for health' community scheme. The training includes practical advice and information on motivating people to participate in the walks and keeping motivation constant. Follow up support is also provided. This training is being provided by local trainers who have already been trained by WHI, and is free of charge. However, local schemes can pay the full cost of the training and book it through the WHI Training Office. The cost includes the provision of training manuals and course administration.

The WHI collects feedback on its initiative through the Outdoor Health Questionnaire (OHQ) which is filled in individually by all new walkers on all health walk schemes. The systematic collection of data in a local, regional and national level helps policy makers, health professionals and the public to understand the benefits of the initiative. It also enables WHI to build a local and national picture of the kind of people who are participating in health walks.

Results: WHI supports over 525 local health walk schemes all over England so far and it has trained more than 33,000 volunteer walk leaders. Since 2000 it is estimated that it has encouraged over a million people to walk more.

Website: www.whi.org.uk

10.4.2 Calorie Maps – Wales

Partners: The Forestry Commission on Wales and the University of Wales Aberystwyth.

Aim: To motivate individuals to walk or cycle more, by linking calorie burning to the actual activity.

Description: This project is a light – hearted introduction to the benefits of exercise. Maps of selected walks and cycle trails have been produced and published by the Department of Sports and Exercise Science at the University of Wales, Aberystwyth. The innovative element of these maps is that they estimate the number of calories burned based on a person's body weight and the walk or trail he/she is following. This way, people are shown how they can introduce exercise to their daily routine, in order to improve health and fitness.

Results: There are 15 walks in and around the town which are included in the project, with the walk from the one end of the town's promenade to the other, as one of the most popular routes.

Website: www.forestry.gov.uk/walks

10.4.3 Get to Know Your Neighborhood – 'Kjenmann Stjørdal', Norway

Aim: To motivate people through conveying information about heritage to visit, get to know and become regular users of green areas in their neighborhood. This also includes people who are not used to physical activity (Photos 10.4–10.6).

Partners: Private project developed and carried out by cartographer Roar Valstad. Sponsored by the municipality, banks and the state forest organization.

Description: 'Kjentmann Stjørdal' is a project developed by Roar Valstad who is a professional cartographer. He has highlighted material and immaterial cultural heritage in the municipality of Stjørdal and marked these points of interest in a detailed map which also includes vantage view-points and other points of interest in the natural environment (Lofthus 2009).

Photo 10.4 Exploring cultural heritage during a trip (Photo: Tor Brekke) (*See Color Plates*)

Photo 10.5 Heritage sites could be interesting for grandparents as well (Photo: Tor Brekke) (*See Color Plates*)

Photo 10.6 Getting to know your neighborhood on an excursion organized by the local council (Photo: Tor Brekke) (*See Color Plates*)

The map includes 52 targets, or heritage sites, for short or longer hikes. An information board has been erected on each site and a booklet giving details on each heritage site has been published.

Once a week an advertisement in the local newspaper encourages people to visit one of the sites on the map. Individuals can also attend a course on how to use a map and how to find the marked sites.

A guided hike is arranged to one of the sites once a month. Details of this hike are advertised in the local newspaper.

Results: In a municipality numbering 20,000 inhabitants, 1,700 booklets were sold and 1,000 gold pins (given after visiting 40 sites) where given out between 2004 and 2006. In 2006–2008, 3,000 booklets were sold. By August 2008, 16,200 people had registered since 2006 at 28 of the sites where it was possible to register. There is generally more than one user for each booklet. The concept is used by trained hikers as well as people new to hiking. Some of the users are in good health, while others have severe health challenges.

Website: www.kjentmann.no/

10.4.4 Children's Trekking Club, Norway

Aim: To motivate children, aged 0–12 years, together with their parents or other adults to join short and easy hikes in the neighbourhood to give them a start in being regular users of green areas in their locality.

Partners: Organized and run by the Norwegian Trekking Association

Description: The children's trekking club provides easy access to outdoor life for children and their families. Experience has shown that in planning successful hikes the following factors have been important:

- Easy participation – short trips for small feet
- No need for expensive hiking gear
- A club focused on children but including adults (parents, grandparents or grown up friends)
- Two adults as trip leaders – responsible for safety. Voluntary resource persons may be included for activities but without being given the responsibility of looking after the children
- A lot of time allocated to fun and fantasy and short activities for the children – rather than long distance walking allowing the adults time to just drink coffee and chat
- Keeping to regular days, same time of the day and same meeting place for each trip

Results: After only a few years the Children's Trekking Club has attracted 16,000 members from Norway. Children mostly participate with parents and/or grandparents many of whom would not otherwise have known where to take their child to enjoy the outdoors. The club is also very popular with parents who are new to the area.

Website: www.turistforeningen.no

10.5 Summary and Conclusions

Even though people today know and accept that physical activity is an integral part of a healthy lifestyle they must generally be motivated to participate in a physical activity. A person decides whether to be physically active after weighing the benefits of participating (health, psychological, cognitive and social) against the real or perceived constraints to participation (intrapersonal, interpersonal and structural). The decision-making process is affected by an individual's personality traits, human needs, attitudes and beliefs (microlevel factors) as well as socio-economic and socio-cultural factors such as ethnicity, gender, and socioeconomic forces (macrolevel factors). The decision to take part in an outdoor physical activity is further complicated by an individual's attitude to the natural environment.

Studies have found that the two main constraints to outdoor physical activity are reported to be 'lack of time' and 'lack of information'. Constraints may be specific to particular target groups on the basis of gender, ethnicity/race, age group, ability and socio-economic status. Strategies aimed at promoting physical activity should aim at removing or mitigating as many target group related constraints as possible.

People may be categorized according to the different levels of motivation and opportunity as follows: committed (high motivation, high opportunity); ambivalent (weak motivation, high opportunity); frustrated (high motivation, low opportunity) and apathetic (low motivation, low opportunity). Different types of strategies are called for to motivate each category of people to physical exercise. Opportunities must be maintained for committed people and provided for frustrated people, while ambivalent and apathetic people need to be induced to participate through clever strategies as well as through opportunity.

Promotional and information campaigns have a vital role to play in motivating people to participate in physical activities particularly in the natural environment. Promotional messages need to be tailored to the specific group being targetted (e.g. safety aspects need to be highlighted to those afraid of getting lost/hurt in an open space; young people can be drawn in through the socializing aspect of an activity).

Successful, effective strategies are built upon knowledge of the characteristics of groups being targeted, their specific constraints and motivators and insights gained from research and experience in complimentary disciplines; for instance: sustainable programs involve stakeholders in the decision-making process;

- Health promotion is effective when it reaches people on emotional level as well as rational; when it relates to people's 'life' context and provides customized information; when it utilizes a mix of media including interactive communication channels including e-health; teenagers will not be drawn to physical activities to alleviate future health problems
- The 50+ age group can be better motivated through positive reinforcement of the benefits of physical exercise than a focus on the negative effects of non-participation

The examples of physical activity programs from Europe featured in this chapter encompass a mix of good practice factors which include:

- Good organization and structure (Walking the Way to Health, England)
- Innovation and added-value information (Calorie maps, Wales)
- Focus outside the physical exercise (Kjenmann Stjordal, Norway)
- Socialization, play and fun (Children's Trekking Club, Norway)

10.6 Basic Steps for Providing Effective Programs for Physical Activity in Green Areas

This section provides an overview of some of the basic steps needed for developing a successful program for physical activity in forest and green areas.

Step 1: Define the goal of the program

Which goals have to be achieved by the program? Possible goals are:

- Getting habitants acquainted with green areas
- Promoting the use of green areas
- Increasing the physical activity of a specific target group (children, elderly, minorities)

Once the goals are defined the SMART-principle can be used (specific, measurable, achievable, realizable, time-based).

Step 2: Collect information about potential users, define target groups and identify their needs

The program should be targeted towards specific target groups defined according to specific requests or based on available data. The users are described and their potential participation in the program is assessed in line with their needs, interests, preferences, capabilities and abilities. A geographic scope could be defined (e.g. based on an inventory of the places where the target groups live). Several target groups can be combined within the program.

Step 3: Plan the activities

Describe the activities which will take place, the place where they are scheduled and the resources needed (including any participation fees). Discuss this schedule with all involved partners (guides, associations, etc.).

Step 4: Translate the program into financial terms
Step 5: Create criteria for measuring effectiveness
Step 6: Make program available
Step 7: Promote the program
Step 8: Evaluate the program
Step 9: Modify program if necessary

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Part IV
Therapeutical and Educational Aspects

Chapter 11
Nature-Based Therapeutic Interventions

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Abstract The point of departure of this chapter is to view nature-based settings as an important asset for improvement and promotion of health. During the last decades the concepts of healthy nature-based settings and accompanying treatment programs have been referred to by many names, making the subject difficult to interpret. Here the development of the theoretical framework and the research area are described. The second part of the chapter focuses on the structure of a therapy program and the health design of the nature-based setting. From the theories and experiences, including both research as well as best practice presented, the chapter ends with recommendations for future aims of research projects within this area.

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11.1 Background – A Shift in Health Policy Towards People's Own Health Capacities

Modern medicine is constantly making progress in fighting diseases and ill health. However, with few exceptions, about 60% of all causes of ill health, disease and premature death in the EU cannot be sought in simple relationships, such as exposure to pathogenic bacteria or genetic factors (Norman 2006; Knoops et al. 2004). What we are dealing with instead are chains or webs of causation that result in some becoming ill and others staying healthy. An increasing number of future's health hazards are related to our lifestyle, such as an increasing sedentary life, physical inactivity, chronic psychological stress, and more and more people staying indoors (Währborg 2009).

Today, people seem to have fewer opportunities to recover and restore from stress (Währborg 2009). More and more diseases seem to be correlated to stress. Emotional well-being is a strong predictor of physical good health, as shown by research in a range of countries. Prolonged stress has serious and harmful effects on all vital organs, including heart- and blood-vessels (Aldwin 2007). Among other things, there are greatly increased of suffering from arteriosclerosis, cardiac infarction and other cardiovascular diseases; diabetes type II, depression and infections (de Kloet et al. 2005; Aldwin 2007; Friedman and Silver 2007). In particular, many psychiatric diseases have a strong association to a prolonged and incorrect stress reaction, including schizophrenia, anxiety syndrome and, above all, depression, burnout and fatigue syndromes (ibid). This is because stress causes the secretion of many stress-hormones which have the capacity to affect sensitive structures in the brain, such as hippocampus and hypothalamus (ibid). This, in turn, changes the sensitive serotonin- and dopamine balances, contributing to some psychiatric diseases (ibid).

Hence, if people cannot restore from stress, this affects their health in many ways, not in the least depression, making stress and depression prominent aspects of health promotion. The World Health Organization (WHO) has made stress-related pain and depression priority health promotion and disease prevention areas. The organization reports that at least 120 million people are affected yearly by depression and that this is related to excess mortality (WHO 2004). The term Disability Adjusted Life Years (DALYs) refers to the number of years of potential life lost due to premature mortality and the years of productive life lost due to disability. In year 2000, depression was the leading cause of disability as measured by years lived with disability, and the fourth leading contributor to the global burden of disease. By the year 2020, depression is projected to reach second place of the ranking of DALYs calculated for all ages and for both sexes. Today, depression is already the second cause of DALYs in the age category 15–44 years for both sexes combined (WHO 2008).

The sedentary lifestyles common in wealthy countries pose another huge problem. The WHO (2006), in its Global Strategy on Physical Activity, mention that at least 1.6 billion adults aged 15 and over are overweight. These circumstances may be connected to the fast rise in obesity, heart disease, diabetes II, osteoporosis, depression and burnout syndrome now seen in many countries, even among children and teenagers. WHO has rated physical inactivity as one of the major causes of death in the developed world. Physical activity can improve mood and may protect against the development of mild forms of depression (Cavill et al. 2006). Young people's self esteem in particular is said to improve with regular physical activity.

From what has been pointed out above, it should be of interest to emphasize salutogenic approaches to therapeutic interventions. The concept salutogenic (Antonovsky 1987) refers to the circumstances that help people to maintain their good health, despite the fact that they are subject to potentially pathogenic biological or psychosocial stressors. These circumstances include the physical outdoor environment. Such a health policy means a shift in perspective towards an approach that will concentrate more on how to stimulate people's own health capacities. An increasing number of governments around the world, including many of the European countries, find advantage in focusing on factors that determine health in addition to pathogenic diseases themselves, thus achieving more effective public health targets (Statens Folkhälsoinstitut 2005). One important asset in this context could be nature, including urban green spaces and gardens with wildlife, biodiversity and plants, both for improvement/promotion of health and prevention of ill health.

Generally speaking healing may be said to be a process that promotes overall well-being (Cooper-Marcus and Barnes 1999). To heal means: to make whole again; therapy is therefore the set of activities needed to heal (Oxford Dictionary 2008). When it comes to medical anthropology the client's personal and subjective experience of recovery is also accentuated (Janzen 2002). It is in other words equally important that the illness is cured in medical terms as that the client experiences a personal feeling of recovery. This chapter will focus on the therapeutic aspects of nature settings, the attached therapeutic interventions and their role in the improvement/promotion of human health and well being and will also briefly explore the likely additional outcomes the human-nature relationship.

11.2 A Brief Historical Perspective on the Relation Between Clients and Nature Settings

11.2.1 From Ancient Time Till the Twentieth Century

During recent decades, an increasing number of research disciplines have begun to address the question of human health. Many scholars are broadening their perspective from the level of details to a more comprehensive, holistic perspective (Qvarsell and Torell 2001). Today health is viewed as a holistic and positive state embracing the individual in relation to his/her entire life situation (including biological, cultural, social and environmental aspects). In a well-designed healing nature setting all of the abovementioned aspects may take place. Remarkably enough, this new perspective on health could be viewed as a return to more ancient beliefs.

There are many theories and practices which embrace the nature setting within the remit of therapeutic process and well-being for people and the social systems they occupy. The garden is a phenomenon that is several 1,000 years old, and it may have been regarded as a healing place from the very beginning of its history (Prest 1988; Gerlach-Spriggs et al. 1998; Stigsdotter and Grahn 2002). This resulted in the use of gardens in medical care for a long period of time. Ideas of relations between human health processes and gardens can be traced back to the middle Ages, the Roman Empire and as far back as the Persian Empire (ibid).

There are therefore long held beliefs that human health and well-being are influenced positively by spending time in natural settings. Gardens, pastoral landscapes and natural environments with small lakes and meadows are depicted as places where people can be restored both mentally and physically. Beneficial properties are attributed to activities in nature, where one experiences natural daylight, fresh air and greenery. This thinking was particularly central to both the so-called theories of miasma and the pythogenic theory, two medical theories that were highly influential through the eighteenth and nineteenth centuries (Urban Parks and Open Spaces 1983; Warner 1998) These two schools of thought were the reason why hospitals, psychiatric hospitals and sanatoria were built in attractive natural settings, many with pleasant gardens for patients' recreation. At that time, the institutions were engaged in promoting the health qualities in the landscape and gardens, as well as the nature-related activities the patients took part in (Jonsson 1998).

11.2.2 From 1900 Till Today: Nature Based Therapeutic Interventions Versus Health Design and -Planning

The concepts of the healthy nature settings and the therapy treatment programs have been referred to by many, not least during the last decades, making the subject difficult to understand and interpret. Some of the most common names for different nature settings are: *restorative gardens or landscapes* (Gerlach-Spriggs et al. 1998), *healing gardens* (Cooper-Marcus and Barnes 1999), *therapeutic gardens or landscapes* (Kamp 1996; Kavanagh and Musiak 1993), *sensory gardens* (Haller 2004), *care farms* (Hassink and van Dijk 2006), *community gardens* (Hassan and Mattson 1993), *urban green therapeutic spaces* (Cooper-Marcus and Barnes 1999; Burls 2008b). Among the most popular names for therapy programs or interventions are: *Horticultural Therapy* (Relf 1992 – USA), *Social and Therapeutic Horticulture* (Sempik et al. 2003 – UK), *Ecotherapy* (Burls 2007, 2008a – UK; Clinebell 1996 – USA), *Onotherapy* (Milonis 2004 – Italy), *Conservation Therapy* (Hall 2004 – UK), *Nature Assisted Therapy* or *Nature Guided Therapy* (Burns 1998 – USA), *Nature Therapy* (Berger and McLoed 2006 – Israel), *Ecological Psychotherapy* (Wilson 2004), *Care Farming* or *Green Care* (Hassink and van Dijk 2006), *People-Plant Relationship* (Flagler and Pincelot 1994) and *Human Issues in Horticulture* (Relf and Lohr 2003).

Because several different professions work with nature settings, gardens and urban open green spaces related to human health and well being, some basic definitions are needed to avoid misunderstandings:

> Concepts like restorative gardens, healing gardens, sensory gardens and urban green therapeutic spaces are often used to explain that the design in itself is intended to have effects on the visitor's health; it's a question of a relationship between user and setting, without any therapeutic program or certain therapeutic activities (Haller 2004). Gardens attached to hospitals, nursing homes and hospices can be described in that way.
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> On the other hand, the meaning of concepts like therapeutic gardens, and care farms involves a special designed or special chosen place *and* a therapeutic intervention: the places are purposely designed to improve the health experienced by a special client group, through the interplay between the therapeutic setting, the therapeutic activities, the therapeutic team and the clients (Cooper-Marcus and Barnes 1999; Stigsdotter and Grahn 2002, 2003). However, all these concepts are often mixed and used in other, quite opposite ways.

We are thus dealing with two different phenomena. One concerns designing and/or planning nature settings or gardens for the improvement or maintenance of people's health. This could be for a certain group of patients or for the general public. We define this as 'health design and planning'. On the other hand, we are dealing with the phenomenon of using a certain setting, specially designed or specially chosen, for a therapeutic intervention. We define this as a 'nature-based therapeutic intervention'.

The concepts concerning different nature-based therapeutic interventions using horticultural activities are also many and hard to survey. *Horticultural Therapy*, *Social and Therapeutic Horticulture* and *People-Plant Relationship* (Relf 1992; Sempik et al. 2003) are concepts we identify as merging under the common concept "horticultural therapy": they all concern therapeutic interventions using horticultural activities in garden settings. Horticultural therapy derives from occupational therapy (Shoemaker 2002; Hewson 1994). However, in England and the US it developed to a discipline of its own, from experiences of successful rehabilitation of soldiers who had been at war. Examples are soldiers who had been captured in trenches in WWI or who had endured heavy shell fire in WWII, all suffering from PTSD – Post Traumatic Stress Disease (Simson and Straus 1998). Horticultural therapy then began to develop in other places in Europe. However, in many countries the discipline mainly finds its origin in medical theories dated from the eighteenth and nineteenth centuries – especially in the version developed within psychiatry (Grahn 2005). Research on the history and development of horticultural therapy is taking place in, for example, Great Britain, Denmark, Italy and Sweden.

From the 1950s, and especially from the 1960s, horticultural therapy has expanded to help curing other diseases or being used in the care of people. Examples are strokes, generalized pain and vascular spasms, Alzheimer disease and autistic disorders (Simson and Straus 1998; Relf 1999; Söderback et al. 2004). Moreover, nature and gardens are more and more being used and being recognized because of their effects on health, in many different contexts.

Care Farming and *Green Care* (Hassink and van Dijk 2006) concern therapeutic interventions in natural settings and, in particular, farms where animals play a crucial role in the therapeutic program. These therapies belong to animal-assisted therapy (ibid), where *Onotherapy* (Milonis 2004) is one special example. We have not included these types of therapies in this chapter.

Ecotherapy, Ecological Psychotherapy, Conservation Therapy, Nature Assisted Therapy, Nature Guided Therapy and *Nature Therapy* (Burns 1998; Wilson 2004; Burls 2007, 2008a) are all related. In the 1970s development in ecology as well as psychology lead to thoughts about reciprocal, supporting systems in the relations between man and nature. Bronfenbrenner (1979) developed the notion of *Ecological Counseling* which he derived from his Gestalt work. Personal and environmental factors are integrated through focusing on their interaction. The practitioner can therefore superimpose any elected therapeutic, educational or counseling models into a logical and coherent approach which includes the 'eco' (the human's *home* or *habitat* – from the Greek *oikos*) and the ecological (learning about the environment and its problems) (ibid). Working with both these elements a person can be helped to understand and react to parallel personal problems, by means of the examples given by nature (Dawis 2000). This work has inspired the development of *ecological psychotherapy* and corresponding therapies, such as *ecotherapy, nature therapy* and *nature assisted therapy* (Wilson 2004; Berger and McLoed 2006; Burls 2008a). These therapies have been well illustrated in the 1990s by Burns (1998), Willis (1999) and Clinebell (1996). The approaches are different in the practice of therapy, but they all derive from the paradigm that man and nature can heal each other in a number of ways. Henceforth – we label all of these therapies 'ecotherapy'.

11.3 Healing Mechanisms

Research into the therapeutic and restorative benefits of contact with nature has generally looked at three main areas of contact: viewing nature (Ulrich 1984; Kaplan 2001; Kuo and Sullivan 2001) being in the presence of nearby nature (Cooper-Marcus and Barnes 1999; Ulrich 1999; Hartig and Cooper-Marcus 2006) or active participation and involvement with nature (Frumkin 2001; Pretty et al. 2005; Grahn et al. 2010). The development of theories and research in this area comes from landscape architecture, from occupational therapy and related therapies (physiotherapy, vocational therapy, etc.) and from the behavioral sciences (environmental and other areas of psychology, sociology, etc.). This can be seen in the theories presented below. Today, many of the theories and Research and Development (R&D) are becoming closer in terms of their philosophy, not least because the research today is more interdisciplinary, which means that the different theories are merging more and more. Integration of theories might follow from theoretical and empirical work that addresses questions about the relatedness of the processes/phenomena they address.

11.3.1 The Evolutionary Approach

Most of the research projects in the area concerning viewing nature derive from two theories about restorative environments. Both of these have an evolutionary approach, maintaining that we are adapted through human evolution to function well in a natural environment, and that some natural environments will better serve restoration than other kinds of environments.

Attention Restoration Theory (ART): natural environments can help people renew a depleted capacity to direct attention after they have dealt with large amounts of information and competing stimuli (Kaplan 1995). The theory is that people use two types of attention: directed attention and fascination, the former effortful and the latter effortless. Directed attention, the mental process we use to deal with cognitive data, originates in a more "modern" part of the brain. This system sorts information we have to use, for example to focus on complex problems we have to solve in our everyday life, and to inhibit undesirable information, like noise, litter and certain problems we do not want to dwell on. The demands of modern society involve complex impressions, which may be difficult to interpret and overcome. This is particularly true when people are under great stress (Kaplan 2001). Directed attention is a highly limited resource, which we can easily exhaust if we do not have opportunities for recovery. People recover best in environments where this system can rest and we can use our other information system such as fascination, a recourse we have in abundance. In nature we use this kind of attention to explore the environment, to detect a glimpse of water, a rustle in a bush or a flower in a forest. Nature is considered to be a suitable environment to rest directed attention and use fascination (Kaplan 1990).

Restorative environments have the following qualities, according to Kaplan and Kaplan (1989), Kaplan (1990):

- Being away: both mentally and physically, moving to a totally different place, another setting, which makes it more likely to be able to think of other things.
- Extent: the site visited should be large enough to give (1) scope (to move around in the area without having to be careful about going beyond its limits) and (2) connectedness (the various parts of the environment must be perceived as belonging to the larger whole). However, the physical size is the only determinant: a well designed small garden can involve the feeling of extent.
- Compatibility: how well the content of the environment supports the needs and inclinations of the user. That is, compatibility among the environmental characteristics, the individual's inclinations and the activities required by the environment: e.g. if some people wants to play football, is the place suitable? To be restorative, the place should be legible, but retain a certain level of mystery.
- Fascination: places well endowed with fascinating objects/stimuli that capture and hold attention, as well as offering many processes that people find engrossing. Soft fascination occurs when there is enough interest in the surroundings to hold

attention but not so much that there isn't room for reflection. Hard fascination occurs when settings are intense enough to completely capture attention leaving no room for reflective thoughts.

The Aesthetic-Affective Theory is inspired by the biophilia hypothesis. The idea that humans have an inherent inclination to affiliate with nature is referred to as *biophilia*, which implies affection for living things (Wilson 1984; Kellert and Wilson 1993). Humans have been shaped by the forces of evolution. The term *Environment of Evolutionary Adaption* is used to denote the qualities of the environment humans are adapted to live in (Crawford and Krebs 1997; Irons 1998). Natural environments were of crucial importance for survival during most of the human evolutionary history. Ulrich (1999) considers that the stress-reducing effects of nature are a matter of unconscious processes and affects, located in the oldest, emotion-driven parts of the brain. These processes or reflexes tell us when we can rest or when we should be active, including being prepared to flee or fight. The Aesthetic-Affective Theory is about special information in nature that can tell us when it is possible to rest, which results in decreased stress (Ulrich 1984, 2001; Ulrich et al. 1991). This is an unconscious feeling of security that occurs in environments like those humans lived in originally. According to this evolutionary theory, our original environment was open pastoral landscapes with wooded meadows and a few larger trees (Ulrich et al. 1991). People have an inherent preparedness to rapidly react on qualities in nature, reducing or inducing stress – aesthetically – via our senses and our most primitive emotions: our affects. Roger Ulrich (1999) argues that the visual impact of the environment itself may signal danger or safety and that this is most important when persons experience high levels of stress. Many scholars (e.g., Herzog 1987; Ulrich 1993; Coss et al. 2003) accept the evidence presented by paleontologists that *Homo sapiens* primeval habitat was on a savannah, in proximity to water. They propose that the safe oasis, which signals safety and restores us from stress, was surrounded by grasslands, punctuated by large, old trees. "Home" was located in protective green surroundings and commanded a view of water and the surrounding terrain – predominantly lightly forested, open fields.

11.3.2 The Activity Approach

The following theories deal with being in the presence of nearby nature or active participation with nature. There is a diversity of definitions concerning nature-based therapeutic programs – especially concerning the role of the therapists – and some are more favored than others in Europe. One such definition affirms that nature-based therapeutic programs involve a process or processes by which individuals may develop well-being using the garden environment by simply being in the presence of nearby nature – the pure and full sensory stimulation a garden has on those who visit it – and/or by active involvement – by practicing horticulture for instance (Stigsdotter and Grahn 2002; Grahn et al. 2010). A gap still exists between some representatives maintaining that nature-based therapeutic programs is about using active involvement solely, and others mixing more passive involvement with active involvement (ibid).

Many nature-based therapeutic intervention programs originated in horticultural therapy. The version of horticultural therapy developed from WWI and WWII in the UK and the US, has a strong focus on the healing effects of activities in the garden, such as weeding, raking, sowing, etc. (Relf 1999; Söderback et al. 2004). This focus on activities is because horticultural therapy derives from occupational therapy (Hewson 1994; Shoemaker 2002). The Model of Human Occupation (MOHO – Kielhofner 1997) is often used in explaining the healing effects of horticultural therapy: The focus derives from the idea that human beings like to be *active*, they like to perform meaningful activities that bring about interest and give the energy to exert oneself (Kielhofner 1997). If a person has a chance to use body and mind in the pursuit of pleasurable and meaningful occupations, he/she feels rewarded, and working in a garden can be particularly rewarding (Relf 1992; Kielhofner 1997).

This is because horticultural activities have four distinct values which in theory support the healing effects (Relf 1999):

- Physical dependency on plants: humans' entire existence and survival is based on plants. We benefit from plants, and their harvesting.
- Observing beauty: the aesthetic form and the existence of plants and animals. The sheer experiencing of life, can lead us to fascination, making us less preoccupied with one's own problems.
- Nurturing of the life in plants: our need to care for and foster a life outside ourselves. By cultivating, we can study the plants needs and growth, thus developing attachment.
- Social interaction: harvesting, cultivating, observing and sharing all these experiences with other people make us integrate in society.

Activities which are connected to the above mentioned phenomena increase our physical, mental, emotional and social well-being and health (ibid).

However, the strong bond between horticultural therapy and the Model of Human Occupation is about to become weaker. Some practitioners and many researchers have been inspired by Attention Restoration Theory as well as the Aesthetic-Affective theory. These are concerned with restorative experiences, and focus on designing health-promoting qualities in the garden and environment, mediated to visitors through their senses (Stigsdotter and Grahn 2002).

11.3.3 The Coping – Communication Approach

This theoretical assertion relies on theories developed by Searles (1960), Frosch (1990), Grahn (1991), Stern (2000), Bucci (2003) and others. They all maintain that a person's ability to communicate, physically and mentally, with the external world depends on the person's capacity to cope with the temptation, demand, pressure and quiescence he/she receive. All three of the aspects (passive viewing, being in the presence of nature or active participation) are embraced in the activities, when guided and developed by the practitioner.

The *Scope of Meaning/Scope of Action Theory* claims that the surrounding environment communicates with the visitor on many levels (Grahn 1991; Stigsdotter and Grahn 2002; Grahn and Stigsdotter 2003; Ottosson and Grahn 2005, 2008; Grahn et al. 2010). The most important, fast and basic system is the non-verbal emotional tone, through sights, smells, sounds, and so forth. It is by an emotional tone a mother or a father communicates with a small child (Stern 2000). The second system is a more cognitive structure of communication. However, these two systems of communication are intimately connected (Tranel et al. 2000). We interpret the external world with the help of our innate reflexes and our emotional/cognitive basic structure which provides us with *reality constancy* (Frosch 1990; Tomkins 1995) built on our earlier experiences (for a more comprehensive description of the theory, see Grahn et al. 2010). The development of this reality constancy starts from childhood, which facilitates the operations of the ego functions – those concerned with the whole environment. Its existence lends stability and continuity to our entire functions and enables the organism to preserve its identity and orientation amidst alterations and changes in the environment. This takes place without appreciable psychic disruption or adaptational dysfunction. It arises in conjunction with the internalization and stabilization of environmental images.

According to this theory, every individual establishes a scope of meaning in which certain structures are more permanent, while others can more easily change in meaning (Grahn 1991, 2007; Ottosson and Grahn 2008; Grahn et al. 2010). This scope of meaning might be understood as a larger framework of different layers of reality constancies and innate memory-like pictures of varying degrees of permanence. This framework gives us the range of our Scope of Action.

During childhood, we all go through stages of emotional development, in which nonhuman entities (stones, water, plants, animals) and people communicate with us on a direct level and may gradually be given a more cognitive, symbolic meaning (Searles 1960; Grahn et al. 2010). For instance, a teenager going through a troublesome period might form a bond with an animal, feel sympathy for and almost be at one with this animal. This attachment may enable the teenager to relate to and communicate with other people. Thus, successful attachment to the nonhuman environment is as important for people's well-being as is successful attachment to a person's love object (Searles 1960; Frosch 1990; Spitzform 2000).

When a person is healthy and well, communication takes place quite easily. Everything fits into the person's schemes of constancies and scope of meaning. However, it seems that when a person is ill, he/she is more dependent on the nonhuman environment and more receptive to emotional tones. In situations of crisis, the individual may need to revert to simpler relations, more stable and clear reality constancies (Ottosson 2001; Ottosson and Grahn 2008). We receive signals from nature that are very important, even though we may not consciously perceive them. More complicated relations may be too much to handle. Our most complex relations are to other people, and the simplest are those we might have with inanimate objects, such as water and stones. More simple natural elements can act as a more stable link between the conscious and the subconscious, which is of special relevance in this context: stones and plants are not associated to confusing demands or guilt (Searles 1960; Spitzform 2000; Ottosson and Grahn 2008).

Contact with plants and nature settings can contribute substantially to people's recovery from critical situations of various kinds. Signals from nature spark creative processes that are important in the rehabilitation process; both through our cognitive system and through the fast emotional tone (Searles 1960; Tranel et al. 2000; Ottosson and Grahn 2008). This, together with being able to master these relationships, helps to reduce anxiety and pain, restore our sense of self, improve our perceptions of reality and promote tolerance and understanding. Because our neuro-physiological systems are totally integrated with the rest of our body, this will affect our muscles, hormones, the immune system and, not least, our quality of life (Ayres 1974, 1983; Hansson 1996). Research has shown that there seems to be eight sensory perceived dimensions which constitute the fundamental building blocks of parks and gardens (Grahn and Berggren-Bärring 1995; Hedfors and Grahn 1998; Stigsdotter and Grahn 2002; Grahn and Stigsdotter 2010; Grahn et al. 2010). These sensory perceived dimensions consist of symbols that manifest themselves through many different sensations – sight, hearing, locomotion, and so forth, and these seem to connect directly with the visitor's scope of meaning and scope of action (for more comprehensive description, see Grahn and Stigsdotter 2010; Grahn et al. 2010). These eight dimensions resemble important qualities mentioned in several studies in restorative landscapes, environmental psychology and horticultural therapy (Grahn and Stigsdotter 2010). Hence, this theory refers to medicine, psychology, occupational therapy, physiotherapy as well as landscape architecture.

11.3.4 The Ecological Approach

The ecological approach relies on theories developed by Bronfenbrenner (1979), Wilson (1984), Burns (1998) and others. The bases of the early models of ecotherapy derive mainly from the philosophical movement of *ecopsychology* (Roszak et al. 1995). This movement espoused and promoted 'the greening of psychotherapy', thus aiming at reuniting man with the natural environment to heal from illness and distress, challenging the separation from nature we have in theory experienced, especially in the western world, since the industrial revolution. Ecopsychologists believe that this detachment from our 'eco' has resulted in a diseased society.

The ecological dimension of ecotherapy becomes the focus for growth and healing. As in the coping-communication approach, all three of the aspects (passive viewing, being in the presence of nature or active participation) are embraced in ecotherapeutic activities, when guided and developed by the practitioner. The practitioner can harness the available situation which needs to be focused into a specific and purposeful therapeutic journey for the client. Most of the existing research shows that healing derived from a relationship with nature can be drawn from passive participation or from a more direct interaction (Burns 1998).

The two most prominent elements in Burls (2007) ecotherapy model are centered around *reflection* and *reciprocity*. These support the active two-way nurturing of man and nature. Reflection is the most powerful tool with which a person can internalize new and more suitable ways of thinking. Reciprocity is embodied in nurturing our ecosystem, which is our home, and preventing its degradation; this encourages people to develop ecologically sensitive life styles. These activities of taking care of our ecosystem are not only about developing a synergy between man and nature, but they are also about learning self-preservation: caring for ourselves and those we care for and their future. This is also the basis of sustainability.

In the practice of ecotherapy there are clear characteristics in the therapeutic environment. There is a three-way therapeutic collaboration between the client, the practitioner and the nature setting itself. Nature is a living co-educator and functions as co-therapist in the following ways:

- Acts as a catalyst which also provides concrete examples of the consequences associated with individual and group actions
- Assists by guiding insight into any change which may occur in the natural environment and provides the relevant focus for metaphors to be developed
- Aids experiential and curative learning, by providing the backdrop and time for individual reflection, modelling self-disclosure, and metaphoric processing.

The therapeutic environment here can be an open space, with no barriers or enclosures like a piece of forest, community garden or other green spaces which are open to the public, but which also are specifically used for therapeutic outcomes for an identified group of users (i.e., people with mental health problems). As this develops with the guidance of the educator/therapist, a bond emerges where each client responds by enlarging him- or herself and other people in the peer group through dialogue, sharing of ideas and skills development. Mutual learning processes help the individual and the group to develop a strong support system and a critical awareness of how they may impact on their environment and how their environment can impact on their recovery.

Metaphors are used to link learning and growth, with adaptation experiences, which help the person to understand and deal with situations found in the person's "real-life". They are therapeutically linked with the activities which take place, leading to personal change, skill development, subjective social engagement and recovery. The practitioner acts as a facilitator and actively helps the client to build metaphorical meanings and develop concrete therapeutic tools, designed to help negotiate personal life challenges and initiate a change process in one's own healthy/unhealthy environments.

Phases of intervention can involve 'healing pedagogy' (Willenbring 2002), experiential learning (learning by doing) (Beard and Wilson 2002), creativity, reflection and applied knowledge. The sense of responsibility, kinship and awe for the habitat, seem to bring about a wish to be a part of that same 'whole', thus strengthening the systemic approach of Bronfenbrenner (1979). Alongside this, there is often a development of 'environmental literacy' (Coyle 2005) in people leading the context of rehabilitation to take on a much broader scope into skills and employability in the areas of gardening, sustainable development, plant retailing and other similar areas. This gives many people a newfound 'personal value' in society. Specific reference to active nature conservation as an expressed social goal is made by the literature (Reynolds 2002; Department of Health 2004; Burls 2005, 2007, 2008a; Burls and Caan 2005; Townsend and Ebden 2006) where the authors make explicit and direct reference to projects working with nature involving users direct engagement and contribution to the design, management, restoration and maintenance of public green spaces (see for example the Mind Meanwhile wildlife garden in London, UK, in the Outdoor Education Chapter). What is intrinsic in the mentioned activities is a type of community engagement and public participation, which has been called '*embracement*' (Burls and Caan 2004). This phenomenon is derived from a self-directed desire to achieve 'agency', to become 'a critical voice' and be heard in one's own community and amongst one's own peers. The self-esteem and self-efficacy derived from the therapeutic/occupational activities of ecotherapy drive people to become active in educating others (including the public) about the benefits of nature to personal and public health. In some case they will also lead people by example in terms of the wider issues of sustainable living, climate adaptation and ecohealth.

In considering humans as a part of the global biosphere this concept of ecohealth inevitably brings human health into a systemic and synthesis thinking approach (Butler and Friel 2006). This concept widens the relationship between human and non-human species, stressing the importance of ecological factors such as biodiversity and the health of our ecosystem. Because of this, it can be seen that ecotherapy does apply to the wider remit of interventions and therapy programs (e.g., Green Care, Horticultural Therapy, Conservation/Nature Therapy) and can encompass all these (Burls 2010). Research on these models indicates that health benefits are achieved not only for the users but that there are also concrete outcomes for the environment, such as increase in wildlife and public use of the areas, thus strengthening the social, public health and ecological outcomes significance of these activities (Wong 1997; Burls 2007).

11.4 Therapy Programs in Nature-Based Therapeutic Settings

Nature based therapies are offered in various programs depending on the needs of the clients and the resources of the organization offering the therapy. The programs vary in settings, depending on the client group and goal of the therapy. These are involved at hospitals, rehabilitation centers, vocational training stations, home for elderly people, community gardens, parks and schools. The activities vary in degree of physical and mental demands. Activities in a forest garden seems to invite a less demanding husbandry approach than in a traditional garden (Grahn et al. 2010).

Through carefully chosen activities in certain settings, the clients are offered – by the professional staff – interaction with the environment as they connect with plants and nature. These aspects are important to consider when choosing activities for specific groups of clients.

The therapist must have the objectivity, honesty and serenity of mind to understand when nature-based therapy is not the appropriate activity for a particular client. Each client has preferences, attitudes and different desires that must be respected above all. From experience and evidence-based practice there is evidence that it is rare to find a person who will refuse to take part in nature-based therapy. This could partly be explained by the fact that the clients self-select this form of therapy. Nevertheless it should not be perceived that any refusal signifies failure on the part of the practitioner or in the therapy approach.

The responsibility of the therapist is to transmit or to provoke a global development of the subject that enables him or her to be self-satisfied, self-appraised and understand that their disability can create difficulties in accessing the external world, but that this does not mean that they have lost their own personal resources.

It is important for the practitioner to have the following skills (Burls 2007):

- Project planning and management
- Ability to appraise risks for both person and environment (risks are multifaceted and multi-relational – person to person, person to environment, environment to person, risk to the public, risks from activities and equipment)
- Assessment of needs (both the client's needs and those of the environment, of the plants and of the animals which may be present in the therapeutic space)
- Appraisal of appropriate interventions (being aware of the consequences that intrusive or excessive interventions can bring about, stimulating without annoying or provoking anxiety)
- Promotion of participation without tiring the client, finding an equilibrium among the needs, the interests and the desires of the person and adapting interventions accordingly

When planning nature-based interventions, it is important to address the fact that every client has a personal threshold of vulnerability and the innate ability to bear and adapt to stress. Stress is not a constant and necessarily negative factor in the life of a person, it needs however to be recognized for its harmful actions and how these could overwhelm the person.

When a nature-based therapeutic program is begun, it is necessary to keep in mind two fundamental concepts:

- Consider the therapeutic intervention as something dynamic, a program in continuous evolution that does not foresee stagnation and operational rigidity
- Each client is unique, and they are the protagonist of the therapy rather than their illness

The session must be personalized as much as possible for the subject, always remembering that every activity must be selected on the basis of the personal or functional needs of the client. Obviously in the case of nature-based therapy the choice to use a certain activity cannot be separated from the seasonality and the meteorological situation (Burns 1998; Grahn et al. 2010).

It is fundamental to succeed in putting at ease the client and in understanding if their attitude toward this activity is attentive and serene or anxious and not in harmony. Also, it is essential to make the client feel as if they won't be judged for what they will or will not succeed in doing during the session (Grahn et al. 2010). Moreover, it is of fundamental importance to understand that the client's perception of the environment involves all their senses, and use this knowledge when designing the therapeutic intervention: activities and setting.

Often people with handicaps (and even more those with serious handicaps) need a lot of sensory stimulation to be able to have direct experiences (Hassink and van Dijk 2006). People with a serious handicap perceive their surroundings, by involving other people through the contact of skin or the body and, out of necessity; they use the whole body to express themselves and to communicate. It is essential to activate and to strengthen the client's awareness that their body plays an essential role in this type of intervention and that gaining consciousness of this can bring about processes of autonomy, self-esteem, and a relationship with the world around them. Finding the correct equilibrium through sensory stimulation and the respect of personal space is the key for the practitioner in order to be able to enter a relationship with the client/environment.

Box 11.1 Nature-assisted therapy in Swedish forests

The Swedish Forest Agency runs two types of rehabilitation projects in forest environments:

1. **The Green Steps program** is intended for unemployed people who have also been on long-term sick leave. This project is run together with Arbetslivsresurs (a state-owned company running work rehabilitation, making individual strategy plans). People participate in a 10-week program, and each week they take part in simple but meaningful forest activities on 3 days and meet a mentor from Arbetslivsresurs on another day. The activities in the forest can consist of, for example, culture and relic inventory, training in using map and compass, inventory of nature reserves, or, at the start, to simply take a walk in the forest. Experiences concerning the result of the program are good.
2. **Green Rehabilitation** is intended for people who have been on long-term sick leave. This project is run together with The Swedish Social Insurance Agency and The Swedish Public Employment Service. This is a 10-week long outdoor education program, where participants learn how to take care of a forest: involving excursions, practicing how to make an inventory of birds, and outdoor lectures concerning biodiversity, how to thin out trees, and so forth. Experiences concerning the result of the program are good.

11.5 Health Design and Nature-Based Therapeutic Intervention Programs

The above mentioned movement and development in philosophy, practical therapies, etc. have involved an increasing interest all over the world, in both research results and practical experience showing the impact of nature-based therapeutic interventions. However, these interventions involve certain therapeutic activities as well as certain ideas concerning the characteristics of the setting. Ideas concerning settings often relate to ancient beliefs and stories about healing places. Where design is needed or planned, this requires knowledge and awareness of how good or bad design issues may influence individuals' well-being (Tenngart Ivarsson and Hagerhall 2008). This is becoming a multidisciplinary and increasingly interdisciplinary area of interest. Some of the most recognized disciplines aware of these implications are landscape architects, architects, interior designers, artists, physicians, nurses, occupational therapists, counseling psychologists, environmental psychologists, sociologists, nature guides, gardeners, horticulturalist, horticultural therapists and psychotherapists.

This broad multidisciplinary interest leads to a need for a deeper discussion on the physical rooms, the therapy treatment programs and the clients who will utilize them. Several different professions work with natural environments, gardens, healing gardens and human health and well being. This leads to two questions:

Is it possible for a garden to be anything else than healing?
Are the healing properties woven into the concept of 'garden'?

During the last 25 years, many studies have suggested that the ancient ideas about healing places may have merit, particularly for stress-related diseases (Cooper-Marcus and Barnes 1999). They indicate that experiences of nature lower stress levels, enhance powers of concentration, alleviate irritability, strengthen muscles and prevent aches and pain all over in the body (Ulrich 1999; Hartig et al. 2003; Ottosson and Grahn 2005, 2008; Grahn et al. 2000; Söderström et al. 2004; van den Berg et al. 2007; Hartig 2007), all of which are important factors for a healthy life.

In addition, epidemiological and semi-experimental studies so far show that spaces where we live and work have an impact on our well-being and health (Grahn and Stigsdotter 2003; Boldemann et al. 2006; Björk et al. 2008). The results above show that healthy places may be specifically designed spaces or natural spaces. And some natural spaces can be specifically designed (or 'health designed), to become therapeutic 'rooms'. However others are natural spaces which do not require nor could be subjected to design, but which can nevertheless be harnessed as therapeutic natural 'rooms' (i.e., a piece of forest, wilderness, wildlife areas, mountains or woodlands) (Tenngart and Abramsson 2005).

11.5.1 Nature-Based Therapeutic Settings

The well-known definition by WHO: "Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (WHO 1948) implies that health ought to be viewed as a holistic and positive state, which embraces the individual in relation to his/her entire life situation, therefore including its biological, cultural, social and environmental aspects. As mentioned earlier, the concept salutogenic (Antonovsky 1987) refer to the circumstances that help people to maintain their good health, despite the fact that they are subject to potentially pathogenic biological or psychosocial stressors. These circumstances contribute to positive health processes and are viewed here to include the physical outdoor environments, offered to clients in the form of nature based therapeutic settings.

A nature-based therapeutic setting should be regarded as a special form of applied art (Stigsdotter and Grahn 2002). When identifying or designing a nature based therapeutic setting, it is fundamental to know which client group the setting is intended for and what effects (health processes, rehabilitation process) are to be achieved. We all experience a setting based on the situation in which we find ourselves. This means that clients, who are impaired in some way, may perceive the manifestation of the setting in a completely different way than people who are not impaired (Cooper-Marcus and Barnes 1999; Stigsdotter and Grahn 2002). The expression of the setting must be easy to understand for the clients, and they must be aware of what the setting offers them; what they can and/or may do (Stigsdotter and Grahn 2002, 2003; Stigsdotter 2005; Grahn et al. 2010).

In finding or designing a nature-based therapeutic setting the landscape architect (or other responsible professional) must strike a sensitive balance. The setting must be attractive, accessible and safe for the clients. At the same time one must keep the different client groups needs in mind. For example, stressed clients often have impaired body awareness. Walking on different ground surfaces and in an undulating terrain may increase their bodily awareness as well as provide exercise for those who have been ill for a longer period of time. At the same time, the setting must be accessible to clients with functional disorders. On the other hand a setting at a nursing home for elderly people must keep in mind the process of dementia and Alzheimer's disease where the garden must still be attractive, accessible and safe. Recently, legislation and regulations concerning the needs of people with disabilities have developed and expanded. The problem is that every country in the European Union has different legislation regarding this topic. Therefore there are discrepancies from country to country. The need for unified European legislation which imposes a uniformed application of the law is becoming ever more important.

The nature-based therapeutic setting exists in a geographical, historical and social context. The ambient landscape interacts with the specific setting and the client's experiences in it. In order to find a good setting, or achieve a good design of a specific therapeutic setting it is important to formulate its purposes in relation to its context.

It should be possible to experience the nature-based therapeutic setting as a whole, that is, as a separate entity or a room, marked off from it surroundings. Several smaller rooms may be identified or laid out inside the nature setting (Stigsdotter and Grahn 2002, 2003; Stigsdotter 2005). The characteristics of living, growing, and constantly changing are the second basic feature in a nature-based therapeutic setting. These give the clients' fundamental feelings of being a part of nature, cyclic changes, hope and life (Burls 2007). Concerning healing gardens, the amount of living plant material has been shown to be important when it comes to restorative qualities (Ottosson and Grahn 2008; Nordh et al. 2009; Grahn et al. 2010).

When planning a nature-based therapeutic setting, one must take the clients' strength of mind into account (Grahn et al. 2010). This means that the setting must insure that the clients are able to become stronger whilst still finding places and activities in the setting compatible to their new needs. The client's experience of the setting will depend on how much he/she is able to absorb from the environment and how strong his/her mental power is (ibid). This may be illustrated with the aid of a pyramid (see Fig. 11.1), where the need for natural environments with few demands is large at the bottom of the pyramid and smaller at the top (Stigsdotter and Grahn 2002, 2003; Grahn et al. 2010). For best results with clients suffering from chronic stress, the setting should include, or be designed, to create different levels of demands for them and to only make greater demands on them when it is thought appropriate.

Nature-based therapeutic interventions are a process (Burls 2007, 2008a; Grahn et al. 2010). During this process clients need to be exposed to demands/risks. However, the clients must meet the new demands and the reduced security at a slow pace. The client must feel that they can manage this transition (ibid). In an urban context, it is important to make sure the settings have different rooms in which sad, distressed and upset clients may be calmed down and restored (Stigsdotter and Grahn 2002, 2003; Grahn et al. 2010). Also the setting constitutes a constantly ongoing process. The setting is not "finished" when it has been found, or redesigned, but must always be open to change in order to best meet the needs, wishes and demands of the clients (Stigsdotter and Grahn 2003).

One of the approaches in the use of a nature-based therapeutic setting is that it should be a safe place for clients. In this case visitors would not be allowed during more demanding therapeutic interventions. This school of thought retains that clients need to feel that the demanding world is locked out on the outside. This therefore

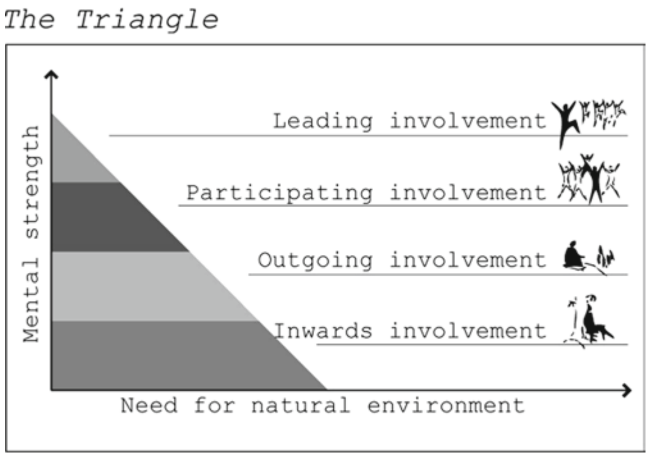

Fig. 11.1 Mental strength triangle (Stigsdotter and Grahn 2002, 2003; Grahn et al. 2010)

requires that the therapeutic setting must be an isolated or enclosed place during such more demanding tasks. In an urban setting, such as in a garden, this can be achieved by using natural material, bushes and trees to “fence in” the garden. By using information boards, visitors can be asked to respect this boundary. More traditional fences can be used in cases where the provision of softer barriers is not sufficient to maintain the privacy required.

Studies concerning people’s preference for different kinds of landscapes date back to the early 1900s (Gyllin and Grahn 2005). These studies showed an underlying structure of preferences: structural properties such as topographic variation, scale and openness of the landscape and certain attributes like water. However, the most significant factor seems to be the degree to which a landscape is natural or manmade (Kaplan and Kaplan 1989; Tenngart Ivarsson and Hagerhall 2008). In the 1980s these preferences were more and more connected to certain effects on people’s health (Kaplan and Kaplan 1989).

The subjects studied by the Kaplans (Kaplan and Kaplan 1989; Kaplan 1990) were all suffering from mental fatigue, as exhibited by the following characteristics:

- They could not concentrate and were easily distracted
- They found it difficult to make decisions
- They were impatient and tended to make choices at random
- They were irritable and not inclined to lend a helping hand
- They had difficulty making plans and tended not to follow the plans they made

After a stay in a wilderness context in Northern Michigan, which lasted a few weeks, all people had recovered significantly from the above mentioned symptoms.

In addition, some properties of such a restorative landscape were presented: it should have high estimations of the characteristics discussed previously: being away, extent, fascination, compatibility and security (Kaplan and Kaplan 1989; Tenngart Ivarsson and Hagerhall 2008):

- **Being away.** As this refers to being in a different setting that makes it more likely that one can think of other things the design should facilitate a totally different place where one can get away from everything that keeps you in the crisis, thus both mentally and physically, allowing freedom from worrying and draining thoughts (Kaplan 1990).
- **Extent.** Many settings may provide a change, but still be limited in terms of scope and connectedness. Restorative settings are often described as places offering a whole different world (Kaplan 1990).
- **Fascination.** Restorative experiences depend upon interest and soft fascination (Kaplan 1990). Both these elements should be present in therapeutic settings.
- **Compatibility.** This component concerns the compatibility of the environmental patterns, the individual’s inclinations, and the actions required by the environment. In a compatible environment, what one wants and is inclined to do are precisely those things that are needed in and supported by the environment (Kaplan 1990).
- **Security.** The safe oasis, which signals safety and restores us from stress, should preferably be surrounded by grasslands, punctuated by large, old trees and commanding a view of water (Ulrich 1999).

As mentioned before, studies have found that experiences in nature/gardens can be divided into eight types (Grahn and Stigsdotter 2010). These characteristics consist of messages manifesting themselves through many different sensations perceived through sight, hearing, smell, locomotion, etc. Moreover, research also concludes that each characteristic satisfies special needs. One can thus speak of types of needs and types of characteristics, which are intimately connected with each other to give a certain outdoor life experience.

One must keep in mind that certain characteristics, or sensory perceived dimensions, scientifically are connected to health outcomes and the preferences for people suffering from stress. People suffering from stress prefer other characteristics than people who do not suffer from stress (Ottosson and Grahn 2008; Grahn and Stigsdotter 2010). This can be explained by the fact that we interpret our surroundings based on how we feel. What a healthy person experiences in one way, could be experienced in a totally different way by an ill person (Cooper-Marcus and Barnes 1999). The results also show how these preferred characteristics should be combined in order to give the most positive impact on health outcomes.

In urban settings, we have to transform this knowledge into a context involving a more or less manmade built landscape. One of these settings attracting a special interest is the garden: All over the world myths, religious doctrines and old manuscripts depict the garden as an enclosed and safe place where one takes refuge to find shelter, comfort and relief from sorrow and pain (Prest 1988; Gerlach-Spriggs et al. 1998; Stigsdotter and Grahn 2002). However, it is important to remember that all gardens do not possess healing or health promoting qualities. Some gardens that were designed to improve human health actually had a negative influence on the clients' well-being (Cooper-Marcus and Barnes 1999).

Box 11.2 The rehabilitation garden in Alnarp (Photo 11.1 and 11.2)

University: Swedish University of Agricultural Sciences, Alnarp
Location: Inside Alnarp Campus, close to Malmö, Sweden
Landscape architects: Patrik Grahn, Sara Lundström, Ulrika K Stigsdotter, Frederik Tauchnitz
Project leader: Patrik Grahn
Clients: Depression and burnout syndrome
Start: July 2001
Description: The rehabilitation garden in Alnarp is designed based on research results and documented experiences. Alnarp rehabilitation garden serve several purposes; offer horticultural therapy, is the setting for research, offers education and is a demonstration garden.
Design (Fig. 11.2):

(continued)

Box 11.2 (continued)

Fig. 11.2 Design of the rehabilitation garden in Alnarp. Illustration Fredrik Tauchnitz

Box 11.3 The healing forest garden Nacadia

University: Forest and Landscape Denmark, Faculty of Life Sciences, University of Copenhagen (UC).
Location: Inside the Arboretum in Hørsholm, Denmark
Landscape architects: Ulrika K. Stigsdotter
Project leader: PhD Ulrika K. Stigsdotter
Clients: Adults suffering from stress-related diseases
Start: Planned to autumn 2010
Description: The healing forest garden Nacadia is designed based on research results and documented experiences. Nacadia will serve several purposes; offer horticultural therapy, be the setting for research, offer education and be a demonstration garden.
Design (Fig. 11.3):

(continued)

Box 11.3 (continued)

Fig. 11.3 Design of the Healing Forest Garden Nacadia. Illustration Ulrika K. Stigsdotter and José Miguel Esteves Lameiras

11.6 Nature-Based Therapeutic Interventions Today – Education, Research and Practice

Horticultural Therapy (HT) or *Social and Therapeutic Horticulture* (STH) are the most practiced examples of nature-based therapies in Europe. However they are diversely applied in different countries. They are quite well known in some countries – such as in the British Islands – and less so in others. There is a range in emphasis of methods, from some having rather uncomplicated, socially directed activities to others being applied in severe, complex treatments. Certain nature-based therapeutic interventions have a very good reputation: this is because the garden has a good design, and members in the team are skilled therapists and have a good professional education. However, in some settings responsible for complicated treatment, there seems to be a pattern whereby staff are recruited as volunteers, often without any education or experience in health care. In addition, the settings could be found in suburban areas or sites without the lush plantings and carefully prepared design needed for the therapy. Hence, there is a great need for education in horticultural therapy and associated vocational training as well as higher education programs on a bachelor and master degrees level. There is also a great need for education in how to design settings for horticultural therapy and how to use natural places appropriately. In some countries, like Great Britain, the Netherlands, Denmark and Sweden, some university courses in horticultural/nature-based therapies have already started, and there are plans to start programs on a master-level in Scandinavia. In England there are Foundation courses and Bachelor of Science courses in social and therapeutic horticulture/ecotherapy. In Wales there now are degree and master-level modules in ecotherapy, which are being taught as part of B.Sc. in Health Studies and M.Sc. in Public Health and Health Promotion, although these are open to all disciplines as Continuing Professional Development. Unfortunately, in spite of these pioneering measures, there seems to be a dearth of sufficient academic courses to prepare practitioners in the practice of and design or care of nature-based therapeutic settings.

Higher education has to be based on sound research, and this research must involve health-outcomes related to the therapeutic settings as well as to the clinical activities. There is also a need to consider the wide ranging set of skills required by practitioners who not only are good therapists, but who also have knowledge of good design. They also need to be equally recognized and remunerated as other therapists and practitioners. In the Nordic countries, the Swedish University of Agricultural Sciences is believed to be the only university that offers a 1 year master program in the subject “Nature, health and gardens”. The program is interdisciplinary and is offered to individuals who have a bachelor’s degree. Although nature-based therapeutic interventions are not taught as the specific subject, the program provides knowledge in closely related subjects. In addition, the University offers three supplementary courses: two courses in Horticultural therapy (an introductory course and a continuation course, together 1 year halftime, for students having a background in medicine or rehabilitation) and one course in Healing gardens, content and design (interdisciplinary). More recently the University of Copenhagen has initiated a master-level course in Health Design for landscape architect students and a continuing education course in health design and horticultural therapy for professionals.

In Norway the universities are developing and offering courses in environmental psychology and landscape planning, focusing on human health in relation to the environment and design. In Finland, colleges are planning gardening and horticulture therapy education programs for health care personnel. The work in Finland is intended to serve as a model for other schools in Scandinavia and a Nordic interdisciplinary group is supported by the Nordic Council of Ministers.

In Italy, beside courses which are meant to prepare practitioners, there is a postgraduate master at the University of Milan, based on healing gardens.

Research within the area of Evidence-Based Health Design is emergent, still fairly limited, and relying heavily on research from the US. Many studies can be criticized for relying too much on narratives from different settings, and very few results can be said to have a standard which can constitute a basis for Evidence-Based Medicine (EBM) – the integration of best research evidence with clinical expertise and client values. Apart from starting research projects aiming to meet such clinical standards, we cannot disregard the design of the setting. The international organization of Health Design has an ambition to integrate Evidence-Based Health Design with EBM, claiming evidence-based design is analogous to evidence-based medicine. Evidence-based health design is used to create environments that are therapeutic, supportive of family involvement, efficient for staff performance, and restorative for people under stress. An evidence-based designer, together with an informed client, makes decisions based on the best research evidence and project evaluations. In horticultural therapy it must be a deliberate effort to base design decisions on best research evidence. A fundamental basis for making progress in the area, supporting the basis for Evidence-Based Medicine, is to start research projects based on formulated theories and hypotheses.

Nature-based therapies are a time proven practice that includes many different types of programs and settings, serving various clients groups. For example, today the practice of horticultural therapy involves several professions and includes, amongst others, professional therapists, researchers, educators, practitioners, volunteers and clients. In the USA, the American Horticultural Therapy Association (AHTA) registers professional horticultural therapists through a peer review system that is intended to promote basic professional competencies within the field. AHTA is the only organization in USA that works for and promotes the development of horticultural therapy. They work in cooperation with Universities, Colleges, Botanical gardens and various organizations offering education and training in horticultural therapy. AHTA offers three levels of professional registration, which are Horticultural Therapist (HT) Assistant, HT Registered and HT Master. These are based upon academic education, working experience and professional training.

AHTA used to recognize and register other international educational programs, but from 2007 the organization has ceased this practice. Now, AHTA encourages worldwide colleagues to develop and build up their own education and registration of professional horticultural therapists and offers advice to those pursuing this (AHTA 2007). In the light of this, there is the opportunity for people living outside the USA to develop the design, certification and delivery of professional training in HT and other allied curricula. This seems timely and most necessary for European countries in order to create educational programs fit to ensure the professionalism of horticultural and other allied therapy approaches, thus encouraging more practitioners to take this on as a legitimate and respected occupation.

11.7 Future Perspectives – Suggested Aims of Research Projects

11.7.1 Some Concluding Hypotheses

From the theories and experiences (research as well as best practice) presented in this chapter we can state the following hypotheses:

- Being in nature affects health in a positive way. All theories presented maintain this strongly: being able to regularly get away from your house or the built environment and perform activities in a natural setting, or just being able to rest in a natural setting can restore a persons mental and/or physical capacities. Having a view over a natural setting, even from your window, can also make a significant difference. This hypothesis has been supported by several studies: epidemiological as well as experimental (e.g. Hartig 2007; Björk et al. 2008; Grahn et al. 2010).

- Certain characteristics in nature affect health in a positive way. The Attention Restoration Theory, the Aesthetic-Affective Theory and the Scope of Meaning/ Scope of Action theory all maintain that certain qualities in nature are important. Some studies support hypotheses that certain qualities in nature affect most people (e.g. Ulrich 1999, 2001) and other studies indicate that it is a matter of a person-environment transaction (e.g. Grahn and Stigsdotter 2010).
- Certain horticultural or nature-related activities affect health in a positive way. This is the core in Horticultural Therapy, Ecotherapy and is also important in the Scope of Meaning/Scope of Action theory (Burls 2007, 2008a; Grahn et al. 2010).
- The health outcome of horticultural or nature related activities depend on the context of the surrounding environment. This is the core of the Scope of Meaning/ Scope of Action theory (Ottosson and Grahn 2008; Grahn et al. 2010).
- Certain people will be more affected than others by treatment in nature-based therapeutic settings, from some being strongly affected to others being affected to a lesser extent. This is put forward strongly by the Scope of Meaning/Scope of Action theory (Grahn et al. 2010).

One long-standing aim of research in this area is to test if treatment with nature-based therapeutic interventions (activities and settings) achieves something more than other traditional treatments. Other aims might need to address the quality of the settings in which therapy takes place, and the effectiveness of the activities. Moreover, there is a need to focus on the relationship between the activities and the qualities of the setting where these activities take place.

11.7.2 Scientific Methods and Approaches Concerning Nature-Based Therapeutic Interventions

11.7.2.1 RCT-Intervention Studies

How is it possible to prove that nature based interventions are therapeutic? And how do we find knowledge about which client groups can benefit the most? – How can the nature based therapies be appraised as effective compared to other therapy approaches? One obvious strategy to reach "best research evidence" would be to have a specific intervention group such as "nature based therapeutic interventions" and a control group "treatment as usual", consisting of "traditional therapies"; these could include occupational therapies or cognitive behavioral therapies. Clients could then be referred randomly to one of the two types of treatment: a randomized controlled trial (RCT). This is the normal and most recognized way to implement a study with the kind of research questions appropriate to this field of enquiry.

Practitioners and researchers should strive to start these kinds of projects. However, in Europe, most therapeutic settings within this specialist area are small and have funding issues, thus reducing the possibilities of doing ongoing randomized studies to test new approaches. Their mandate is to treat every single person who is referred to the setting with a recognized and researched based therapeutic approach. A system of waiting lists set out before intervention to identify a suitable control group would facilitate this, however most therapeutic settings are reluctant to have waiting lists for reasons of funding and resources.

11.7.2.2 National Register of Diseases

National boards of health, as a rule, make nation wide registers of common diseases: treatment (medicine, therapies, etc.), health process (time on sick leave, early retirement, back to work, etc.). These lists are invaluable when making comparisons concerning research on new treatment, such as nature-based therapeutic interventions. In the future, these lists may replace "treatment as usual", because of cost-effectiveness and the large number of individuals in the control group.

11.7.2.3 Triangulation Techniques

Another possibility would be to use triangulation techniques within each nature-based therapeutic setting, and repeat the project in several settings. If most of the results converge in the same direction, advocates for this approach claim the results can be recognized as being more valid and reliable. The principle of triangulation is currently a preferred strategy in the social sciences (Yin 1994; Gorard and Taylor 2004). It refers to the use of more than one research method so as to enhance the credibility of the ensuing findings. It implies that to gain reliable and valid knowledge about a problem, one must illuminate that problem from different angles. Much research is founded on the use of a single research method, and as such often suffers from limitations associated with this, or from the specific application of it (Yin 1994; Webb et al. 1966). The main reason for using a triangulation approach lies in its strategy of convergent validity and reliability. Moreover, the failure of two or more sets of results to converge may prompt new lines of inquiry, leading to new discoveries or theories. One can use theory, interdisciplinary, and/or methodological triangulation (Jick 1979; Yin 1994; Gorard and Taylor 2004).

Health effects involve medicine, psychology, psychotherapy, occupational therapy, physiotherapy, nursing and other caring sciences; the garden room as such may involve landscape architecture and horticulture; the activities in the garden room may involve horticulture, occupational therapy and physiotherapy; ecotherapy may involve conservation and biodiversity ecologists, foresters, psychotherapists, social workers and urban planners. So, it would be quite natural to have an interdisciplinary triangulation approach in projects within this area.

Methodological triangulation involves employing several purely qualitative or quantitative methods in the same project, or both qualitative and quantitative methods

(Jick 1979; Yin 1994; Gorard and Taylor 2004). Qualitative techniques involve direct observation, participatory observation, logs and diary entries, focus group interviews and/or deep interviews and action research (Kemmis and McTaggart 1988). Quantitative methods include surveys, questionnaires, clinical or diagnostic scales.

11.7.2.4 Action Research

Action research is a multi-stage type of research, in which an area is researched, changes are made (concerning the setting, the activities and the therapeutic team), the area is researched again, and more changes are made, and so on. The action researchers are by nature the members in the therapeutic team. Their main task may be described as conceptualizing the events. This involves identifying relevant factors that lead to the emergence of concrete decisions and measures in relation to research questions. This also involves stimulating this ongoing process of developing the setting and the therapy, through theory testing. In this way, practice proximate research such as this can serve as a support by following and systematizing the development taking place. The preeminent way is to use a process that alternates between action and critical reflection. Thus, one is working in a developing process that takes shape as understanding increases, step by step, and that converges towards a better understanding of what is happening and why.

11.7.3 Defining Tools with Reference to Measuring Health Outcomes

In order to be able to compare the results from different nature based therapies there is a need to find a common box of tools for measuring the health outcomes achieved. There is a wide range of tools available to use. The goal is to detect the best, validated and reliable test tools, explain why they are the best and work towards making them an international standard box of tools. Evaluations of rehabilitation outcomes are more and more standardized to use the following perspectives and measures just before the intervention starts, when they finish the intervention and 1 year after the intervention has finished.

11.7.3.1 Back to Labor Market

This is a common way of documenting rehabilitation outcomes, and is also often recognized as the primary outcome of rehabilitation: The percentage of clients who are capable of returning to work or studies after rehabilitation. Some claim this is the most true and “objective” measurement.

11.7.3.2 Symptoms of Illness

Another evident measurement is to state if the illness has decreased in extent and significance. This can be documented through diagnoses by e.g. physicians, occupational therapists, psychologists or physiotherapists, according to international classification systems such as DSM-IV or ICD-10. Blood-samples can be useful for global health status (Hb, potassium etc), and samples connected to a specific status of a disease, such as peptides, steroids and hormone levels (monoamines, cortisol, testosterone, oxytocine). Physiological measures, such as blood pressure, heart rate variability and skin-conductance and other special neuro-physiological methods (EEG, PET, fMRI and TMS) are also helpful. Moreover outcomes can be measured through assessments of symptoms such as structured clinical diagnostic protocols (example: SCID-I) or self-assessment forms which have been suitably, validated and reliability tested. There is a variety of forms, such as Pain Drawing (used by physiotherapists) or MADRS, Hospital Anxiety and Depression scale (HAD) and SCI-93 (used by physicians).

11.7.3.3 Functioning

Client's level of functioning after rehabilitation is also important to measure, but is not always included. This can be documented through assessments by e.g. physicians, physiotherapists or occupational therapists according to international standards, such as the Global Assessment of Functioning (GAF) or International Classification of Functioning (ICF). There are tests of attention, such as Digits Backward and Digits Forward, or of motor capacity. There are also many self-assessment forms, validated and reliability tested. Some of them are related to Activities of Daily Living such as Occupational Self Assessment (OSA) deriving from the model of human occupation (MOHO) and widely used internationally. Others are related to e.g. coping, salutogenic status and executive functioning. Examples are Self Mastery Scale, Rosenberg Self-Esteem, General Self-Efficacy and Sense of Coherence.

11.7.3.4 Wellbeing

From the perspective of the society, and not least from the perspective of single employers, it is of course important to know that a form of rehabilitation can bring people back to labor market. Moreover, it is important to know that symptoms of the illness can be reduced and the level of functioning can return. However, more and more people within the society – politicians, molders of public opinions as well as single employers – have understood that it is important to know if a certain kind of rehabilitation can raise a patients own view of his/her level of wellbeing and quality of life. These dimensions can be documented with an array of different validated and reliability tested forms. The most widely used in Europe is the SF-36

Health Survey, where these dimensions are included, and which are known to have sound validity and reliability. Today, others such as the Lancashire test (LLKP), General Well-Being (PGWB), Quality of Life Inventory (QOLI) or EuroQol – (EQ-5D) are also quite often used.

11.7.3.5 Cost-Benefit

Today, politicians increasingly demand that evaluations of rehabilitation outcomes must include a cost-benefit analysis. This type of analysis can be broken down into certain more specific analyses within health economics. The most often used is Cost-Effectiveness Analysis (CEA), in which the costs and consequences of alternative interventions are expressed as costs per unit of health outcome. This is to determine the technical efficiency of a certain type of rehabilitation, measured as costs compared with what has been decided to be the primary outcome, such as how many people have returned to the labour market – or have no or very few symptoms of the illness. Today, however, CEA is often compared with a Cost-Utility Analysis (CUA). Here, costs and consequences of alternative interventions are expressed in terms of quality of life, and some-times also quantity of life. One such measure is the 'quality adjusted life year': QALY.

Health outcomes can also be documented by qualitative techniques, such as diary entries, deep interviews, focus group interviews, participation and observation. Another way of studying the development, where all inter-relations can be studied, is through action research.

11.7.4 Recommendations

To be able to study both health outcomes and qualities concerning the setting and the activities (therapy program), we propose a multi-method, multi-disciplinary triangulation approach in several single settings, preferably with action researchers as well. The multi-method approach involves both quantitative and qualitative techniques. We define the separate single settings, such as a nature based therapeutic intervention, as a unit in which the physical environment and behavior are indissolubly connected. The structure of such settings is determined by how they are positioned in time and space and their composition in terms of entities and events (activities involving clients, objects, environment, behavior), processes (sounds, sun, scents, etc.) and outcomes (effects on pain, fatigue syndrome and other healing processes). Their boundaries are identifiable, and their components are arranged in a functional way and are part of a whole. Moreover, their functions are, to the extent possible, independent of other units. Clients are part of the unit, as are the events they bring about.

Research shows there is a strong interdependence between the setting and the resulting behaviors. This concept is useful when analyzing human spaces by disaggregating their functional parts. Thus, one can identify specific units (i.e., areas for walking, resting and cultivating) and their association with different levels of physical and mental activity. This is essential for understanding the impact of nature-based therapeutic interventions on clients' behavior, experiences and the resulting health effects. Yet given that people have different goals in different settings, tracking health-promoting experienced qualities in nature settings must involve many methods. The notion of an indissoluble relationship between client and setting may be seen as an impediment to traditional research designs concerned with the properties and attributes of physical space rather than with the behaviors of its users. Landscape architects as well as other researchers involved in these interdisciplinary research projects can in this way contribute to evidence-based design. Health design can be powerfully influenced by the efforts of all researchers/practitioners involved, who seek to understand the effects of the environment on clients and staff. Clearly, the area of treatment of diseases like fatigue syndrome, depression and pain justifies the use of a multi-method research approach where intrapersonal, interpersonal and institutional factors, as well as environmental variables, are taken into account.

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Chapter 12
Outdoor Education, Life Long Learning and Skills Development in Woodlands and Green Spaces: The Potential Links to Health and Well-Being*

Liz O'Brien, Ambra Burls, Peter Bentsen, Inger Hilmo, Kari Holter, Dorothee Haberling, Janez Pirnat, Mikk Sarv, Kristel Vilbaste, and John McLoughlin

Abstract Formal and informal education and learning in woodlands and green spaces can play an important role in contributing to people's health and well-being. Two mechanisms are outlined which might explain this: (1) through general exposure

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to nature when undertaking educational activities outdoors; (2) through active 'hands on' intensive and/or extensive contact with nature gained through learning outdoors. Outdoor learning, what it is and what it involves is described as well as three learning theories particularly relevant to outdoor learning. The links between outdoor learning and health focusing on the two mechanisms outlined above are explored in detail. Conclusions highlight potential ways in which to encourage the use of woodlands and green spaces to deliver learning, and health and well-being outcomes.

12.1 Introduction

This chapter focuses on outdoor education and learning in nature. We use the term nature to include people's interactions with the environment from the countryside and rural areas through to urban green spaces in heavily populated areas, and gardens or green spaces within school grounds. We argue that outdoor education in natural settings can potentially lead to a range of health and well-being benefits through two possible mechanisms.

1. Through general exposure to nature and being active in nature which is as an essential part of outdoor education – leading to potential improvements in physical health, mental well-being and restoration. For example, health and well-being outcomes can be gained through outdoor learning as a by-product of being in nature; these benefits can also be gained through other activities such as outdoor recreation.
2. Through active 'hands on' and intensive or extensive contact with nature gained through outdoor learning – leading to attitude and behavior change, new skills and competencies, improved confidence and self esteem; and interpersonal and social skills. For example, health and well-being benefits are gained specifically through outdoor learning approaches that are intensive, 'hands on' and/or long term (Fig. 12.1).

The health and well-being benefits derived will be mediated globally, nationally and locally by different education and learning approaches and policies, health policies, social norms, accessibility of woodlands and green spaces, cultural attitudes to outdoor education and contemporary societal interest in, and value for, contact with nature (Valentine 1996; Kahn 1999; Kahn and Kellert 2002). Issues such as accessibility of nature spaces, quality, size and location can impact on the likelihood of outdoor learning taking place, as well as institutional practices. The quality of learning, relevance to the individual and impact on the individual are key factors in outdoor education. Nail (2008) argues that issues of health are very closely related to education. She suggests that new health policies to address obesity, attention deficit disorder, depression and mental health can be partially addressed through the closer working of health and education departments. The Scottish government has recognized the strong connections between successful learning and health in its 'Curriculum for Excellence' (Scottish Government 2004).

The above provides the rationale for our focus on outdoor learning in this chapter. In Section 12.2 and 12.3 we describe outdoor learning: what it is and what it

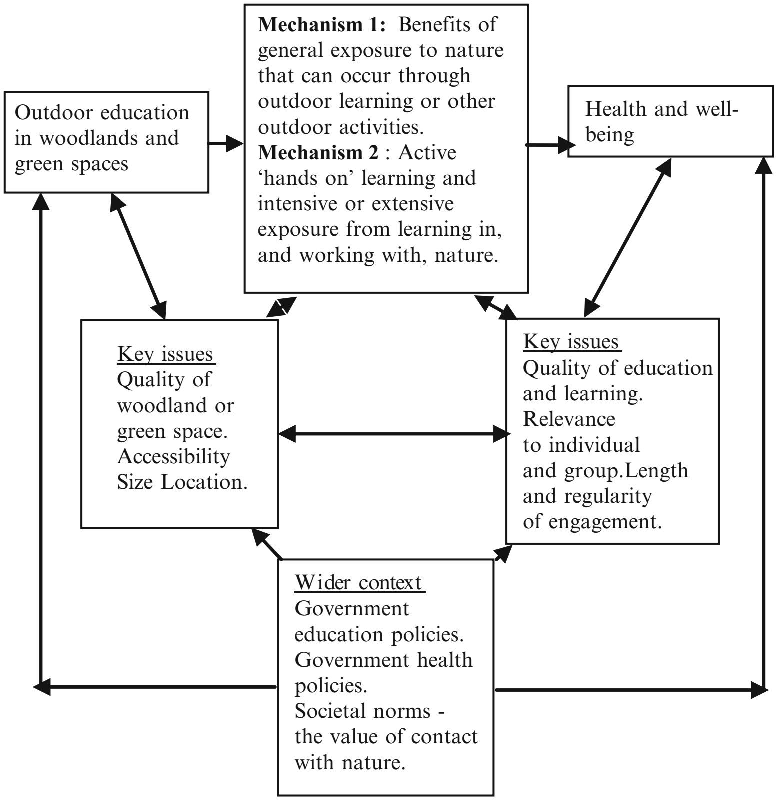

Fig. 12.1 Potential ways in which outdoor education can impact on health and well-being

involves, as well as exploring learning theories that we suggest are particularly relevant to outdoor education. In Sections 12.4 and 12.5 we explore the links between outdoor learning and health and well-being focusing on the two mechanisms outlined above. Section 12.6 outlines our conclusions and highlights potential ways in which to encourage the use of woodlands and green spaces to deliver learning, and health and well-being outcomes. We focus primarily on children and young people, but life long learning is very important for all ages in developing and gaining skills throughout life to meet new challenges.

12.2 Links Between Education and Health

Before we move on to discuss outdoor education we outline some of the broad links that have been identified between health and education. Ross and Wu (1995) studied these links through two large scale surveys of United States households; they found that there was a positive association between education and health and provide three explanations for why this is the case: (1) well educated respondents were more likely to be working, have fulfilling jobs and suffer less economic hardship than poorly educated respondents; (2) the well educated felt a greater sense of control over their lives and health and reported higher levels of social support; and (3) the well educated were less likely to smoke, more likely to exercise and to drink moderately. Ross and Wu (1995) argue that educational attainment can directly and indirectly impact health through work and healthy lifestyles. The Canadian Public Health Association (CPHA 2009) suggests there is a growing awareness of the tie between education and health for individuals and communities. It argues (CPHA 2009) that those with little education have shorter life expectancy and are sick more often than the well educated. Statistic Canada (CPHA 2009) reported that those with 12 years of education were less likely than those with less education to have high blood pressure, cholesterol or be overweight. Culter and Lleras-Muney (2007) also suggest that a 'large and persistent association between education and health has been well documented in many countries and time periods for a wide variety of health measures'. They have found that the well educated have low morbidity rates independent of basic demographic and labor market factors. However they suggest that the mechanisms through which education influences health are complex and may include 'interrelationships between demographic and family background indicators, effects of poor health in childhood, greater resources associated with higher levels of education, a learned appreciation for the importance of good health behaviors and one's social networks'.

Similarly the Economic and Social Research Council in the United Kingdom is funding research on whether education leads to better health. The researchers state that a number of studies in different countries have found that those with little education have poorer health, greater disability and greater chances of premature death than the well educated. However the researchers argue, as others have, that the relationship between health and education is not clear cut and that investment in education does not automatically guarantee better health. They suggest pathways for the link between education and health include education leading to healthy behaviors such as eating well, not smoking and that high education levels can lead to better paid employment and healthier lifestyles. The researchers suggest that interventions can be made not only through education but at different points in people's lives through a focus on work or living conditions for example. However they argue that investment in early years would have the most impact, and encouraging people to be healthy when young has an impact on later life (Economic and Social Research Council 2007). This research outlines strong links between education and health, but it does not make any reference to where that education takes place, and the majority is likely to occur in indoor environments.

12.3 Outdoor Learning and Theories of Learning

Outdoor learning is a broad concept that does not have clear boundaries. It can involve a variety of different approaches and activities as outlined in Table 12.1. Outdoor education and learning is different from environmental education which can also take place outdoors. Outdoor learning can cover any subject, not just focus on the environment and it can be targeted at a range of age groups.

Table 12.1 Outdoor learning approaches

Outdoor learning approaches	Examples include
School grounds/gardens/community projects	Eco schools
Outdoor therapeutic and learning projects	Wilderness therapy interventions
Outdoor visits	School visits/trips to a forest classroom or green space
Regular outdoor learning	Forest School, nature kindergartens, practical environmental volunteering, and more targeted projects for people with certain disabilities or social problems
Guided walks/events	Fungi foray's, nature walks, bird watching
Environmental education	Trips to field study centers, residential courses
Outdoor play – particularly for young children	Nature kindergartens, nature in school grounds, Forest School
Modern apprenticeships	Training and skills development in nature through specific programs
Adventure and recreation activities	Outward Bound and residential courses

This is not an exhaustive list, but it highlights the breadth of approaches that can come under the heading of outdoor learning. Not all of these categories are mutually exclusive, for example, an outdoor therapeutic learning approach might be based around adventure or wilderness types of activities (Photos 12.1–12.2). However, it will have a different focus due to its therapeutic aspects than organizations providing adventure and recreation activities to challenge young people. Outdoor learning can be formal, taking place through schools (Photos 12.3–12.5), universities or specific courses and it often follows particular curricula and identifies specific learning outcomes. These activities are led by teachers, biologists, nature interpreters, lecturers, guides and instructors. Informal learning is undertaken for broad interest and enjoyment or for health and social outcomes and can be facilitated by parents, guides, therapists and rangers.

12.3.1 What Does Outdoor Learning Involve?

The key aspect of outdoor learning is that it takes place outdoors and not in the built environment. Another key factor is that learning outdoors often involves a kinesthetic style of learning, e.g. people are physically engaged through 'hands on' learning – making or building objects or identifying flora and fauna (Photos 12.6–12.9). For example people might get actively engaged in building a shelter at Forest School (see Box 12.1) or using maps to work out a route through the landscape in adventure and wilderness activities. It might involve identifying plants or birds in environmental education approaches or growing food in a school garden or conserving wildlife habitat in an urban green space. Therefore active 'hands on' engagement is especially important in outdoor learning and a number of approaches advocate the importance of this taking place on a regular basis over a long period of time such as through Forest School or nature kindergarten approaches (see Box 12.1 and 12.2).

Photo 12.1 Holding your balance, sort of, teenage adventure camp. (Photo: Jasper Schipperijn) (*See Color Plates*)

Photo 12.2 Building a mini shelter for toy animals at Forest School (Photo: Forestry Commission) (*See Color Plates*)

Photo 12.3 Children working together to build a shelter (Photo: Forestry Commission) (*See Color Plates*)

Photo 12.4 Forest School participants discuss mini shelter designs (Photo: Forestry Commission) (*See Color Plates*)

It often involves experiential learning, for example learning through day to day direct experience. Kolb (1984) drew on the work of educational theorists such as Dewey (1938/1997), Piaget (1962) and others to develop a model of experiential learning which has four stages moving from concrete experience, to observation and reflection, to the formation of concepts, and the testing of these in new situations (Photo 12.7). This makes learning an active interpretive process rather than an outcome and can be regarded as a model for life long learning. Some outdoor learning approaches can be concentrated and intensive for a week or

Photo 12.5 Camping out in the urban woodlands of St Petersburg, Russia (Photo: Jasper Schipperijn) (*See Color Plates*)

2 weeks, such as adventure, wilderness or field studies approaches which are often residential and take people away from their usual environment. These can lead to life changing experiences. Other approaches are one-off, e.g. a day trip to a forest classroom, and some approaches take place in the same setting on a regular basis over a long period of time (sometimes years) such as Forest School or nature kindergartens. We are especially interested in these approaches rather than very short or one-off visits.

'Curative education' often has a focus on the outdoors and contact with nature. It is an approach based on Anthroposophy by Steiner (1904 and 1990) and was first established in Germany. In this approach, those with mental and emotional development problems or special needs live as part of a community and are provided with opportunities for individual development. It is a form of learning and teaching that has a healing effect on the person. It encompasses care, education, craft and artistic activities adopting a holistic view of the human being.

12.3.2 Theories of Learning

There are many theories concerning how people learn, absorb information, and respond critically to knowledge. The theories outlined below are particularly relevant to outdoor education and learning and are provided here to emphasize that different

Photo 12.6 Looking for mini-beasts, England (Photo: Forestry Commission) (*See Color Plates*)

Photo 12.7 Looking for mini-beasts, England (Photo: Forestry Commission) (*See Color Plates*)

Photo 12.8 Nature school in the urban woodlands of St Petersburg, Russia (Photo: Jasper Schipperijn) (*See Color Plates*)

Photo 12.9 Sucking up ants while not getting bitten is not easy (Photo: Jasper Schipperijn) (*See Color Plates*)

Box 12.1 Forest School in Britain (Photos 12.2–12.4)

Aim/objective: Forest School is an inspirational process that offers children and adults regular opportunities to achieve, and develop confidence through hands-on learning experiences in a woodland environment.
What happens at Forest School: Children get involved in a range of activities such as creating artworks, carry out counting exercises when collecting e.g., twigs for the fire, and they discuss and improve language skills by describing what is around them. Children and young people spend a morning or afternoon at Forest School once a week or fortnight over a period of between 2–12 months.
Outcomes: Increases in gross motor skills and stamina due to physical activities undertaken over a period of months. Restorative benefits of the woodland environment can have a calming effect on the children.
Lessons learnt: Regular contact with Forest School can have wider impacts on teachers and families as children take their experiences with them and inform family and friends. Long term engagement can lead to increases in self-esteem and self confidence.

Box 12.2 Fortet Naturbarnehage/Nature-kindergarten, Norway

Aim/Objective: Offering children a huge variety of experiences in nature. Outdoor experiences throughout the year to enhance fondness for nature and potentially a desire to conserve nature.
What happens at Fortet kindergarten: The children play all day out in the woods. Kindergartens often have long-lasting on-going projects.
Outcomes: Physical activity through ongoing activities and play which contributes positively to health and well-being. The children use all their senses, cooperate, play together and they experience psychological well-being.
Lessons learnt: Children gain an understanding of nature, conservation and interaction in the natural world. The children experience and learn about animals and plants, and about their mutual dependence and importance to food production. Good experiences in nature also contribute to the process of understanding the significance of sustainable development.

educational approaches may be undertaken depending on ideas of how people learn. Learning theories often illustrate fundamentally different assumptions about how learning might occur in outdoor nature settings. French philosopher and psychologist Merleau-Ponty talked about the links between bodily experience and cognitive learning, suggesting that it is through the body that the world is understood (Smith 1962).

For teaching in the outdoors, which often focuses on practical work, these ideas are important and a reason for encouraging children to behave physically.

12.3.2.1 Constructivism

Constructivist learning is concerned with the ways people construct understanding of the world around them through their various experiences (Kahn 1999). In the constructivist approach, priority is given to people's mental lives and the active ways in which they construct understanding of their world and how they act upon it. This approach allows for problem solving, experimentation and hands on experience. 'Constructivist teachers find out what interests their pupils or students and then build a curriculum to support and extend those interests. They allow students to help shape the curriculum and give them the freedom to explore, take risks, and make mistakes' (Kahn 1999: 214). Knowledge is not passively gained by a person through the senses, instead exchange of knowledge is organized and adjusted through mental activity and active communication (Jordet 1998). In a constructivist approach, pedagogical principles would focus on learning and not performance, engaging learners in practical tasks is seen as important, teachers guide the pupils rather than instruct them and learners are viewed as co-constructing knowledge with teachers and peers (Adams 2006). This type of approach moves away from what is considered a more traditional type of learning in which teachers instruct pupils and test them. Kolb's model mentioned previously provides a better understanding of the processes by which people construct meaning out of their engagement with the world.

12.3.2.2 Multiple Intelligences

Gardner (1983) defines intelligence as a group of abilities and he originally identified seven intelligences including verbal/linguistic, logical/mathematical, visual/spatial, body/kinaesthetic, musical/rhythmic, interpersonal and intrapersonal. Gardner suggests that learning should be holistic and focus less on the traditional verbal/linguistic and mathematical approaches to include other types of intelligence and the use of all the senses. This framework has allowed educationalists to think about learning differently and to realize that if a person did not learn through traditional routes, then other approaches might be useful. Gardner moved the debate on from intelligence being seen as something identified by traditional intelligence tests to a broad view of what constitutes intelligence. Later, Gardner (1999) added an eighth intelligence to his theory: naturalistic intelligence. He discovered that there are children who appear to exhibit acute awareness of patterns in nature at an early age. Naturalist intelligence deals with sensing patterns in, and making connections to, elements in nature. People with naturalist intelligence are often keenly aware of their surroundings and changes in their environment, even if these changes are subtle. This is due to their highly-developed levels of sensory perception, which helps them notice similarities, differences and changes in their surroundings more rapidly than others.

People possessing this form of intelligence are usually interested in other species and the environment, and they have a strong affinity to the outside world; these interests often begin at an early age. This intelligence would have been especially appropriate during the evolution of the human race for hunters, gatherers and farmers. Today it may be responsible for people becoming botanists or farmers. Examples of cultural groups possessing and valuing this form of intelligence are many including Native American Tribes and Aboriginal Peoples. It is believed that naturalistic learners would learn more through being outside and this type of intelligence can be cultivated and nurtured within outdoor learning and ecotherapeutic activities.

12.3.2.3 Social Learning Theory

Also known as observational learning in which the observer's behavior changes after they see the behavior of a model or person they can identify with and the outcomes of that behavior. Attention, retention, production and motivation are seen as important factors in this type of learning. Using this approach teachers and parents can model what are thought of as appropriate behaviors that learners can identify with and act upon. Vygotsky (1986) argues that language has a decisive function. The best learning and development occurs when children solve problems together with others, especially adults, by talking and discussing experiences; therefore learning in a social context is particularly important (Vygotsky 1986). The knowledge attained through personal experience and that which is connected to real situations is thought to be long lasting.

12.3.3 Outdoor Learning in Europe

In a number of societies outdoor learning is embedded within a particular culture while in other societies it is not a tradition, or concerns about risk and safety, particularly for children and young people, prevent large scale outdoor learning. For example in Denmark, as in much of Scandinavia, there is a historical and widespread tradition of using the outdoors for learning. For decades the outdoors has been used as a playground for children at pre-school level on a daily basis. In Denmark the term *friluftsliv* is understood in a very broad sense to mean outdoor recreation and education and the popularity of *frilufsliv* has grown in the past 3 decades (Andkjær 2005, 2006). In Norway, outdoor teaching in schools and the increase in time spent outdoors with children in kindergartens is positively valued by society. Studies in Scandinavia have shown that there are several reasons why it is important to give children opportunities for outdoor activities from an early age. Fjørtoft (2000) has shown that children develop better physical skills in this way. Other studies indicate that children have more physical and mental energy, more self-confidence and are happier (Kaarby et al. 2004; Hilmo et al. 2006). Traditionally in Britain outdoor learning for young people has encompassed both nature oriented learning and adventure activities that are primarily undertaken outside of school hours. However the current discourse on learning outdoors has embraced a broader concept and can be seen as an approach that can enhance and integrate a range of activities that connect people with the environment, their community, society and themselves (Dillon et al. 2005).

In Slovenia, the Waldorf education system based on Rudolf Steiner's ideas has been established for 15 years and in this time the methods have been transferred to the public school system in Slovenia. An example of this is the inclusion of children with special needs that has shown success in the Waldorf school of Ljubljana and social inclusion is now regarded as a positive option for all schools by the Slovenian Ministry of Education and Sport (see Box 12.3). In Estonia, learning outdoors is deeply rooted in its culture and language. The word *õppima* means to learn but also has the meaning to experience, and to taste. Learning often happens in forests with careful observations made of nature through the School Forest Movement, and efforts to promote outdoor learning have increased in recent times (see Box 12.4). In Switzerland, the idea of Forest School based on Federal law was implemented by a forester and over the past few years outdoor education for small children has become increasingly popular, and a small number of kindergartens spend all their time outdoors. Research in Switzerland is being undertaken on the health promotion of these sorts of approaches (Gugerli et al. 2004). These are a few examples of the ways in which outdoor education is viewed in different countries.

Figure 12.2 outlines the DPSEEA (Drivers, Pressures, State, Exposure, Effects, Actions) model adapted to show a nature and physical activity/education example. The DPSEEA model is used by the World Health Organization in designing environment and health indicators within a decision making context. It has also been

Box 12.3 Waldorf School Ljubljana, Slovenia

Aim/Objective: Waldorf Schools provide practical therapeutic activities in nature for children with special needs to help create interest in school work. These schools are based on the philosophy of Rudolf Steiner.

What happens at Waldorf Schools: Children with learning and behavioral difficulties use the forest near the school for a variety of activities. Practical activities are undertaken that help the children to learn and develop responsibility towards nature through hands on experience. The children walk, play and observe in their sessions in the forest.

Outcomes: Developing gross motor skills and balancing skills, improving walking skills. Stimulation of all the senses in therapeutic activities.

Lessons learnt: The children carry out a number of exercises that include touching different trees, making a circle around a tree, working with others, following the movement of the sun. They use ropes to make large geometric forms in the forest between the trees and walk on these, they then draw them in notebooks in the class; this helps with mathematics in school.

Box 12.4 Outdoor Learning Teacher Training Project, Estonia

Aim/Objective: Promote outdoor learning with teacher training and undertake research on its impact.
What happens in the Teacher Training project: 30 schools and pre-schools were selected and 32 television broadcasts made on national television. Study materials were published on a series of DVDs and sent to 400 schools in Estonia. 150 teachers received in-service training in outdoor learning. The research among participating teachers indicated that use of outdoor spaces for learning increased significantly, many schools initiated creation of learning forests around their schools.
Outcomes: Participating children felt that learning outdoors was good because of fresh air, movement and the use of social skills. All the children preferred learning outdoors. The teachers, who participated in training, were after the 4 days of training less stressed, their memory improved, and they were motivated to use outdoor learning in their practice.
Lessons learnt: The children and teachers learn and demonstrate the opportunities and ways of learning in integrated ways through different curricula subjects in outdoor areas. The teacher training and television broadcasts demonstrated how learning can be combined with play.

adopted by the Scottish Government (2008) in a recent document ‘Good places, better health’ which is a new approach to strategically link the environment and health. We have produced the brief populated model outlined in Fig. 12.2 which could be relevant across a range of countries in western society that are increasingly urbanized, risk averse, sedentary, car oriented; with easy access to high fat food and pressures on existing green space for development. The model outlines where some actions could be taken to raise awareness and increase the use of green space and woodlands for education purposes and physical activities.

12.4 Health and Well-Being Outcomes: General Exposure to Nature

An increasing amount of literature, experiments and research over the past 3 decades outlines a range of health and well-being benefits that can be derived from contact with nature from brief periods of contact to longer contact (Ulrich et al. 1991; Bird 2004; Pretty et al. 2005). The Chapters in this book provide a wide range of this evidence in terms of physical and mental health and physical activity and the prevention of illness. The biophilia hypothesis was developed by Wilson (1984) and debated by others (Kellert and Wilson 1993, Kahn 1997). It emphasizes people’s innate desire to have contact with nature. Chawla (2006) outlines the

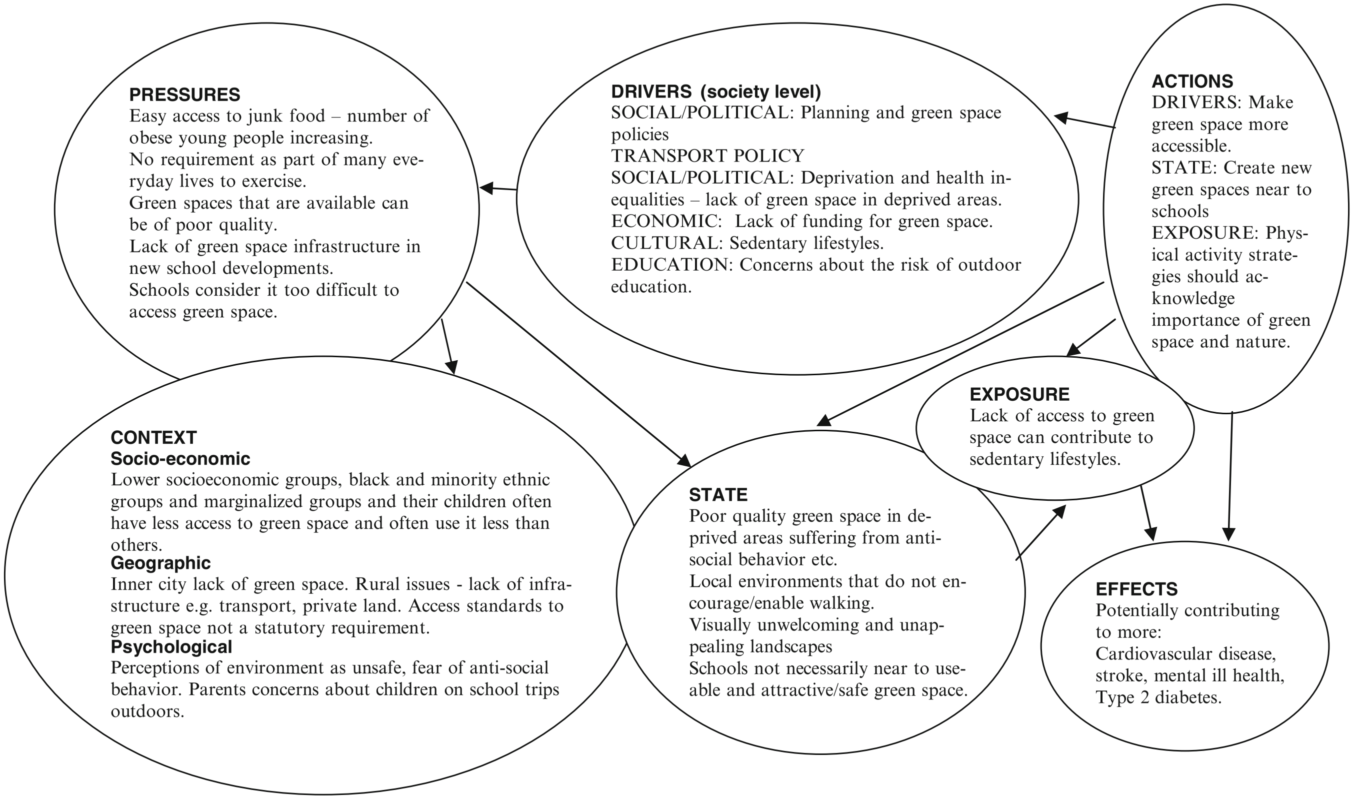

Fig. 12.2 Modified DPSEEA model: nature/green space and physical activity/education example

importance of nature experiences during childhood in stimulating interest and care for nature in adulthood. In this section we suggest that there are physical and mental health and well-being outcomes that can be gained from exposure to nature and that these can be experienced through outdoor learning approaches or through other outdoor activities such as recreation.

12.4.1 Physical Exercise and Improved Stamina

Outdoor learning often involves some form of physical activity and this can range from mild to moderate, to very active. Woodlands and green spaces allow opportunities for exercise and activity that can lead to improvements in stamina if undertaken over a period of time. These opportunities can increase fitness or improve motor control as young people learn to deal with the uneven terrains of woodland, mountains and heathland. O'Brien and Murray (2006) in their study of 24 children attending Forest School in England over 8 months found that Forest School leaders observed the children's stamina increasing over the months as they became less tired at the end of their Forest School sessions. Fjørtoft (2004) studied the effects of natural environments on children's play and motor development in Norway. The author looked at children playing in a natural environment and had a control group playing in a traditional playground. She found that when children were provided with a natural landscape to play in, they showed a statistically significant increase in motor fitness. Lovell (2009) studied young children at a Forest School in Edinburgh; she assessed the levels of physical activity the children got involved in at Forest School and the level of activity they undertook in school and the school playground. Results highlight that the children were significantly more active at Forest School and there were fewer gender differences in activity between boys and girls at Forest School than in the school playground.

The above findings are reinforced by Kaarby et al. (2004) who spent time in two kindergartens observing children in the woods. She found that the children were physically active most of the time. Exercise-play was the prominent part of the children's activity. Where elements such as a good climbing tree, a windfall or dense bushes were available, the children included them in nearly all of their play. So through regular outdoor learning such as Forest School and nature kindergartens children and young people can become physically active. Through other approaches such as adventure and wilderness learning, intensive physical activities might be undertaken such as mountain treks and rock climbing. This can potentially lead on to a life long interest in these or other physical activities, contributing to healthy lifestyles.

12.4.2 Restorative Benefits of Contact with Nature

Attention restoration theory and the idea of restorative environments have been developed by Kaplan (1995) and Hartig et al. (1991). The theory suggests that people use directed attention when they need to concentrate, on work for example, and this is fatiguing, as they have to focus, concentrate and screen out distractions. People recover from directed attention through involuntary attention that requires no effort. Kaplan (1995) and Hartig et al. (1991) suggest that natural environments are particularly good for involuntary attention as the environment holds people's fascination, allows them to get away from distractions and stimulates the senses, but requires no specific effort. Chapter 5 in this book outlines restoration theories and the benefits of restorative environments in much greater detail. We argue that these restorative benefits can be gained through outdoor learning processes in nature, but being in nature is the important element rather than necessarily the learning process. Berman et al. (2008: 1211) report on two recent experiments that show how walking in nature or viewing pictures of nature can improve directed attention, and they argue that these demonstrate the restorative value of nature 'as a vehicle to improve cognitive functioning'. If cognitive functioning can be improved through contact with nature then this may have particular implications for those trying to advocate the importance of outdoor learning.

Research has also shown that nature can have a calming impact on those with emotional and behavioral difficulties. A survey of parents of children with Attention Deficit Disorder (ADD) questioned them about their children's attentional functioning. They were asked about their children's attention after activities in a number of settings, including indoor and green space settings, and found that the greener children's play areas were, the less severe their attention deficit symptoms. This suggests that contact with nature may support attention functioning for those with ADD (Taylor et al. 2001). There is evidence that children who experience ADD are growing in numbers, and that their behavior problems improve when they are allowed to be in natural environments, exploring, being active and absorbed by the surrounding environment (Ferrini 2003). Their engagement is guided by the restorative elements of plants, trees, animals and weather.

For many children and adults excluded from school or society (i.e. offenders and pupils excluded from school) experiencing the outdoors can provide them with a 'calming' and 'focusing' effect. An example of this can be seen in Offenders and Nature Schemes (OandN) (Carter 2007) which explicitly apply 'ecotherapy' to support people with addiction problems and/or mental-health issues. Ecotherapy is contact with nature through a range of activities such as conservation or a horticultural program that can lead to physical, social and mental well-being benefits for participants/patients (Burls 2007, 2008). Drawing on the capacity of nature to calm and inspire, OandN projects use small teams that usually complete voluntary physical tasks with highly visible effects such as path creation and scrub clearance. The effects of working hard and in all weathers can also improve physical fitness. Participants learn to be reliable and to adjust to full-time work routines. This is a different approach to spending time inside a prison, a factory or school. Those who are selected for this kind of activity can learn new skills which can lead some of them to apply for college courses, apprenticeships or jobs in the field of land management: a particularly useful stepping-stone to gaining employment in the longer term and rebuilding their lives. MIND (a mental health charity in the UK) calls for a green agenda for mental health due to the growing evidence of ecotherapy approaches as accessible and cost effective additions to existing treatments for mental ill health (MIND 2007).

12.4.3 Physical and Psychological Barriers to Accessing Nature

Whilst physical and restorative benefits can be derived from general contact with, and exposure to, nature, there can be barriers to gaining these benefits due to physical and psychological issues to accessing the outdoor environment. These barriers can differ in different cultures and depend on societal perceptions about crime and safety issues. O'Brien and Murray (2007) in their study of the impacts of Forest School on young children found that some of the experiences the children and practitioners had were negative at first. Stakeholders identified that some children were unfamiliar and uneasy in the woodland setting, and being out in all weathers meant that the children at times got wet and physically uncomfortable. Some of the teachers were unfamiliar with teaching children in an outdoor setting and were nervous of this. There can be a range of barriers that prevent or impact on people's enjoyment of woodlands and green spaces, such as fears about safety, worries about uncared for spaces, unfamiliarity with using such spaces, and unpleasant myths and stories about particular places (O'Brien and Tabbush 2005; Weldon et al. 2007).

Perceptions of risk, particularly in relation to children and young people are important issues in a range of European countries. Different societies view risks in different ways due to social norms and the activities and crimes that take place within each particular society. In a study on the amplification of risk, Petts et al. (2000) suggest that there are complex ways in which people receive, compare and filter information concerning risk from a range of sources such as the media. Louv (2005) reports on the idea that children are becoming removed from having much contact with nature in contemporary society, mainly due to the perceived dangers that reside in outdoor environments, and thus parents and guardians encourage children not to interact with nature. He calls this 'nature deficit disorder'. Norris (2004) refers to the 'extinction of experience', a problem also fuelled by the feelings of danger from strangers, fears dramatized by the media, parents with too little time, for example, to walk to school with their child (Cooper 2005) . The sedentary lives that many children now lead is resulting in obesity with the ensuing long-term health problems associated with it. Due to these negative issues it is difficult to advocate uncritically that education and learning outdoors will be beneficial to all. Milligan and Bingley (2007) in their work on the impacts of woodland on the mental well-being of young adults found that while childhood access to woods affected the likelihood of adult use, they also found other mechanisms at work that could overcome positive views of woodlands, such as parental attitudes and adverse media reporting. We need to become more aware of the barriers to accessing nature and deriving benefits from contact with nature. Therefore research needs to explore experiences for different groups and ages of people rather than assume positive benefits accrue to everyone in the same way.

12.5 Health and Well-Being Outcomes: 'Active Hands On', and Intensive or Extensive Contact with Nature Through Outdoor Learning

Section 12.4 outlines potential health and well-being outcomes of general exposure to nature which can be gained through a range of activities including outdoor learning. In this section we focus on the added value of outdoor learning in nature and explore some of the benefits derived from this. We argue that 'hands on' active, intensive and/or long term outdoor learning can lead to changes in knowledge and skills, and attitudes and behaviors, and self esteem and social skills (MIND 2007; Burls 2007a and b). These changes, we argue, take place through the combination and integration of enhancing the learning environment through contact with nature providing a unique or on-going experience for young people. This moves beyond imparting information to evoke a deeper level response in young people and others and this can lead to health and well-being benefits. We draw on a range of literature; but more research is needed in this area as research on education often focuses on educational outcomes or personal and social development. For example, few explicit links are made to health, although broader well-being is sometimes discussed. More research is also needed to explore in greater detail the impacts for specific groups of people (girls, black and minority ethnic groups) in different countries and through various learning approaches. Chapter 11 outlines therapeutic aspects of engagement with nature for those with a range of mental health and 'burn out' syndrome problems. There is a strong history of therapeutic approaches in horticultural therapy. Learning is often an important component of these therapeutic approaches aiding people to change behaviors and develop positive mental approaches to life.

12.5.1 New Knowledge, Skills and Competencies

The learning outcomes derived from outdoor education will differ for different outdoor learning approaches and depend on the objectives of the educator and the subjects or skills being taught (Museums, Libraries, Archives Council 2004). Learning outcomes are what an individual should know, understand or be able to do at the end of a program of learning or course. Grahn (1996, 1997) found that children in Sweden who attended day care centers with green spaces had greater attentional capacity than those in centers with no green space. Children have a curiosity about nature and this can be encouraged through both formal and informal learning (Kahn 1999). The outdoor environment provides opportunities for different types of skills to be learnt for example making a den, identifying and picking non-timber forest products, and planting trees or carrying out conservation activities. Rickinson et al. (2004) critically examined 150 pieces of research (published in English) on outdoor learning between 1993 and 2003. The review covered outdoor learning approaches such as fieldwork and outdoor visits; outdoor adventure activities; and school grounds/community projects. They found substantial evidence that well planned and taught fieldwork gave important opportunities to develop knowledge and skills which added value to classroom work. They also found that fieldwork could have a positive impact on long-term memory due to the nature of the outdoor settings and its impact on young people. O'Brien and Murray (2006 and 2007) in their study of children at Forest School found that through this approach the children gained an interest in woodlands and respect for the environment. As a result the children became eager to discover things for themselves and were motivated to learn (Bredekamp et al. 1992). Parents and teachers in this Forest School study identified that the children were able to transfer skills which they acquired to other settings. For example, changes were noticed in their vocabulary and descriptive language which they gained by learning the names of plants and developing the ability to describe what was around them.

A study by Hilmo and Holter (2004) explored how teachers remembered the outdoor education element of their teaching program and how they used it in their own teaching practice. They interviewed preschool teachers who stressed the importance of their practical exposure to outdoor nature study during their education. The preschools teachers suggested from their experience: (1) there were many activities that could be undertaken in nature; (2) children frequently experienced feelings of competence in nature spaces; and (3) children helped each other and this links to social competence.

Both as students and as preschool teachers, the participants emphasized the importance of being exposed to nature. After some years in the teaching profession, they emphasized even more explicitly the importance of being in nature as a method for the general healthy development of children and for developing specific competencies. The preschool teachers pointed to the fact that both common experiences and a huge diversity of experience are available in natural environments, and provide a solid basis for children's speech and personal development.

12.5.2 Self-Esteem and Social Skills

Lack of self esteem can be a precursor to depression and personality disorders (Marmot 2003; Mruk 2006). The review by Rickinson et al. (2004) found substantial evidence that adventure programs and school grounds/community projects positively impacted on young people's attitudes, beliefs and perceptions in terms of outcomes such as independence, self-esteem and confidence, control, self efficacy and coping strategies. In the school grounds/community projects the review found that young people gained a sense of responsibility and belonging from their outdoor learning.

Burls (2007a) found similar patterns of development in self-esteem for adults with mental health problems in a therapeutic learning project in London (see Box 12.5). These are discernable in many examples of current practice and in active projects related to green spaces. Participants can learn: (1) skills related to personal problem-solving, cooperation, communication; (2) to face personal challenges and changes; (3) to accept personal responsibility; and (4) to more accurately assess themselves and maintain a higher degree of control over their environment.

Dillon et al. (2005) found that teachers and pupils who engaged in outdoor learning experiences were aware of personal and social developments that arose from this engagement, such as increased confidence and self-esteem. Culter and Lleras-Muney (2007) tested the relationship between education and health through an analysis of the National Health Interview Survey in the United States. One of their findings was that educated individuals reported suffering less from anxiety and depression; they found this to be similar for men and women.

Much of outdoor learning involves working with others often as part of a team. O'Brien and Murray's (2007) focus on Forest School found that overall development of social skills was characterized by a more developed awareness by the children of the impact of their actions on others, for example, holding a branch so that it does not fly into another child's face. In a study of young people's interaction with natural heritage through outdoor learning, Mannion et al. (2006) found that young people valued outdoor learning that was fun and not inhibiting, and they particularly valued the interrelation of social aspects (being and working with others),

Box 12.5 An Ecotherapeutic Public Green Space in Britain

Aim/objective: 'Meanwhile Wildlife Garden' is a therapeutic garden and part of a larger public green space. It is a linear park, located in a built up urban area in London. The project is aimed at creating habitats for wildlife, promoting biodiversity in inner city areas, but it is also a resource for public mental health.

What happens at Meanwhile Wildlife Garden: The project focuses on adults with mental health problems. The activities carried out have pre-determined outcomes for both the persons involved and the natural space which is a therapeutic environment, but also an ecologically significant area. Ecological education and skills development are the central aims of the activities. Participants are not only 'stewards' of a natural resource, but they also provide a 'natural health service' for themselves and for the public, whilst learning new skills.

Outcomes: Participants develop a sense of self using all the senses and focusing on the whole person. They become included socially because they provide a service for their community. Other benefits include the increase in motor skills and stamina due to physical activities, literacy, social skills and ultimately new employment for participants.

Lessons learnt: The therapeutic input is woven through this by the use of experiential learning and self appraisal through guided reflection. This eventually leads to recovery of physical, social and mental health for people and ecological health for urban green spaces. The result is the achievement of ecohealth (Butler and Friel 2006).

the activity and the outdoor location. Social capital has been defined by Putnam (1995) and focuses on social networks having value, trust being important and people being inclined to help each other (known as norms of reciprocity). It has been posited that social capital may influence healthy behaviors, so that, for example, healthy norms of behavior such as physical activity are adopted. Nicol et al. (2007) in researching the views of young people, teachers, specialist providers and representatives of Local Authorities in Scotland, found that young people particularly valued experiences that allowed them to do something new, carry out activities that engaged with all the senses, be close to nature, undertake 'hands on' practical activity and be exposed to the effects of the weather. Bond (2009) draws on a range of research to outline how people's behaviors are influenced by other people, suggesting that social norms spread through friends and friends of friends. Watts (2004) argues that seeding local or small groups with certain ideas, e.g. healthy behavior, can lead to these having wider effects. Potentially this can occur through outdoor learning approaches in which individuals are influenced by the social norms of the group and instructors and teachers.

12.5.3 Attitudes and Behaviors

Changes in attitudes and behaviors can be realized through outdoor learning approaches. Rickinson et al. (2004) in their review of outdoor learning found that there were examples of outdoor programs such as adventure/wilderness programs leading to the promotion of positive behavior and improved physical self image and fitness. This potentially can lead to healthier lifestyles for young people. Dillon et al. (2005) in their report of the outdoor classroom in a rural context found that the outcomes of outdoor learning encompassed changes in attitudes and feelings, values and beliefs as well as activities or behaviors.

Children may become attached to particular spaces and develop specific interest in the environment through outdoor learning. The Chopwell Wood Health Project engaged children in northern England and four schools made four visits each to Chopwell Wood to take part in physical activities and learn about nutrition, healthy eating and stress reduction (O'Brien 2007). Interviews with teachers and parents revealed that children started to ask questions about whether their lunches had enough fruit and vegetables. The children's enthusiasm for the woods in this project and at Forest School's led to their parents taking their family to a woodland at the weekend. Sense of place encompasses physical settings, as well as human experience. The term is often used in relation to characteristics that make a place special or unique, and fosters a sense of human attachment and belonging. Sense of place derives from strong identity and character aspects that are often deeply felt by local inhabitants and visitors alike. Physical settings will impact on the range of meanings people ascribe to a place, while at the same time people bring their particular social and cultural experiences and incorporate these into their values and meanings for new places (Kahn and Kellert 2002; O'Brien 2007). Peacock (2006) found that pupils had an ongoing attachment to the

National Trust sites they got involved with through school and went back to the sites after their involvement in the scheme had ended, even after they had left school. Fostering a sense of place can directly influence the establishment of a strong sense of self.

Outdoor education activities can address the need for changing perceptions and attitudes of diverse cultural groups, or bring people of different ethnicities together. This can change the atmosphere of a nature space, encourage healthy social relationships between target groups and members of mainstream groups, and promote access by disadvantaged and socially excluded people. There can be dormant knowledge and skills within ethnic groups. Certain groups come from communities that use plants in everyday life and have practical skills in cultivation and care of the natural environment, which they can share with the wider community. The use of the environment for learning and healing can greatly benefit from an intercultural approach that also fosters exchange of skills, traditions and knowledge.

Nicol et al. (2007) found growing evidence that outdoor activities in natural environments promote health and well-being, but they argued that issues to do with health and physical activity have yet to be fully developed through outdoor education approaches. This is relevant with the notion of salutogenesis (Antonovsky, 1996) and stresses the importance of giving children the opportunity of developing habits in, and a love of, spending time in nature.

12.6 Discussion and Conclusions

In this chapter we have argued that outdoor learning in nature can lead to health and well-being benefits and outcomes through two potential mechanisms: (1) general exposure to nature, and (2) active 'hands on' learning approaches in nature. We suggest that different age groups and types of people in a range of countries can benefit. However the accumulation of any health and well-being benefits will depend on factors such as length of engagement through outdoor learning, the intensity of people's experience, what is being taught/learnt, and links that are made between what is learnt outdoors and other areas of people's lives.

Outdoor learning is a complement to indoor teaching and learning. The aim is to inspire lifelong learning through contact with natural settings, culture and society. Outdoor learning is a field of study that has potential and deserves support and research. At the same time it is important to be critical. It seems there is sometimes an assumption that learning and being outdoors is automatically beneficial. The aim is not to detract from the importance of indoor learning, but to argue for outdoor learning as a crucial complement to indoor learning. The arguments developed in this chapter highlight the importance of learning-out-of-doors and this in turn has implications for practitioners, policy makers and researchers. It is argued that outdoor education and learning can be important motivating factors in life long learning, health and well-being and in ecologically sustainable societies.

The increased interest from governmental, private and non-governmental organizations has heightened the demand for research on the educational use of natural and green spaces. Therefore it is important to stimulate both the quality and quantity of outdoor education and learning (Rickinson et al. 2004). Making outdoor teaching and learning a compulsory part of teachers' education could be one way to increase the quality and provision of outdoor learning in nature, woodlands and green spaces. Outdoor teaching is often dependent on the individual teacher (Limstrand 2003). Studies from Norway and Sweden indicate that teachers practicing *udeskole* (see Box 12.6) are devoted enthusiasts with personal experience in outdoor recreation (Ericsson 1999; Lunde 2000; Limstrand 2001). As Dahlgren and Szczepanski (1998) argue, outdoor education can be an important methodological tool that can make the intentions of curricula come alive, it can bring experiential, conceptual and theoretical knowledge together. However, the extent to which its importance is recognized differs between different countries and is often based on how culturally embedded contact with nature is from an early age within a particular country.

Another approach could be to establish support structures for citizens, schools and teachers. The political will of Local Authorities in providing support is seen as an important factor in the provision of outdoor learning. Spending time in nature is not always an obvious part of modern western culture, but people can be inspired to go outdoors. It is important that society creates possibilities for all: the disabled, the elderly, ethnic groups, and sedentary people. Research by Ward Thompson et al. (2008) highlights the importance of childhood use of green spaces, a strong relationship was found between frequent childhood visits to green spaces and the likelihood of using these spaces as an adult. Outdoor education approaches focusing on children

Box 12.6 *Udeskole* in Denmark

Aim/objective: *Udeskole* draws on a pupil-centered pedagogy which emphasizes direct experiences, experiential learning, and problem-based learning (Jordet 2007). The definition of *udeskole* is: 'Outdoor school is a way to teach, where parts of the everyday school life are moved outside to the nearby environment. Outdoor school gives the pupils possibilities to use all their senses, so they will have personal experiences of contact with nature. Outdoor school makes room for activities, spontaneous development and play'
What happens at Udeskole: A range of activities take place focused on practical and direct experience.
Outcomes: Although *Udeskole* is primarily focused on education and learning, there are specific health and well-being benefits in continuation with these outdoor activities. In a case study with a Danish nature class physical activity levels were measured with an accelerometer. The case study demonstrated a significantly higher bodily activity if combining in-and-outdoor learning settings. Outdoor teaching more than doubled the mean activity level of pupils compared to a normal school day.
Lessons learnt: Offers a multitude of learning opportunities.

and young people have the potential to instill an interest in accessing these spaces for activity throughout life.

It is also important to identify personal and organizational barriers to outdoor teaching. Improving access to nature might be another important opportunity for action. Cooperation between schools, teachers and local government and green space managers is one way of tackling problems of access.

The role of landscape planners and managers should not be underestimated. The green sector can support and assist the social, education and health sectors, so these sectors in cooperation can solve challenges in relation to outdoor learning. The examples outlined in this chapter show potential in the use of nearby nature.

There is a need for more research in relation to outdoor learning. Although teachers, parents and instructors have some evidence about the processes and impact of the outdoors on learning, and health and well-being there are few well documented longitudinal research projects. In spite of the increased interest and emerging body of knowledge there are still areas that need further investigation. The overall message of this chapter is that outdoor learning can have an important impact to make on society and on health and well-being of a range of people with differing needs, and on sustaining ecological systems.

In conclusion the following issues are of particular importance for taking forward outdoor education and learning.

12.6.1 Practice

- Training is important so that teachers with little experience of outdoor education can become more comfortable with teaching, and taking people outdoors.
- Re-establish nature in school grounds and play areas.
- Promote a feeling of being close to nature and a growing understanding of the concept of sustainable development through a range of European and International programs such as Eco-Schools.
- Promote the benefits of learning outdoors in nature which are many and include key elements such as:
  - Physical activity
  - Mental well-being
  - Social connectedness.

12.6.2 Policy

- Ensure, wherever possible, that everyone has access to the opportunity of learning outdoors.
- Improve links between schools, education establishments and those involved in outdoor learning.

- Acknowledge that support needs to be provided as it is a challenge to facilitate outdoor learning and develop opportunities for being out-of-doors for all children regardless of culture, ethnicity and ability/disability.
- Policy should communicate the outdoor learning that takes place and its importance to other wider policy agendas including health.
- Develop policies that acknowledge the importance of nearby woods and green spaces for outdoor education and learning and for health and well-being.

12.6.3 Research

- Attention needs to be given to the way in which specific outdoor activities contribute to learning.
- Attention needs to be given to the types of outdoor education and learning activities that can have an impact on health and well-being.
- Develop assessment data to explore the formation or changes in attitudes and values over the long term towards the natural environment.
- Gain a greater understanding of how to integrate outdoor learning with school curricula – preparation work, and follow up work after being outdoors.
- Lack of evaluation of learning outcomes as well as other personal and social development outcomes and health and well-being outcomes leaves the sector in a vulnerable position – unable to fully state the benefits of outdoor education. Therefore good evaluation and longitudinal research is needed to explore changes over time.
- Action research is needed to embed learning and good practice into everyday approaches.

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Part V
Forest and Health Policies and Economics

Chapter 13
Measuring Health Benefits of Green Space in Economic Terms

Ken Willis and Bob Crabtree

Abstract Health benefits attributable to green space include increased physical exercise resulting in reduced incidence of coronary heart disease, cerebrovascular illness (stroke), and colon cancer; psychological benefits from reduction in stress; and improved air quality resulting in a reduction in respiratory diseases. Reduction in mortality and morbidity due to improved physical exercise are quantified; and various economic methods to value preventable fatalities and diseases are outlined. The economic value of health benefits of a 1% reduction in the sedentary population is estimated; together with the health benefits of reduced air pollution due to trees. A major problem in the estimating economic benefits is linking green space to increased physical exercise of those in need of physical exercise to improve their health. Some policy conclusions are drawn on the location of green space to maximize health benefits.

13.1 Introduction

This chapter, which is a development of an earlier more detailed study by CJC Consulting (2005), assesses the extent to which health benefits associated with green space can be quantified in economic terms. Health benefits may include the opportunity for increased physical activity, the relief of psychological stress with an associated improvement of mental health; and a reduction in health problems associated with polluted air. These effects are examined separately and in each case the aim is to quantify the benefits so that these can be compared with the cost of provision. The provision costs include both investment to extend the resource

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through tree planting or open space creation, and investment to increase access and use of existing green space including organized health programs.

This systematic economic approach contrasts with a considerable volume of research based on associative effects. For example, Mitchell and Popham (2008) related mortality with exposure to green space in England. After removing income differences, they showed that death rates from all causes and from circulatory diseases were lower in groups with a higher exposure to green space. More greenery, especially in the area of residence, was associated with lower all-cause and circulatory disease mortality. Ellaway et al. (2005) found that higher levels of greenery and lower levels of graffiti and litter in residential environments are associated with being physically active and not overweight and obese. Residents in high 'greenery' environments were 3.3 times as likely to take frequent physical exercise as those in the lowest greenery category. In contrast Sugiyama et al. (2007) found that perceived neighborhood greenness was more strongly associated with mental than physical health.

However, such studies are limited because they do not explain the associations found and are subject to the confounding effects of green space 'quality' and variation in the social and economic characteristics of the population in different locations (e.g., Nielsen and Hansen 2007). Nor do they provide the basis for decisions regarding additional investment in green space.

13.2 Benefits from Physical Activity

The Department of Health (2004b) has reported on the evidence relating to physical activity and its impact on health. It estimates the cost of physical inactivity in England at £8.2 billion per year with an additional £2.5 billion cost for the inactivity element in obesity. The Public Health White Paper (Department of Health 2004a) has 'reducing obesity', 'increasing exercise' and 'improving mental health' as three of its six overarching priorities, and an action plan for physical activity (Department of Health 2005). The Department of Health (2004b) concentrates on the preventative effects of physical activity and concludes that 'for general health, a total of at least 30 min a day of at least moderate intensity physical activity on five or more days of the week reduces the risk of premature death from cardiovascular disease and some cancers. It is estimated that only around 37% of men and 25% of women currently achieve this level of activity in the UK (Joint Health Survey Unit 1999), and that 23% of men and 26% of women are sedentary (take less than one 30 min period of moderate activity per week) (POST 2001). Green spaces such as woodland with public access can increase the opportunities for people to engage in physical activity.

Research suggests that increased exercise would principally reduce the incidence of

- Coronary heart disease (CHD). Inactive people have nearly twice the risk of developing CHD than active people. Persuading sedentary people to take regular light exercise (e.g. walking) could reduce deaths from CHD by 14%.

- Cerebrovascular illness (stroke). Increasing physical activity could reduce the number of strokes by around 25%, although existing data are not conclusive regarding a relationship between physical activity and stroke (NCCDPHP 1999).
- Cancer. Physical exercise is associated with decreased risk of certain types of cancer. The risk of colon cancer is three times higher for sedentary people than it is amongst the most active members of the population.

The impact of obesity on Standardized Mortality Ratios (SMRs) for different age groups has been documented by Bender et al. (1999). No excess mortality was associated with a body mass index (BMI) of at least 25 but less than 32 for the 50–74 age group. But SMRs did increase significantly in higher BMI categories. So health benefits in terms of reduced mortality would flow to those taking additional physical activity who are moderately or severely obese, and who lose weight in addition to taking physical exercise.

13.3 Approach to the Economic Analysis of Health Benefits

Health benefits of green space can be measured using

- Cost effectiveness analysis (CEA): which assesses costs in relation to health effects measured in physical terms (e.g. number of deaths averted, and illness episodes avoided)
- Cost utility analysis (CUA): which assesses costs in relation to utility (rather than a money measure of benefit). The utility of a health improvement (on a scale of 0 = dead to 1 = perfect health) is often estimated by a standard reference gamble (SRG); or in terms of quality adjusted life years (QALYs). A QALY is a period of time in perfect health that is equivalent to a year in a state of ill health (see Sox et al. 1988; Drummond et al. 2005).
- Cost benefit analysis (CBA): which assesses health improvements in economic or monetary terms

This chapter concentrates on CBA. Early CBA studies adopted a 'human capital' approach to measure health benefits. The human capital approach to the value of avoidable illness and death is based on the notion that morbidity and premature death results in lost output to the economy from that individual. This opportunity cost approach can readily value lost output from the ill health and premature death of economically active people. But clearly under this approach there is no lost output from the preventable fatality of economically inactive people (e.g. children, housewives and those retired), since there is no reduction in recorded gross domestic product (GDP) by their death. However, non-working people provide some economic benefits e.g. child-care, housework, etc., but these benefits are not measured in the market. Moreover these people are willing-to-pay to avoid the risk of illness and premature death. These deficiencies rendered the human capital approach theoretically unappealing. Hence the human capital methodology has been replaced by an approach based upon the individual's willingness-to-pay (WTP) to avoid the risk of death or injury. This can be measured through

- Insurance: how much people are willing to pay to insure against a risk (Freeman and Kunreuther 1997)
- Hedonic wage model: estimating wage premiums for additional risks (Marin and Psacharopoulos 1982; Viscusi and Aldy 2003; Black and Kniesner 2003)
- Contingent valuation: asking people to state how much they are willing to pay for reducing or avoiding risk or conversely how much they are willing to pay for health improvements (Krupnick et al. 2002; Van Houtven et al. 2006).
- Choice experiments: in which individuals trade-off various health gains against a cost to them (Ryan and Skåtun 2004; Cameron et al. 2008).

Most recent studies have used contingent valuation and choice experiments to value people's WTP to reduce the risk of death and illness from various types of disease; and also to assess people's WTP for health improvements.

13.4 Quantifying the Health Benefits from Physical Activity

The health impact of increased physical activity is estimated as the proportion of a disease in the population that could be eliminated if increased physical activity were undertaken.

13.4.1 Reductions in Mortality

Studies investigating the impact of increased physical activity invariably use a population attributable fraction (PAF) to estimate the proportion of deaths, or other measure of disease burden, caused by a particular risk factor. PAF represents the proportion of a disease in the population that could be eliminated if the exposure were removed from the population. PAF is the number of actual deaths from disease *X,* minus the number of deaths from disease *X* if all people were regularly active, divided by number of actual deaths from disease *X*.

The impact of physical activity on deaths, and averted hospital admissions, depends upon the proportion of sedentary people in the population. Swales (2001) estimated the health impact of increased physical exercise in Northern Ireland (NI). He assumed 20% of the population was sedentary, which increased the risk of premature death or illness from CHD, stroke and colon cancer. On assumptions about the relative risk from lack of physical activity of CHD, stroke, and colon cancer, he estimated excess deaths due to physical inactivity to be 1,271 due to CHD, 709 due to stroke; and 82 due to colon cancer; or 2,062 in total. With a sedentary rate of 15% the respective excess deaths would have been 1,031, 600, and 65; or 1,696 in total. Since the proportion benefiting from the physical activity policy in NI (as elsewhere in the UK) is unknown, Swales assumed that the physical activity strategy in NI would reduce the sedentary population by 5% units from 20% to 15% of the population: a reduction in 366 deaths (= 2,062–1,696).

The calculation of excess deaths requires an estimate of PAF, and the relative risk (RR) for each disease. RR is subject to uncertainty: different studies have estimated different RRs for a specific disease. Moreover, the RR depends upon the 'with-without' perspective: how much physical exercise takes place to that which would occur in its absence, and without green space. For example, for colon cancer, US Department of Health and Human Services (1996) found different mean RRs depending upon the comparators often with fairly wide confidence intervals (CI): RR = 3.6 (95% CI: 1.3–9.8) for least active relative to most active at work and leisure; 1.8 (95% CI: 1.0–3.4) low activity relative to high (work and leisure); and for sedentary relative to active: 1.6 for men (95% CI: 1.1–2.4) and 2.00 for women (95% CI: 1.2–3.3). Some studies adjusted for one of more confounding factors such as age, sex, BMI (body mass index), smoking, diet (e.g. various factors such as energy intake, fiber, protein, fat, etc.) in the calculation of RR; other studies do not. Results also have wide statistical confidence intervals (CI). Thus, some uncertainty surrounds the RR rate to be adopted for CHD, stroke, and colon cancer.

We assume the only population benefiting is sedentary population; and that the colon cancer RR, for sedentary relative to active, is 1.6 (to account for the probability the population benefiting may not actually become fully 'active', but only become irregularly active). The RR of 1.6 is slightly lower than that used by Swales (2001) which was 1.8 for colon cancer; but higher than that employed in some American studies. A RR of 1.4 was used by Walker and Colman (2004) for colon cancer in a study of the cost of physical inactivity in Halifax, Nova Scotia. Swales (2001) used a RR of 2.0 for CHD and 3.0 for stroke. We also adopt a RR of 2.0 for CHD; but for stroke an RR of 1.4. The National Centre for Chronic Disease Prevention and Health Promotion (1999) concluded that because of different pathophysiologies, physical activity may not affect ischemic and hemorrhagic stroke in the same way. Thus the NCCDPHP report concluded that existing data do not unequivocally support an association between physical activity and the risk of stroke. Nevertheless some studies have revealed an inverse association between physical activity and stroke. A RR of 1.4 for stroke was also used by Walker and Colman (2004); whilst a stroke RR of 1.6 was used by Bricker et al. (2001) for physically and irregularly inactive population. There are no data on RR by age groups, so, following Swales (2001) the same RR from physical inactivity is applied for each age group respectively, for each disease.

PAF was calculated on the above RR for CHD, stroke, and colon cancer, with a sedentary rate of 23% for men and 26% for women. The number of avoidable deaths attributable to physical inactivity is estimated by multiplying the deaths attributable to each inactivity related disease by the PAF for that disease.

This analysis for the UK as a whole suggests that there are 12,055 male excess deaths from CHD attributable to lack of physical exercise (see Table 13.1), and 10,931 excess female deaths, or 22,992 excess deaths per year in total. Note that excess deaths increase with age, so that there are proportionately more excess deaths amongst older age groups.

Table 13.1 UK deaths by coronary heart disease: males and females

	All ages	<35	35–44	45–54	55–64	65–74	75+
Males							
Population	28,581,233	13,420,047	4,334,429	3,854,688	3,061,093	2,300,533	1,610,443
Deaths	64,473	131	950	3,376	8,035	16,426	35,555
Excess deaths	12,055	24	178	631	1,502	3,072	6,648
Females							
Population	30,207,961	13,255,941	4,442,961	3,921,713	3,157,716	2,635,541	2,794,089
Deaths	53,003	45	191	735	2,406	8,035	41,591
Excess deaths	10,937	9	39	152	496	1,658	8,582

National Statistics (2002) Census 2001: First results on population for England and Wales. The Stationery Office, London (for population). British Heart Foundation (2004) Statistics Database. www.heartstats.org (for deaths by cause, age, and sex) (reports data from the Office for National Statistics 2003). Deaths Registered by Cause and Area of Residence (personal communication); Scotland General Register Office (2003), Northern Ireland General Register Office (2003)

Analogous calculations for cerebrovascular illness (stroke) and colon cancer shows that there are; 6,093 excess deaths from strokes, and 2,069 for colon cancer, in addition to the 22,992 excess deaths from CHD due to inadequate physical activity.

13.4.2 Averted Deaths

How many of these deaths could be averted from increased physical activity from the provision of green spaces depends upon the extent to which green spaces induce physical activity amongst the sedentary population. Unfortunately research on the probability of exercising as a result of the provision of green space (e.g., Ellaway et al. 2005) needs to be extended before the effect on reducing the proportion of sedentary population can be reliably estimated. If green space reduced the sedentary proportion of the population from 23% to 22% for men, and from 26% to 25% for women, then it would have the effect of saving 1,063 lives in the UK that would otherwise have been lost as a result of CHD, stroke, and colon cancer (Table 13.2).

However, it is unlikely that the same proportion of people aged 75+ would either be capable of taking, or could be induced to undertake, the recommended amount of moderate physical exercise five times per week. Hence, following Swales (2001), we might arbitrarily exclude potential physical exercise benefits to these very elderly people. When this is done, a 1% unit decrease in the proportion of sedentary population saves only 343 lives from CHD, stroke and colon cancer. However, it is likely that some 75+ year old sedentary people could be encouraged to undertake increased levels of physical activity. A study by Brown et al. (2000) of different female age groups and activity levels, suggested that low-to-moderate levels of exercise are associated with a range of health benefits for women of all ages. Munro et al. (1997) also suggest from available evidence that physical activity for the over-65s is cost effective for the NHS.

Table 13.2 UK deaths averted by green space provision reducing sedentary population from 23% to 22% for males, and from 26% to 25% for females

	All ages	<35	35–44	45–54	55–64	65–74	75+
CHD							
Male lives saved	429	1	6	22	54	109	237
Female lives saved	336	0	1	5	15	51	264
Stroke							
Male lives saved	85	0	1	2	5	16	61
Female lives saved	138	0	1	2	4	13	118
Colon							
Male lives saved	41	0	1	2	7	12	19
Female lives saved	34	0	0	1	4	8	21
Total	1,063	1	10	34	89	209	720

13.4.3 Reductions in Morbidity

The incidence of CHD and stroke by age and sex are reported by the Office for National Statistics (2000) from a sample survey of 211 GP practices, with 1.4 million patients (2.6% of the population), in England and Wales (Table 13.3). The rates of CHD and stroke by age groups were applied to the UK population age distribution to derive estimates for the UK as a whole. These are presented in Table 13.3.

The same procedure was used to estimate excess morbidity, as that used to calculate excess mortality. It was assumed the same RR, prevalence or risk, and proportion of sedentary population moving from inactive to active would pertain for morbidity as for mortality. On this basis the excess morbidity cases (EMC) are those documented in Table13.3. If green space results in the proportion of the sedentary males and females in the population falling by 1% unit then this would have the effect of reducing morbidity cases in the UK by 14,414 for CHD and by 445 for stroke. Again, excluding those aged 75+ from the analysis reduces these estimates to 8,910 for CHD and 224 for stroke. A similar analysis for colon cancer indicates that a 1% decrease in the sedentary population would lead to 137 fewer cases.

13.5 Valuing Reduced Mortality and Morbidity

13.5.1 Reduced Mortality

The benefits and costs to society from avoidable illness and deaths include lost utility or WTP to avoid illness and death, plus non-pecuniary benefits and costs to family members and friends through avoided pain and suffering. WTP estimates of the value of a statistical life (VOSL) saved, i.e. the value of a preventable fatality (VPF), and estimates for the value of reduced incidence of illness, have been established in the UK and other countries.

The VPF was originally established in the UK in the mid 1980s when the human capital approach was replaced by a WTP approach to avoid the risk of death. Research by Jones-Lee et al. (1985) employed a contingent valuation (CV) method to assess the population's WTP for a small reduction in the (already small) probability of a traffic accident and the risk of death in such an accident. A significant number of WTP responses in the survey for the Jones-Lee et al. (1985) study were inconsistent or invariant to the size of the risk change; and the standard deviation of the mean WTP value was extremely large. Since that study, CV methodology has advanced considerably (see Bateman et al. 2002; Haab and McConnell 2002), and the application of this methodology would increase the accuracy and robustness of any new study. Nevertheless the approach and WTP value to avoid the risk of death was accepted by government and has been used ever since (with updating to reflect increases in gross domestic product (GDP)) to value preventable fatalities not only in transport but also, with suitable adjustment, in other sectors of the economy (H. M. Treasury 2009).

Table 13.3 Prevalence of coronary heart disease and stroke by age and sex (UK)

Age	0–34	35–44	45–54	55–64	65–74	75–84	85+	CR	ASR
CHD males									
Rate/1,000	0.1	4.9	30.2	94.5	184.0	230.5	233.8	42.0	37.2
No. cases	1,342	21,239	116,412	289,273	423,298	299,744	72,486		1,223,794
EMC	9	142	776	1,928	2,821	1,997	483		8,155
CHD females									
Rate/1,000	0.1	1.7	13.0	49.3	111.5	166.6	180.0	32.4	21.9
No. cases	1,325	7,553	50,982	155,675	293,863	329,879	146,524		985,802
EMC	8	48	324	988	1,866	2094	930		6,259
Stroke males									
Rate/1,000	0.2	0.5	1.2	3.5	8.1	16.3	20.5	2.3	2.0
No. cases	2,684	2,167	4,626	10,714	18,634	21,197	6,356		66,377
EMC	9	7	16	36	63	71	21		223
Stroke females									
Rate/1,000	0.2	0.4	0.9	2.0	5.4	11.3	20.4	2.2	1.4
No. cases	2,651	1,777	3,530	6,315	14,232	22,375	16,606		67,486
EMC	9	6	12	21	47	74	55		222

Office for National Statistics (2000) for rates; 2001 Population Census for age distribution. CR = crude rate (all ages); ASR = age standardised rate (all ages); EMC = excess morbidity cases. Number of cases and EMC are estimates

The VPF for road deaths used by Government is £1.312 million (third quarter 2003 prices). This includes human cost, lost output, and medical costs (Table 13.4). These values can be updated to current prices using the UK GDP deflator. (see http://www.hm-treasury.gov.uk/data_gdp_index.htm).

These values were derived in the road accident context. The VPF amount is applied to value avoided deaths in other contexts e.g. by the Health and Safety Executive (HSE) for work related deaths. The road accident VPF figure is weighted to reflect cognitive psychological aversion to different types of death associated with voluntariness of risk, immediacy, knowledge, control over risk, newness of risk, chronic-catastrophic, common-dread, severity of consequences. However, there is no agreement on how the basic VPF ought to be adjusted to reflect cognitive psychological aversions to different types of death. The HSE, Department of Environment, Food and Rural Affairs, Department for Transport, Home Office and HM Treasury jointly commissioned research by Chilton et al. (2002) to assess whether the VPF estimate was affected by differing dimensions of risk : the number (likely to be killed in a single event); personal control (how much personal control people have over risks); voluntariness (how much choice people have in being exposed to the risks); media-attention (how much media

Table 13.4 Value of preventable fatality, accidents, and illness

	Description	Values (2003 Q3 prices)
Fatality		£1,312,260
Injury: permanent incapacitating	Moderate severe pain for 1–4 weeks. Thereafter some pain, gradually reducing, but may reoccur when taking part in some activities. Some permanent restrictions to leisure and possibly some work activities	£207,200
Serious	Slight to moderate pain for 2–7 days. Thereafter some pain/discomfort for several weeks. Some restrictions to work and/or leisure activities for several weeks/months. After 3–4 months, return to normal health with no permanent disability	£20,500
Slight	Injury involving minor cuts and bruises with a quick and complete recovery	£300
Illness: permanently incapacitating illness	Same as for injury	£193,100
Other causes of illness	Over 1 week absence. No permanent health consequences	£2,300 + 180 per day of absence
Minor	Up to 1 week absence. No permanent health consequences	£530

Department of Transport (2004); Health and Safety Executive (2004). All values are average figures and include human cost, lost output, and medical costs. The difference between the values for a permanent incapacitating injury and a permanently incapacitating illness accounts for the large human cost attributed to injuries due to their short-term effect. The “human cost” (i.e. WTP) element for a fatality is £860,380. There may be some variation in these costs depending on the type of morbidity attention the risks receive); expert-knowledge (how much experts know about the risks); uneasiness (how uneasy people feel about the risks); number-per-year (the number of deaths per year resulting from each of the risks); age-groups-affected (the ages of people affected); and household benefit (the benefits of the safety programs to respondents and their households). The research revealed that trade-offs between preventing deaths in different hazard contexts were much less pronounced than had been thought (the VFP varied by less than 20% between the different contexts) (see Chilton et al. 2002).

So, can the values in Table 13.4 be used to value excess deaths and reduced illness by engaging in more physical activity? Values are likely to vary according to factors such as dread (of particular risk or type of death), voluntariness, and other factors listed above. Dread effects vary substantially by cause of death. For expected utility maximizers, Chilton et al. (2006) list these as pedestrian accident 1.0; accident in the home 0.81; automobile driver/passenger accident 1.67; train accident 8.65; fire in public place 5.80. However, the disutility of these dread effects is offset by a lower baseline risk for these activities (800 in 50 million for pedestrian; 40 in 50 million for rail accident; 30 in 50 million for fire in a public place). Unfortunately these dread effects are for accidents rather than death by diseases.

Cameron et al. (2008) used a choice experiment to investigate how individual WTP in the USA for health risks varied with the type of health threat. They estimated the value of a statistical illness profile (VSIP) i.e., the marginal utility of a series of health states (latency, illness years, and lost life years) in relation to the marginal utility of income. The VSIP for a one in 1 million reduction in the risk of a heart attack was much higher than for a similar traffic accident risk of sudden death. WTP to reduce cerebrovascular illness (stroke) was only three-quarters of that for heart disease; and WTP to reduce colon cancer risk was only half that for heart disease, for a person with an annual income of $42,000. The WTP values for risk reduction in all these diseases varied with latency of illness, illness time, and the age of the person (which reduced WTP).

A WTP study of residents in Ontario and the USA provided more evidence on the effect of age and baseline health on WTP for mortality risks. The study, by Alberini et al. (2004), found some support for the notion that WTP declines with age (as in the Cameron et al. 2008 study), but only for the very oldest residents. A 5 in 1,000 risk reduction resulted in a 25% reduction in WTP over the age 70. They found no support for the idea that people with chronic heart or lung conditions or cancer are willing-to-pay less to reduce the risk of dying than people without these illnesses. WTP should be higher the lower the chances of survival, and the greater the discounted value of lifetime utility. Older people with chronic diseases have lower chances of survival (so WTP↑), but fewer expected life years (value of lifetime utility) to look forward to (so WTP↓). The net result depends on which effect dominates. There is thus some controversy on the effect of age on WTP. This has implications for valuing the health effects of green space, depending on the age profile of users.

13.5.2 Reduced Morbidity

The economic costs of CHD are high. Liu et al. (2002) and the British Heart Foundation (2005) have estimated the cost of CHD at £7,055 million per year in 1999 prices. This comprises £1,730 million in terms of health care costs, and £5,325 million in terms of production and/or informal health care costs. However, £701.2 million of this was attributable to production loss due to mortality, and some of the health care costs will also be incurred on patients who subsequently do not survive. Inpatient care at £917.2 million, and medication at £582.4 million, comprised the two largest items of health care costs. Total medical costs (£1,730 million) divided by the number of CHD occurrences (2,209,596) is £783 per CHD patient. So, if green space induced a 1% unit reduction in the sedentary population this would save £11.28 million in medical costs per year associated with CHD; or £6.97 million (= 8,910 × £783) if people aged 75+ are excluded.

Increased physical activity will also induce reductions in productivity loss due to morbidity (estimated to be £2,207 million per year in 1999 prices) plus savings in informal care costs (estimated to be £2,416 million in 1999 prices). This amounts to (a mean of) some £2,903 per CHD incident. If it is assumed that green space results in 14,414 less CHD incidents, then the reduction in productivity and informal health care costs amounts to some £41.845 million per year; or £25.866 million (= 8,910 × £2,903) if the population aged 75+ is excluded.

The welfare value from improvements to health due to physical exercise is likely to be larger than the above estimates. The above estimates are based on costs incurred as a result of CHD, not people's WTP to avoid CHD. A more accurate estimate of the benefit of reduced morbidity from CHD would be obtained by mapping the value of people's WTP to avoid different degrees of severity of CHD.

The direct health care cost of stroke to the UK has been estimated to be £1,655 million (British Heart Foundation 2005). Dividing these medical costs by the number of stroke occurrences (133,863) gives a cost of £12,363 per stroke patient. This presumably reflects the longer care treatment time for stroke patients. There are no estimates for productivity costs and informal care costs for stroke, but these are also likely to be very substantial per patient compared to CHD costs. So, again, a 1% reduction in the sedentary population would save £5.5 million (= £12,363 × 445) in medical costs per year associated with stroke; or £2.769 million (= 224 × £12,363) if the population aged 75+ is excluded.

It has been estimated that the hospitalization costs of each colon cancer patient are £3,000 (Health First Europe 2005). There would be additional medical costs to the health service in terms of General Practitioner time and costs that might add say another £650 per patient. If so, this would suggest savings in medical costs of around £0.5 million for reduction in the prevalence of colon cancer.

The benefits of increased physical activity due to green space for CHD, stroke, and colon cancer, increase the probability of immediate survival. Unlike reductions in air pollution due to green space the effect of physical exercise on CHD, stroke, and colon cancer, is not to simply add 1, 2, or 3 months on to a person's life at the

Table 13.5 Annual value of health benefits from a 1% unit change in the sedentary population (£m) (UK)

	Mortality		Morbidity		Total	Total[b]
	Cases (no)	Cost (£m)	Cases (no)	Cost (£m)	Cost (£m)	
CHD	766	1,005.19	14,414	41.85	1,047.04	372.31
Stroke	223	292.63	445	[a]5.50	298.13	60.51
Colon cancer	74	97.12	137	[a]0.50	97.62	46.18
Total	1,063		14,996		1,442.79	479.00

[a]Indicates that costs are initial medical costs only and do not include long term treatment costs and more importantly lost output (wages) as a consequence of being partially or wholly incapacitated

[b]Total excluding those aged 75+ for CHD and stroke and 70+ for colon cancer

end of his/her life. It affects the probability of survival now. Hence the appropriate valuation approach is similar to the case for valuing mortality and morbidity as a result of road accidents.

Table 13.5 presents a summary of possible benefits of green space provision with respect to reductions in mortality and morbidity, assuming green space induced physical exercise such that proportion of the sedentary males and females in the population fell by 1% (from 23% to 22% for males; and from 26% to 25% for females).

The value ranges from £479 to £1,442 million per year depending on whether older people (75+) are excluded or included in the analysis. This range can be regarded as a minimum set of values for two reasons. First, for stroke and colon cancer morbidity the health value is for savings in medical costs only, and does not include other benefits such as reductions in lost working time (e.g. wages). Second, the morbidity benefits should be based upon people's WTP to avoid contracting these diseases. Typically such an approach to valuation produces higher estimates of benefits than simply counting medical costs saved and lost wages. Unfortunately due to a lack of information both on the severity distribution of the incidence of CHD, stroke, and colon cancer across the population, and information of people's WTP to avoid these different degrees of severity, it is not possible to operationalize this approach at the current time.

These benefits of increased physical activity are larger than those estimated by the Government Strategy Unit (2002). The 'Game Plan' estimated the total cost of physical inactivity in England to be £1.89 billion per year. This was based upon direct health care costs of physical inactivity, loss of earnings due to sickness absence, and earnings lost due to premature mortality. Set against these benefits were sports injury costs of £996 million per year, giving a net benefit of around £500 million per year from eliminating physical inactivity in England. The difference between the 'Game Plan' estimates and those in this report can be partly explained by the methodology adopted (estimates in this report are based on WTP to avoid the risk of death and illness, and these will be significantly greater than lost earnings), and geographical coverage (UK in this report compared with England in the 'Game Plan'). Note, we have not adjusted our benefit estimates for the costs of injury associated with the use of green space. Since the predominant activity is walking, these costs are expected to be relatively minor.

13.6 Psychological Benefits

Psychological health benefits from green space have been discussed in detail in Chapter 5. Here, we briefly review the literature in order to assess the extent to which benefits can be subjected to economic analysis.

Psychological benefits may be associated with physical activity (not included in the previous analysis) or related to the visual impact of green space. It includes benefits for significant psychological disease such as depression, as well as more subtle gains in vitality, general mental state, and experience of social inclusion, as found by in studies of housing projects in America (Kuo and Sullivan 2001a). Kaplan and Kaplan (1989) also developed a theory of green space having 'restorative' psychological benefit for many people, explaining the preference many people express for access to nature.

A more rigorous study was undertaken by van den Berg et al. (2003) in The Netherlands. Participants were rated for depression, tension and anger or a mood scale. Videotapes of four walks (street along a canal, street without a canal, woodland without water, woodland with water) were shown to 114 participants. Participants rated these four environments. They then completed a mental concentration test. Participants with higher levels of stress had higher preferences for natural environments and lower preferences for built environments; whilst the natural environments were associated with more positively toned changes in mood states and marginally better performance in concentration. Hartig et al. (2003) also analyzed psycho-physiological stress recovery and directed attention restoration in natural and urban field settings in California, using repeated measures of ambulatory blood pressure, emotion and attention collected from 112 randomly assigned young adults. Sitting in a room with tree views promoted a more rapid decline in diastolic blood pressure than sitting in a viewless room; and walking in a nature reserve promoted greater stress reduction than afforded by walking in urban surroundings.

Pretty et al. (2007) assessed the effect of green exercise on mental health using 263 participants. Data were gathered on six mood measures (anger, confusion, depression, fatigue, tension, and vigor) for each individual, and a total mood disturbance (TMD) score calculated. Participants engaged in an activity: walking, cycling, conservation, horse riding, boating, woodland activities, and fishing. Green exercise activity was more effective in reducing TMD and improving self-esteem following participation. However, the reduction in TMD scores following participation in the green exercise activities was similar for all of the ten case studies, irrespective of whether the activity occurred in a forest.

In the urban environment there is good evidence from a study of two housing areas in Greenwich, London (Guite et al. 2006) that the extent of access to green open spaces has a significant effect on scores for mental health and vitality. Dissatisfaction with the green space surrounding the block (particularly the absence of trees) was one of several elements in the local environment affecting mental health. One of the areas studied had been the subject of a design award when built in the 1980s but few residents liked it, in part because of a lack of attractive green space.

Trees are known to produce psychological benefits in terms of improving medical recovery rates (Ulrich 1984) and also in reducing crime (Kuo and Sullivan 2001b). There is also some evidence to suggest that woodland can be therapeutic in reducing anxiety and stress. Milligan and Bingley (2007) gathered evidence on this from young people, aged 16–21, using qualitative and psychotherapeutic techniques to facilitate access to memories, fantasies, and recalled multi-sensory awareness of the past. The study identified woodland as therapeutic for young people, but also found certain types of wooded areas (particularly those enclosed, dark and dense), as intimidating.

Viewing woodland and greenery seems to lead to a feeling of well-being thus aiding medical recovery rates; and to increase in levels of concentration, i.e. positive psychological benefits. There is evidence that the quality of the space proximate to where people live is important for their mental well-being. There are therefore positive effects both in recovery from mental health problems and as a prophylactic measure. The only negative impact is some evidence of negative psychological effects in some studies of woodland (e.g., Bullock 2008).

However, there are no data available that allow an economic analysis of the psychological benefits from green space. Neither the public's WTP to reduce the risk of psychological disease nor their WTP to increase the probability of recovery from mental health problems are known. Nor is it known how access to green space affects these probabilities. However, if green space does provide 'restorative' psychological benefits, but ones that cannot as yet be priced, there is only one economic conclusion that can be drawn: existing green space provides social benefits for the treatment and prevention of some psychological conditions where access is available at negligible cost. Where additional access or provision of green space is not cost-free it is not possible at present to quantify the benefits such that costs and benefits to society can be compared.

13.7 Cost and Benefits of Green Space Provision

To take the economic analysis further on the cost side it is necessary to differentiate between autonomous use of green space, which is cost free unless there is increased space provision, and use created through increased accessibility or health promotion programs, which requires investment.

13.7.1 Autonomous Use

Autonomous use that produces health benefits requires regular accessibility and this is self-evidently maximized by proximity of the green space to population centers. But the characteristics of green spaces are also important in determining the likelihood of positive health behavior.

There has been limited research on the effect of woodland and other green space on the probability of engaging in physical exercise of sufficient duration (30 min, 5 days per week) and intensity (e.g. brisk walking). Estimating such an effect would ideally need to take into account substitutes (alternative physical exercise opportunities available locally in urban areas – see Townshend and Lake 2009), distance to the wood or green space, attractiveness of the wood vis a vis alternatives, and any concerns about safety (of walking in a wood as distinct from say a suburban street). Factors confounding the relationship between physical activity and green space are the socio-economic composition of the population and self-selection. Wealthier more educated people, who tend to take more exercise, often live in areas with more green space or make more recreational visits to woodland. People who have a greater propensity to exercise may choose to live in neighborhoods that offer greater opportunities for exercise. These factors need to be standardized in any assessment of the impact of green space and woodland on physical activity.

Humpel et al. (2002) assessed 19 studies and concluded that physical environment factors (accessibility, opportunities and aesthetic attributes) had a significant association with physical activity. (Giles-Corti and Donovan 2002; Giles-Corti et al. 2005) used direct studies of behavior to assess the effect of attractiveness and accessibility of public open space on physical activity within the 408 km^2 of metropolitan Perth, Western Australia. Interviews were conducted with 1,803 adults, aged 18–59, on access to public open space and physical activity, specifically investigating the effect of distance, attractiveness, and size of public open space. 28.2% of respondents reported using public open space for physical activity. Those with good access to large, attractive open spaces, were 50% more likely to achieve high levels of walking. Attractiveness features which influenced use for walking were trees, water features, bird life and size and the absence of dedicated sports space.

In the USA, Cohen et al. (2006) studied 1,556 grade 6 girls who were randomly selected from six middle schools in each of six field site areas across the USA. The girls wore accelerometers for 6 days to measure metabolic equivalent–weighted moderate-to-vigorous physical activity, a measure accounting for the volume and intensity of activity. Each park within half a mile of an adolescent girl's home was associated with a 2.8% (17 min) increase in non-school moderate/vigorous physical activity per 6 days. Beyond half a mile each park increased moderate/vigorous physical activity by 1.1% of 6.7 min per 6 days. For the average girl with 3.5 parks within one mile of home, parks increased total non-school moderate/vigorous physical activity by 36.5 min per 6 days, or approximately 6%.

The above results together with those of Ellaway et al. (2005) and Wang et al. (2004) strongly suggest that attractive, accessible green space will be used to increase physical activity, and is thus likely to provide health benefits to the users. But not all studies reach this conclusion. Maas et al. (2008) investigated whether physical activity (with respect to walking and cycling during leisure time and for commuting purposes, sports and gardening) was related to the amount of green space, and whether there was a relationship between this and self-perceived health. The study covered 4,899 people; and the amount of green space within a 1-km and a 3-km radius around the postal code coordinates was calculated for each individual. Multivariate analyses found no relationship between the amount of green space in the living environment and whether or not people met Dutch public health recommendations for physical activity. Indeed, people with more green space in their living environment walked and cycled less often and fewer minutes during leisure time; although people with more green space spend more time gardening.

The most detailed attempt to value individual attributes of urban green space has been made by Bullock (2008). He used choice modeling to determine the values attributed to both existing and new (hypothetical) green spaces by households in Dublin. The preferences of respondents were for well-maintained areas with good facilities (paths, seating, trails, playgrounds etc.). There were consistent preferences for mixed open areas and trees but generally not for 'more wooded areas' unless these were areas that the residents were familiar with. The study strongly supports the benefits derived from scattered trees in mixed open areas but is less supportive of new urban and peri-urban woods.

The above studies suggest that improving the quality and accessibility of the physical environment can increase physical activity levels, although the amounts may be quite small. However, the health benefits of woodland and green space depend on the extent to which it results in sedentary individuals increasing their level of physical activity. This cannot be assessed by simply observing how many people use green space, since some of the users may not be in need of additional exercise or they may have substituted green space activity for activity elsewhere. It requires a controlled to monitor the location, duration and intensity of the physical activity. Of course, such a controlled trial may also be subject to a Hawthorne effect (McCartney et al. 2007).

13.7.2 Created Use Through Health Programs and Increased Access

A huge number of schemes have been developed in the UK and other countries in recent years to encourage people (and especially sedentary people) to become more active. Some, but not all, of the schemes are closely linked to the prescription of exercise by doctors. The outdoor schemes largely concentrate on walking. Natural England (2008) in conjunction with the National Heat Foundation has a large-scale scheme to encourage walking (*Walking the Way to Health*) with sites throughout England. In Scotland the Forestry Commission acting on a cost-benefit review of the public estate (CJC Consulting 2004) created a Woods In and Around Towns (WIAT) initiative to extend locally accessible woods (Forestry Commission 2010). This has health benefits as a key objective.

An example of one local medically-driven scheme is the Chopwell Wood Health project (CWHP) in the north of England (Powell 2005). The overall aim was to improve the health and well-being of local communities through use of a local woodland. The main health element was a doctor referral scheme for patients that would benefit from more physical activity (to cycle, walk, undertake T'ai Chi or carry out conservation work). There is evidence to suggest that participants in an intervention group were almost twice as likely to increase physical activity as a control group (without physical exercise encouragement) 6 months later, and 25% of the intervention group who received an information pack were regularly active 12 months later (Mutrie et al. 2002). Assuming physical activity saves between two and six lives per 1,000, the expected preventable fatalities from the first cohort of 12 participants who completed the CWHP will be between 0.024 and 0.072 lives saved. At £1.3 million per life saved the expected (capitalized) health value of the CWHP will be between £31,200 and £93,600 for mortality reductions. In addition there will be some expected savings in medical costs from morbidity and avoided production losses due to reduced absence from work from the other participants on the program. These net benefits might be expected to exceed the low costs of the health program which relies on largely autonomous use of existing local green space.

Nevertheless, health schemes using green space are very difficult to evaluate in cost-benefit terms because they rarely provide enough information, and are not established with suitable control procedures. Many of the participants in such schemes may already be taking adequate levels of physical activity or may substitute organized programs for previous autonomous use. In addition, they may not adhere to a program in the longer term. Health benefits at the margin will then be reduced. Anecdotal evidence from many schemes indicates that participants feel there are benefits in well-being but part of this may reflect the social and psychological benefits from increased social contact (Maas et al. 2008).

Whilst a cost-benefit framework can be used to appraise investment in new or improved green space, estimating the probability that a sedentary person will use the green space for at least moderate physical activity for at least 30 min on 5 or more days per week is not well documented. Table 13.5 indicates a benefit of £1,442.79 million per year for a 1% unit shift in the UK sedentary population, which is £2,423 per person (if the oldest age group is excluded this reduces to £804.4). Using the £2,423 per year social benefit obtained by shifting a person from sedentary to active status, the net benefit per year (B, £) from an investment in green space and any associated health programs can be summarized as:

$$B = R(p_1 + p_2) * 2{,}423 - (c_p + c_h)$$

where:
R = the size of the target sedentary population
p_1 = the probability of autonomous use such that the guidelines are reached

p_2 = the probability of health program uptake such that the guidelines are reached (created use)
C_p = the cost of the new green space provision (£ per year)
C_h = the cost of the health program (£ per year)

This benefit estimate excludes any psychological health benefit. It is also partial because there may be substantial benefits to the active population reflected in their WTP for access to green space which are additional to these health effects.

In relation to applying the equation, provision costs are relatively simple to estimate but quantifying the probability that sedentary people will achieve active status through green space investment is not. Much would depend on the size and location of the green space and its attractiveness for walking and whether it linked to other areas to provide longer linear walks (Giles-Corti et al. 2005). The 1% reduction in the sedentary population (an implied probability of 0.038–0.043, Table 13.2) is not easily achieved and would be demanding for most additional green space. This is an area in which more carefully controlled research is clearly needed so that guideline estimates for different contexts become available.

A lack of data on uptake probabilities limited the NICE (2006) assessment of the cost-effectiveness of outdoor health (walking and cycling) programs. They concluded that "evidence for the effectiveness of community-based walking and cycling programs in increasing physical activity is equivocal." However, they did find that other brief intervention in primary care and exercise referral (e.g. exercise in gyms) was cost effective. The cases reviewed, however, were those where the participants increased exercise as part of treatment for medical conditions.

Improved access to existing green space is likely to be much less costly than the creation of new space. In the case of woodlands, new planting takes many years before benefits are fully realized and an emphasis on making existing woods more accessible and attractive has clear merit. Where government has transferred access rights to the public on previous private land such as open land and the coastline in England, cost-benefit analysis has underpinned the prior appraisal (Entec UK 1999; Asken 2007). Such studies find difficulty in incorporating the health benefits from improved access because the extent to which the access will increase the activity levels of the sedentary population is unclear.

13.8 Air Pollution Benefits

Trees, woodland, and to a less extent other green space, reduce air pollution, and thereby reduce the incidence of diseases exacerbated by air borne pollutants. This section only assesses the impact of trees, since trees are by far the most important element of green space for absorbing air pollutants.

Trees improve air quality by

- Absorbing gaseous pollutants such as nitrogen dioxide (NO_2), sulphur dioxide (SO_2), and ozone (O_3)

- Intercepting particulate matter (PM) such as dust, pollen, and smoke
- Releasing oxygen (O_2) through photosynthesis
- Transpiring water and shading surfaces, thus lowering local air temperatures, thereby reducing O_3 levels (McPherson et al. 1999; Vargas et al. 2007)

The air quality improvement effect of trees is proportionately greater in urban than rural areas per unit area of trees, since in urban areas trees are closer to sources of air pollution, and because woodland around urban areas is smaller and more fragmented there are greater edge effects. Trees at the edge of woods capture more pollutants than those in the middle of forests. By providing shade urban trees can also with suitable planting reduce summertime electricity consumption and reduce carbon emissions from summertime electricity use (Donovan and Butry 2009).

13.8.1 Air Pollution Adsorption Effect of Trees

Trees are effective in removing NO_2, SO_2, O_3 and particulate matter (e.g., PM_{10}), from the air. Trees also remove carbon dioxide (CO_2) from the atmosphere. Since CO_2 is a greenhouse gas, the non-market benefit of CO_2 removal is mainly in terms of the value of carbon sequestration in reducing global warming. The layered canopy structure of trees, which has evolved to maximize photosynthesis and the uptake of carbon dioxide, provides a surface area of between two and twelve times greater than the land areas they cover (Broadmeadow and Freer-Smith 1996).

Particulate matter is captured through deposition on leaf and bark surfaces and this is the main dry absorption route. The process of dry deposition is complex, depending upon tree type. Deposition varies depending on the density of the foliage, leaf form, tree spacing and surface topography. Particulate capture occurs when an air stream is disrupted as it passes the aerodynamically rough plant surfaces, while the particle continues in a straight line and strikes the obstacle, either through direct interception or electrostatic attraction. Retention can be helped by rough, pubescent, moist and/or sticky surfaces. Beckett et al. (1998) found evidence that increased stickiness of surface particularly facilitates greater coarser particle capture, while surface roughness has a greater influence on the uptake of finer particles. Some particles may be absorbed into the tree but most are retained on the plant surface. Some particles will be re-suspended, but others will be washed off (particularly soluble particulates) or fall with leaves or twig fall. Re-suspension of fine particulates is less likely as they are easier embedded within the leaf boundary layer (Beckett et al. 2000b).

Tree types vary in their ability to capture air pollutants. Beckett et al. (2000b) found that coniferous species captured more air borne particles than did broad-leaved trees, with pines capturing significantly more material than cypresses. They also found that trees situated close to a busy road captured significantly more material from the largest particle size than trees situated at a rural background site. However, Beckett et al. (2000a) found little variation between the urban (park site in Brighton) and more rural site (situated on the outskirts of Brighton on the South

Downs) in the weight of particles from the two smallest particle size fractions (i.e. the particulate matter sizes most damaging to human health). Cavanagh and Clemons (2006) point out that theoretically greater deposition should occur over coniferous woodland due to a typically larger leaf surface area of pines (e.g., pine has 479 g foliage per m^2 of ground area, whilst oak has 106 g foliage per m^3 ground area). Dochinger (1980) found coniferous forests were more effective in removing particles than deciduous forests. Bark captures more particles per square meter than leaves. However, leaf area is greater than bark surface (6 m^2 leaf area per m^2 ground compared to 1.7 m^2 bark).

Some trees emit volatile organic compounds (VOCs). Rates of emission depend on tree species. These VOCs can contribute to the formation of secondary pollutants such as ozone (O_3) peroxyacetyl nitrate (PAN) and secondary particulates following the reaction with oxides of nitrate in sunlight. Urban Tree Air Quality Scores (UTAQS) can be calculated taking into account positive and negative changes in O_3, NO_2, HNO_3, NO, and PAN. Stewart et al. (2002), using O_3 to represent all air pollutants, found that trees with the greatest capacity to improve air quality were ash, common alder, field maple, larch, Norway maple, Scots pine, and silver birch. By contrast, crack willow, English oak, poplar, sessile oak, and white willow are trees that have the potential to worsen air quality. A subsequent study including more pollutants (O_3, No_2, HNO_3, NO, and PAN) confirmed this, with pine (Austrian, Corsican and Maritime), larch, silver birch and Norway maple having the greatest potential to improve air quality, whilst English oak, white willow, crack willow, aspen (*Populus tremula*), sessile oak, red oak, can worsen downwind air quality if planted in large numbers (Donovan et al. 2005). A simulation in the West Midlands metropolitan area, assuming existing woodland cover plus 20% for each tree species in turn found that some species (oaks, willows, and poplars) could be detrimental to air quality during stagnant summer time conditions. Species most likely to improve air quality were alder, field maple, hawthorn, larch, laurel, Lawson cypress, Norway maple, pine and silver birch.

13.8.2 Epidemiological Impact

Air borne pollutants, principally particulate matter of 10 μm (PM_{10}) or less, NO_2, SO_2, and O_3, affect lungs and exacerbate respiratory and heart diseases, and PM_{10} may carry carcinogenic compounds into the lungs. Research has focused on PM_{10}, but the finer fractions such as $PM_{2.5}$ and $PM_{1.0}$ are becoming recognized in terms of health effects. Particles are carried into the lungs where they can cause inflammation and a worsening of the condition of people with heart and lung diseases. Moderate concentrations of SO_2 can result in reduced lung function particularly in people suffering from asthma. Higher SO_2 levels result in tightness in the chest and coughing, requiring medical attention and/or hospital admission. O_3 irritates the airways of the lungs, increasing the symptoms of those suffering from asthma and lung diseases. These health impacts can be compounded when SO_2, PM_{10} and other air pollutant concentrations are all high.

The finer particles $PM_{2.5}$ (between 2.5 and 10 μm in diameter) originate primarily from fuel combustion and are so small that they stay in the air for long periods. Air borne concentrations of PM_{10} are higher in urban areas due to increase automobile wind disturbance and eddies formed around buildings. PM_{10} fall out near the point source, while $PM_{2.5}$ tends to remain air borne. Trees near urban areas therefore tend to capture PM_{10} rather than $PM_{2.5}$. Because $PM_{2.5}$ tends to be dispersed more than PM_{10} trees are less effective in capturing these particles (e.g. relative to rainfall). For example, in a study of trees in Oakville (Canada), the urban forest, of 1.9 million trees, filtered all of the local industrial and commercial emissions of particulate matter (PM_{10}) but only 7% of $PM_{2.5}$. However, epidemiological effects of $PM_{2.5}$ can be dangerous because their smaller size permits them to penetrate the lower lung.

The epidemiological impact of air pollution absorption by trees is difficult to estimate. It requires the matching of exposure to air pollution with morbidity and mortality effects attributable to air pollution. Estimates are typically based on cross sectional studies, relating spatial variations in air quality to morbidity and mortality effects from respiratory illnesses. However, there are lagged effects in the relationship; variations in meteorological conditions; substantial coupling between different pollutants making it difficult to separate out the effect of any one pollutant; differences in people's exposure to air pollution over their lifetime; and different genetic and behavior patterns.

Nevertheless, it has been estimated that small particular matter of less than 10 μm ($<PM_{10}$), SO_2, and O_3 contribute most to increased mortality and respiratory hospital admissions. For PM_{10} the Department of Health (1999) estimated that deaths brought forward increased by 0.75% per 10 $\mu g/m^3$ (24 h mean) and respiratory hospital admissions increased by 0.80% per 10 $\mu g/m^3$ (24 h mean). Respective rates for SO_2 were +0.60% and +0.50% per 10 $\mu g/m^3$ (24 h mean); and for O_3 +0.60% and +0.70% per 10 $\mu g/m^3$ (8 h mean). Mortality and respiratory hospital admissions increase with age of the population.

13.8.3 Health Benefits

The health benefits of improvements in air pollution comprise reductions in deaths and illness, and reductions in medical costs. Medical costs are the easiest to measure. The benefits of reductions in deaths and illness are more difficult to measure for a number of reasons. First, air pollution reduction mainly results in delay in death of people who already suffer from respiratory illnesses. There is considerable uncertainty about the extent to which air pollution reduction will increase the months or years of life of people who are already ill. Second, the value of a preventable fatality (VPF) (see above) is based on people's WTP to marginally reduce an already small probability of death. However, this value is that for the 'average citizen', whose life is cut short by, on average, many years due to un unforeseen accident. In contrast, deaths attributable to air borne pollution tend to be older people whose life is cut short by a few months. A lower value of life therefore tends to be used to account for this difference.

Moreover, in terms of morbidity it is argued that a reduction in air pollution may only marginally improve the quality of life for someone who is already seriously ill with respiratory problems: again suggesting a lower value for WTP for an improvement. On the other hand, WTP to avoid a particular risk can vary with the risk, e.g., type of health effect (lingering or sudden), risk context (voluntary or involuntary), attitude to risk (younger people are less averse to risk), etc. The Department of Health (1999) therefore modified the Department for Transport's VPF to take these other factors into account. They adjusted the road VPF of £847,580 (1996 prices) to an air pollution risk context value of £2 million. This value was then modified for other factors such as age, impaired health state, latency, etc. The Department of Health (1999) estimated that the WTP for a small reduction in risk per death brought forward had an upper-bound of £1.4 million and a lower-bound of £32,000–110,000 for 1 year, and £2,600–9,200 for 1 month delay in the probability of death from air pollution.

The benefits of reduced morbidity comprise reductions in public costs e.g. cost to health provision (NHS); private costs to households e.g. for medicines, etc.; lost output of people prevented from working due to ill-health; welfare costs (reflecting on the pain and discomfort of illness). The Department of Health (1999) estimated NHS costs of £1,400–2,500 for a respiratory hospital admission; and about £1,500–1,700 for a cardiovascular admission. No estimates were provided for private costs and lost output. Lost output would be small, and indeed zero for those >65 who were retired. However, the Department of Health (1999) report did not mention that there would be some lost 'black economy' output as a consequence of the illness of these individuals (loss of casual part-time jobs, inability to undertake own home improvement jobs, loss of services e.g. in terms of looking after grand-children, etc.). These might amount to 10% of wage rate individual obtained whilst in employment.

Department of Health (1999) assumed an 11 day average hospital admission and a change in the quality of well-being (QWB) score from 0.6–0.47 [on a scale of 1 = normal and 0 = dead]. This produced a cost of £170–735 (at 1996 prices), or an estimated cost for a hospital admission avoided of about £530 (updated to 2002). On the basis of these figures, Powe and Willis (2004) calculated the air pollution absorption of woodland (>2 ha) in Britain reduced the number of deaths brought forward by five to seven per year and hospital admissions by four to six. This suggests the benefits of air pollution absorption by woodland >2 ha is some £900,000 per year. However, the health benefits from air pollution absorption within smaller woodlands (<2 ha), not included within the Powe and Willis (2004) study, might be much greater. Many of these woods and trees are located closer to urban populations, closer to sources of pollution, and with larger edge effects, and will have a proportionately greater air pollution capture effect, per unit area, than that for larger blocks of forest located at distance from urban areas.

There is some debate about the amount by which latency and an impaired health state reduces WTP to reduce risk. In a recent contingent valuation study in Italy on WTP for reductions in the risk of dying from cardiovascular and respiratory causes, the most important causes of premature mortality during heat waves and air pollution episodes, Alberini and Chaibai (2007) found that older individuals were willing to pay less for a given risk reduction than younger individuals: persons 60–69 and persons aged >70 had WTP amounts 58% and 41% of those aged 30–59. They also found that persons with cardiovascular problems were willing to pay, *ceteris paribus*, about 45% more than persons in better health. The latter finding goes against the use of QALY measures, as used in the Department of Health (1999) estimates, which discount the value of lives saved and the value of extended lifetimes, of persons in poor health, from improvements in air quality. Thus the health benefits of woodland and green space may be much greater than that indicated by the Department of Health's approach to estimating the health benefits of air quality improvement.

13.8.4 Woodland and Green Space Location

Woods which are located close to the source of pollution capture more pollutants than those located at greater distance. Trees at the edge of woods and forests capture more pollutants than those in the middle of forests. Thus urban trees characterized by rows of single trees, small clusters of trees, and small urban woods, are particularly effective in capturing air borne pollutants.

Higher estimates have been suggested for urban areas. Stewart et al. (2002) estimated that doubling the number of trees in the West Midlands could reduce excess deaths due to particulates by up to 140 per year. The West Midlands air pollution absorption model (McDonald et al. 2007) indicated that increasing total tree cover in the West Midlands from 3.7% to 16.5% reduces average primary PM_{10} concentrations by 10% from 2.3 to 2.1 μg/m^{-3} whilst in Glasgow increasing tree cover from 3.6% to 8% reduces PM_{10} concentrations by 2%.

Unfortunately the study by McDonald et al. (2007) did not estimate what alternative measures would reduce PM_{10} values by an equivalent amount to that which could be achieved by tree planting in the West Midlands and Glasgow conurbation. An interesting research project would be to compare the cost of achieving a reduction in PM_{10} through woodland planting compared with the economic cost of achieving an equivalent reduction by some alterative means e.g. restricting vehicle usage in these urban areas.

The results of the Powe and Willis (2004) and McDonald et al. (2007) appear to conflict. The former underestimates (probably substantially) the excess deaths from reduced air pollution because they only included 2 ha woodland blocks within a 1 km^2 block. The latter group used much more detailed information on small groups of trees of less than 2 ha and the location was urban. But their method of estimating excess deaths was less precise and may have overestimated the impact.

13.9 Conclusions

The health benefits from increased physical activity of sedentary people can be measured in economic terms. The annual value of decreased morbidity and mortality from a 1% unit reduction in the percentage of sedentary people in the UK was estimated at £1.44 billion (a mean of £2,423 per additional active person per year). This figure is reduced to £479 million if older people are excluded. Seventy percent of the benefit was related to reduced mortality from CHD.

There is evidence for psychological benefits in both recovery from, and prevention of, mental illness but there is a lack of quantitative information on which an economic analysis of these effects can be based.

The net benefit from additional green space provision or programs to increase physical activity on existing green space depends on provision costs and success in changing sedentary behavior over the long term.

Green space can provide health benefits from the absorption of pollutants when green space is suitably located. However, there is disagreement between studies in the size of the benefits and more detailed research is needed.

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Chapter 14
Postscript: Landscapes and Health as Representations of Cultural Diversity

Klaus Seeland

14.1 Introduction

Cultures are reflected by their varying representations in landscape and perception of nature. The perception and acceptance of shaping the landscape as spaces according to social needs and preferences in urban and in rural areas are important dimensions of identification and health and well-being of the population inhabiting these spaces for long. Wherever human beings live, they appropriate nature as culture (Seeland 1997), i.e. they are inevitably shaping landscapes in developing their own culture. This process is a practical and symbolical one. These perceptions, beliefs and values find their material and immaterial expressions in planning and preferences for certain elements such as forests, parks, or open landscapes. In processes of encoding and enciphering culture into landscape and its re-modelling from time to time due to new ideas and demands of its use and management. In order to understand these cultural key concepts, they have to be read and interpreted. Landscapes are thus representations of entire life-worlds and each of these cultural views reveals that natural surroundings can only be understood by deciphering the social essence which is represented in them. Therefore it requires keys to read and understand the various cultural landscapes of the world.

Landscapes are phenomena that include the natural, the social and the built environment in a state of constant shaping and re-shaping. They are dynamic configurations of many interests and actors working on and in them as a space in which political power and economic development aspirations matter. For instance, the transformation of pristine nature into agricultural land or the transformation of arable land into construction sites in the wake of the enlargement of the built environment through rapid urbanization are a representation of socio-cultural changes in the respective landscape. This happens within a range of cultural and biological diversity and the climatic limits of a distinct geographical region.

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Landscapes indicate as well the political history and the material culture of a region. They represent the economic potential as well as the cultural character of their inhabitants, their humour, aesthetic taste and preferred life-styles. The assessment of these elements as core themes in landscape planning is fundamental to meet the expectations of various cultural groups and sections of the society in the future.

14.2 Landscapes and the Challenges of Modern Life Styles

Landscape aesthetics represent the cultural values of a region's residents and their economy and political institutions at a given time (Sheppard and Harshaw 2000). It generally depends on how people do actively interact with particular landscapes and whether the respective landscape is embedded into their social activities or vice versa. Perceiving landscapes as cultural metaphor for regional and national identity means, for instance, that lakes, mountains, forests, cities etc. make up a unique blend. High standards of publicly appreciated landscape beauty represent a high standard of emotional and cultural attachment that becomes visible in the landscape.

Plachter (1995) argues that there is no common ground of understanding of what a particular landscape means to whom. Just for the same reason one could say, landscape always remains something opaque which is impossible to grasp as there is a multitude of cultures and cultural legacies to be found in a larger space. A landscape reflects the social diversity in a common and thus unifying space. Social and distinct cultural values and aesthetics are exposed in landmarks of intrinsic quality which are reflected in the mood of the landscape and the impact it has on people, in which social norms of what is generally accepted and flavoured by local characteristics have shaped a visible whole. Any landscape is therefore a socio-cultural definition, a process by which diverse landscape phenomena are related to phenomena of a particular human life style and a code of conduct which perceive these phenomena as natural.

14.3 Close-to-Nature Landscapes as Cultural Constructions

Landscapes are social and cultural interpretations of nature and constructions of the human mind to define the position of human beings and their social institutions towards it. In this sense a landscape always denotes a social relationship between the landscape and the inhabitants. Such as the peasant has "his landscape" in mind when talking about landscape in general and the ecologist and the green activist may have an imagination of how it was or should be for future generations: landscape is the experience of surroundings which may physically be the same but are perceived by people in a different way. There are short-term and long-term aspects in every landscape which are more or less prone to change within the live-time of three or four generations living together in the same era.

Where industrial mass production pushes aside small farmers and artisans, where city-life-styles become usual phenomena, wherever the insignia of civilisation spread, nature is claimed to be threatened and vanish. Technical progress, and this point of view is almost taken for granted, goes along with phenomena of de-naturalisation of the environment. The more the living standard improves, and this has as well since long become a common sense notion, the more polluted and the poorer in biodiversity nature becomes.

What does cultural construction mean in this context? Similar to societal change, which denotes the totality of continuous social action and development, cultural construction means the confirmation of what is generally claimed as cultural reality by all those who participate in public everyday life, being taken as representative for their culture. Norms such as aesthetics in nature and cultural heritage conservation are agreed upon in laws and regulations, referring to tradition and social conventions. These norms are based on assumptions and implicit meanings which are taken for granted. It can thus be widely taken for generally accepted today in economically advanced societies that closeness to nature is a common value in almost any modern industrial society in the world, whereas anything being far from nature or natural is perceived as less desirable. Whether they are productive or protected landscapes, whether they are managed or not, they have to look as if they were natural landscapes.

14.4 Culture, Recreation and Health and Well-Being

The strong and still increasing trend towards urbanisation meets the challenge to link urban upper middle class notions of what is perceived to be an appropriate life-style pattern for themselves with the amenities of high value peri-urban recreation areas, with a variety of sports facilities and entertainment parks, country restaurants etc. Good health and beauty is an important nexus between one's own body and mind and the spa landscape reflects this and promises to provide these values to its visitors. These values are communicated very much among the peer groups of the same or similar social strata and are important criteria for one's social self-esteem and an indicator to define one's social rank in society.

The regional identity and community ties are also derived from landscape characteristics providing those who live there with advantages (i.e. more sunny days, marvellous view, less noise, less smog or fog etc.) and respective admiration by others who live in less favoured areas. The prominent position of certain landscapes in comparison to others is a quality-of-life standard of high value. The fact that there is a socially relevant ranking of landscape qualities underlines the importance of perceptions and cultural preferences related to them in landscape planning. For the low and middle class sections of society who cannot afford housing sites in a predominantly green sub-urban or peri-urban location, cultural diversity of the landscape matters substantially for their health and recreation. A recreation landscape therefore is a macro-economic benefit to the whole society as it potentially contributes to the maintenance of a good health status of the population and thus helps to reduce costs in the health sector.

14.5 Landscape and Diversity

Landscapes are principally characterized both by cultural diversity and biodiversity of its flora and fauna, by their smell, light intensity and sound and always unique configurations of this diversity. As similar landscapes may ever look, they are never the same. In an era of globalization where international standards of technology and consumer taste tend to prevail, diversity has become a rare quality and uniqueness a value in itself. Cultural diversity is a distinct configuration of cultural patterns which are designed purposively different from those of other cultures (Benedict 1989) with respect to the place where they are located. As geographical places are themselves distinct, cultures are likewise distinct from each other. Yet, assimilation and acculturation have been and are still happening ever since. To maintain cultural diversity is an even more delicate undertaking in a globalized world than it was in previous times of little or sporadic communication between cultures living in isolated places. Cultural identity is distinction from patterns of other cultures but also a response to the conditions of a unique place or habitat. As more cultures can inhabit one habitat but respond to it in culturally distinct ways, the question arises what makes cultures distinct from each other if it is not their habitat? This question has been discussed and was disputed for generations in environmental sciences (Milton 1996, p 106) Floating between environmental and cultural determinism, and finally uniting both approaches, this discourse of what is adapting to what has never really succeeded to solve this theoretical problem. The most convincing answer to this question is that cultures perceive, interpret and understand a landscape in different ways. May the physical facts of a landscape remain identical, their meaning and emotional qualities are differently perceived according to the cultural background on which they are reflected.

14.6 Cultural Diversity and Healthy Landscapes

Landscapes are ubiquitous phenomena. There is no place in the world without landscape. Analogous to this fact, health is a ubiquitous demand of humankind ever since and anywhere in the world. In the wake of a rapid urbanization throughout the world, no matter in whatever culture, green and healthy surroundings in an urban environment will become scarcer and less affordable for the urban masses. Linked to urban centres healthy surroundings are a luxury product and well-being cannot easily be satisfied by access to healthy but remote landscapes as the metropolises and the mega cities are more of cityscapes than landscapes. Indoor oriented lifestyles and escape into the cyber-world of the electronic media and online realities will sooner or later dominate technologically advanced societies.

Landscapes outside the big cities are visited on weekends or on holidays by the city dwellers and the countryside is a metaphor of a romantic but no more authentic lifestyle for them. Landscapes are visited like open-air museums or sanatoriums by city dwellers. But what happens to the knowledge and wisdom, not to speak of the symbolic cultural value encoded in the landscapes that have become or are truly exotic in due course of time? Will nature and landscape education, i.e. to learn how to 'read' and interpret a landscape, follow environmental education one day? The alienation of post-industrial society from nature and landscape and their inherent meanings, which are more than health benefits and recreation, will then become a threat to culture itself. A society that cannot understand the meaning of its landscape anymore has lost its cultural legacy and no message in this respect to the future generations. Then the landscape will have become a remembered landscape and will be preserved at a stage of an era when society had withdrawn from using it actively and make a living from it. Landscape management will then be a realm of conservationists and either it will turn into a planned wilderness or maintained as a society's 'garden' with a substantial financial input, where landscape gardeners manage the aesthetic imagination of the past and not a primary productive sector as it was ever since.

In landscape architecture and therapy research landscapes and gardens have been found to have health properties and can be efficiently used for various forms of therapy (Burnett 1997; Gerlach-Spriggs et al. 1998; Sachs 2003; Tyson 1998; Ulrich 1979, 1986). Little attention, however, has hitherto been given by scientists as well as by administrators to the cultural dimension of landscapes and gardens which is an inherent quality, but has to be made explicit to assess the role of culture in landscape design and planning. The interconnectedness between plants, animals and humans is a constituent in the development of any culture and thus also a part of the medical history before and still after the advent of allopathic medicine.

The same phenomenon, according to recent research, applies to the healing properties of landscapes that are related to cultural perceptions and interpretations of their inherent healing potential for stress (Grahn and Stigsdotter 2003), Alzheimer disease, burnout syndrome, dementia, disabled, and elderly people in general. Comparative epidemiology shows that the extent and spreading of disease varies geographically and is largely influenced by the development status of a society. In post-industrial societies in which people have a remarkable distance towards natural life styles and primary production, landscape and garden therapy has therefore gained increasing importance during the past decades. Irrespective of the cultural background of the users they provide their services to those who are seeking recreation, relief from everyday hassles and recovery from diseases in landscapes. The user or spectator, or one can even say, the consumer of a landscape can feel and experience the cultural content in a landscape even if he cannot always detect and decipher its history and meaning. Thus, the cultural diversity of landscapes means enrichment in perception for alien visitors of how other cultures express themselves in their surroundings. It is a chance for new experiences in the animal, plant and human world across one's own cultural boundary (Selin 2003). The unusual, the new which is encountered in a landscape, particularly if one expects a healthy effect from visiting it, may have unpredictable consequences on the landscape consumer, such as any cultural encounter. Whether a landscape reveals its healing properties to someone depends largely on a mutual responsiveness between the landscape character and the receptiveness of the person who thus represents the openness of a culture and its ability to absorb other messages encrypted in different landscapes. The unveiling of the encrypted landscapes by reading, interpreting and understanding them can be taken as an important factor for recovery, if not itself the very process of healing.

14.7 Conclusion

With a view on any landscape one is automatically confronted with cultural diversity for the reasons given above. The various value dimensions of landscapes, be it that they are given or achieved by transformation, contributed to the fact that the most prominent ones have been and are still declared world cultural heritage sites. All of them represent uniqueness under an overarching concept of appreciation of diversity. The attention that was given to culture in landscapes was since times immemorial partly an unconscious and partly a conscious development driven by the rise and decline of cultures. The cultural dynamics of modernization has led towards a standardized way of shaping the built environment in the cities all over the world. The landscape in the countryside has thus become more than ever a characteristic marker of cultural identity and national character.

The challenges to the physical and mental health of citizens living a modern life style have come along with economic development and are a widespread hazard to the future of post-industrial societies. In order to allow for a healthy environment an adequate landscape design has to care for what was previously a replication of an autonomous landscape design in more or less secluded regions over the ages.

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Index

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