Monitoring recreational activities in urban forests using long-term video observation

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Summary

Urban forest management needs information about the amount and kinds of recreation use, in particular about emerging recreational activities such as Nordic walking and winter bicycling. Between 2003 and 2004, year-round use levels of recreational activities were investigated in a forest in Vienna using permanent time-lapse video recording and counts by human observers on sampling days. The amount of use, yearly, weekly and daily use patterns, as well as the group size of the traditional activity groups were compared with Nordic walking and winter bicycling to characterize these activities and to better understand recreation use. For all activity groups, the rates of participation varied significantly across most of the time dimensions, and the relationships between the time of day and rates of participation were different for individuals and groups. Nordic walkers displayed a temporal use pattern similar to that of jogging with workday evening and weekend morning use peaks, while winter bicycling was similar to bicycling activities with afternoon use peaks during snowy periods. Nordic walking and winter bicycling activities added to the multi-use character of the heavily used forest, but seemed not to increase the potential for user conflicts because of the current low participation rates and the Nordic walking group's avoidance of times of heavy use.

Introduction

Sound urban forest management requires knowledge about the amount and kinds of recreation use occurring during the year, especially as forest use is characterized by heavy and multi use (Hörnsten and Fredman, 2000; Konijnendijk, 2000; Arnberger, 2006). Currently, new recreational activities such as Nordic walking and winter bicycling under snowy conditions are becoming more popular in Central European forests (Ammermann and Leitner, 2004; Krämer *et al.*, 2004; Shove and Pantzar, 2005). Thus, forest owners and administrations will face a new challenge to provide for sustainable urban forest management and meet the specific requirements of these activity groups. However, no studies have tracked the use patterns of Nordic walkers and winter bicyclists over an extended period of time in an urban forest and compared their use patterns with traditional recreational uses such as walking, dog walking, bicycling and jogging.

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One reason for the knowledge gap may be the lack of methods enabling visitor monitoring over an extensive period of time and, simultaneously, differentiating between activity groups to identify and characterize new recreation activities. Video observation can satisfy such management information needs.

The rapid spread of new activities

New recreational activities can emerge rapidly and become management issues; a good example is mountain biking. Within the three decades following the development of the first mountain bike in the US, the increase in the popularity of mountain biking has been exponential. It has been estimated that tens of millions of North Americans and Europeans own mountain bikes and many of them are avid trail riders (Morey *et al.*, 2002). In 1983, mountain biking reached Europe, and ~150 000 mountain bikes were sold in Germany in 1989. In 1995, the number of mountain bikes sold reached 600 000 (Wöhrstein, 1998). Because of its social and ecological impacts, it has affected forest management and a great deal of research has been undertaken to characterize the kind of use, users and user conflicts (Watson *et al.*, 1991; Ramthun, 1995; Wöhrstein, 1998; Cessford, 2003).

A similar development can be observed for Nordic walking. Nordic walking is conventional walking with special poles. As in cross-country skiing, the arms use the poles to match each step. Launched in 1997, Nordic walking was originally designed to increase the involvement of the Finnish population in fitness. Since then, interest has grown rapidly. In 2003, the number had increased to 400 000 (Vuori, 2003). Nowadays, ~20 per cent of the Finnish population go Nordic walking on a regular basis (Shove and Pantzar, 2005). In less than 10 years, Nordic walking has become the seventh most popular form of exercise, in terms of participant numbers, in Finland (Kotro *et al.*, 2005). In a recently conducted representative survey of 1000 Austrians (SPECTRA, 2005), it was found that 13 per cent of the population undertake Nordic walking more or less regularly. One year previously, the portion of Austrians engaged in Nordic walking was only 9 per cent, and in 2000 no participation in Nordic walking was recorded.

A second example of an emerging recreational activity with little extant information is recreational winter bicycling. Overall, an increased participation in technology-driven activities such as cycling has been observed (Cordell and Super, 2004), and based on this trend, further new technical improvements in the bicycle regarding tyre profile, weight and frame were carried out, enabling the use of the bike under heavy snow conditions (Ammermann and Leitner, 2004).

These examples document the rapid spread of recreational activities, in particular of Nordic walking, among European populations and the need to collect data. Thus, tracking and characterizing these emerging activities in forests is an essential tool for urban forest management; however, little research has focused explicitly on the long-term use patterns of activity groups in urban forests – and especially on the use patterns of Nordic walkers and winter bicyclists.

Video monitoring as a tool for characterizing emerging activities

Comparisons with traditional recreational uses are a prerequisite for characterizing emerging activities. Therefore, standardized monitoring of all recreational activities during 1 year is needed. Key elements for the characterization of activities are the amount of use, temporal use patterns during the seasons, week and day, group size and temporal use patterns according to group size. The knowledge about the total amount of use is essential for assessing visitor impacts on the resources, facilities, planning, budgeting and calculating the economic contribution that recreational use provides (Cessford and Muhar, 2003; Van Herzele *et al.*, 2005). Variations in the time of use are important for trail management, personnel plans and for the potential for conflicts between activity groups and the environment (Scott, 1997; Janowsky and Becker, 2003; Ploner and Brandenburg, 2003; Arnberger, 2006). Information about group size, and temporal use patterns according to group size, is also a key indicator for user behaviour and ecological impacts (Roggenbuck *et al.*, 1993; Monz *et al.*, 2000).

Video observation offers such valuable information for characterizing emerging activities. This method allows for the identification of traditional and new forest activity groups, their

respective group sizes and temporal use patterns and, thus, for inter-activity comparisons. In contrast, traditionally used long-term monitoring devices such as automatic counters and pressure pads (Dwyer, 1988; Rauhala *et al.*, 2002; Melville and Ruohonen, 2004) do not permit the detection of new forest user groups. Although observations by humans would provide such information, high costs limit this method to short-term observations. Particularly during the winter season, day-long observations in the field are almost impossible in Central Europe.

So far, very few studies have used video monitoring for long-term investigations to characterize urban forest use. Janowsky and Becker (2003) videoed recreational activities in the urban forest of Stuttgart, Germany, during 1 year. Walkers, joggers and bicyclists characterized forest use, while no Nordic walkers were identified. Similarly, Arnberger and Brandenburg (2002) and Arnberger (2006) used video recording to identify user types and their temporal use patterns during 1 year in an inner urban forest in Vienna and in two sections of a national park located in Vienna and Lower Austria. In all three long-term studies, the main forest users were walkers, bicyclists, dog walkers and joggers; again no Nordic walkers were observed, although the latest monitoring was done quite recently between 2002 and 2003. In all of these studies, information about bicyclists during snowy conditions, group sizes of activity groups and temporal use patterns according to group size was also not provided.

Most of these studies have also not linked the use patterns of activity groups to the general timetables of the social system, i.e. employment schedules, school times etc., to further the understanding of urban forest use. The influence of leisure timetables on distinct outdoor activities can be different (More, 1985; Scott, 1997) and long-term use patterns of activity groups identified by video observation allow for drawing conclusions about the characteristics of users engaged in distinct leisure activities.

Study objectives

In this study, two emerging recreational activities, Nordic walking and recreational winter bicycling were tracked by means of video monitoring during 1 year. Comparisons between these activities and traditional area uses: walking, dog walking, jogging and bicycling, also tracked by video during the same period of time, were undertaken to investigate the following research questions: (1) are distinctive recreational activities related to different dimensions of time, including season of the year, day of the week and time of the day according to the day of the week? (2) are the new activities of Nordic walking and winter biking similar to other traditional activities in terms of temporal use patterns (seasonal, weekly, daily)? (3) are the new activities similar to other traditional activities in terms of group size and variations in group size according to the time of the day and day of the week? (4) is there an increased potential for user conflicts in the forest caused by the temporal overlap in use of the new activities with other major user groups and the total amount of the emerging user groups? The aim of the study was to improve our understanding of the recreation use of urban forests and the influence of the general timetables of society on distinct activities and to provide information that will be useful in the planning and management of forests.

Study area

The urban forest is situated in the west of Vienna in the sixteenth district and is part of the Vienna Woods, recently established as a biosphere reserve. The hilly forest of 194 ha is managed by the municipal forest department. The woodlands consist of mainly of beech and oak; residential areas and garden allotments surround this forest (Figure 1). The forest is a conservation area, managed for landscape conservation and recreation. Due to nature conservation issues, one forest section of 14 ha is managed without any timber production. The forest provides ~29 km of forest roads, gravel trails and many footpaths. Two local hiking trails pass through the forest. One barbeque area, several meadows for sunbathing, a winter toboggan run and one observation tower are offered. Cycling is permitted only on the paved main road dividing the forest. Access by public transport is easy and several parking lots are provided. Approximately 4000 inhabitants live within 15 min walking distance.

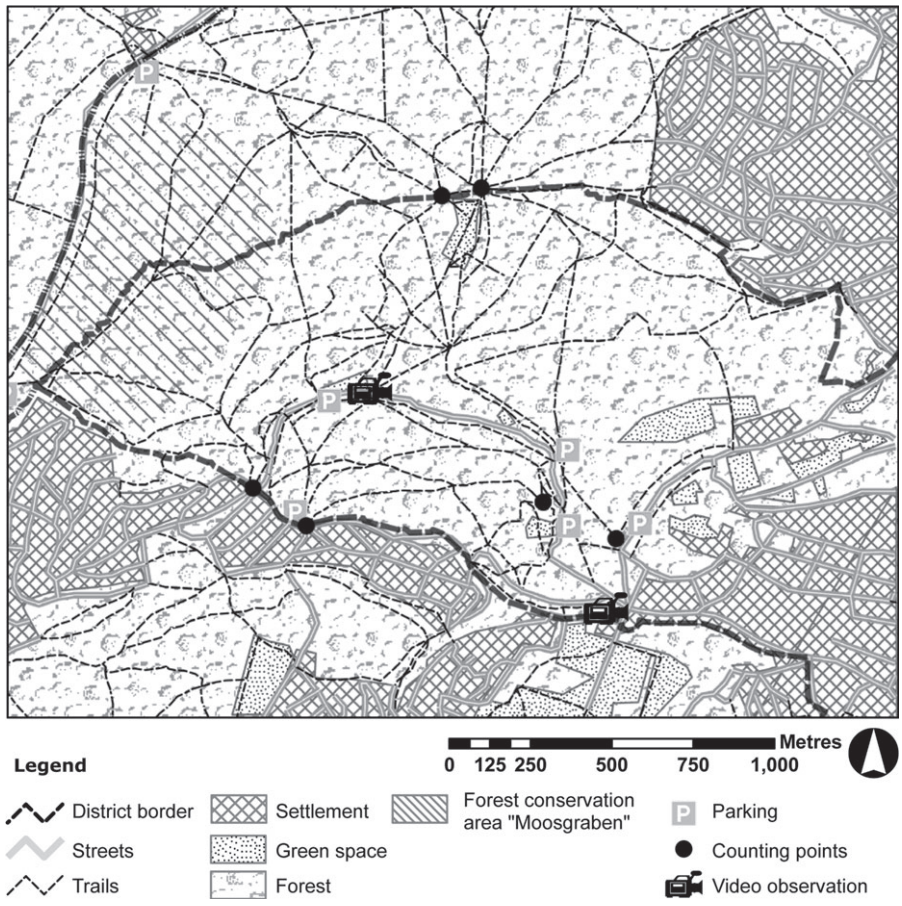

Figure 1. Map of study area (within the district border) observation points and trail network including trampling trails (Mehrzweckkarte Wien MA 41 – Stadtvermessung).

Methods

The recreational use in the study area was investigated during a 1-year time period using a combination of long-term and short-term counting methods, as well as on-site interviews. The data for the study presented here were collected by means of video observation and counts by human observers.

Video observation

Video monitoring was undertaken at the forest's two main access and intersection points (Figure 1), over a period of one entire year between October 2003 and October 2004, daily from dawn to dusk. One camera was installed outdoors on a wooden pole ~4 m above the ground. This monitoring unit consisted of a weatherproof black-and-white video camera with integrated heating and two time-lapse video recorders placed in a nearby building and used to observe a heavily used access and intersection point close to parking place. The camera was hidden in a nesting box to prevent vandalism and allow for unobstructed observations. The other black-and-white camera and recorders were placed on the second floor of a building and filmed recreation use through a window. This camera observed the southern main access point to the forest, where, beside

some small hiking trails, a paved road runs into the forest.

The time-lapse video recorders captured single images at fixed intervals of 1.1 s over the entire day. With the type of video camera installed and its specific setting, it was impossible to identify individuals in the video images, ensuring their anonymity. This was achieved by the low image resolution of the cameras and a minimum distance between camera and visitor. As a drawback, it was impossible to distinguish unique visits from repeat visits by the same person who might pass a camera at different times of the day or at another camera location. A notice that video monitoring activities were taking place was posted at the main northern entrance point.

For the analyses, only 15 min of observations per hour for walkers and 30 min of observations per hour for the other activity groups were taken into account. To verify that this sampling was valid, results were checked against a complete 2-week survey. The examination using linear regression resulted in an R^2 value of 0.9. The sample periods per hour were changed weekly, avoiding any time-related biases. About 4.5 per cent of the days of the 1-year observation accounted for missing data as a result of power supply cuts and damaged cables. There was no parallel loss of data from the two observation points and missing data could be replaced by linear regression using data from the other video station.

Trained students viewed the tapes on a television monitor and counts were classified and recorded on an MS-Excel spreadsheet. In peak use situations, the videotape could be rewound and forwarded repeatedly and investigated frame by frame until a situation was clarified and the accurate number and type of visitors and the direction of travel had been determined by the video interpreters. One drawback associated with the video monitoring method, revealed in a previous study, was the inaccurate assessment of visitor numbers at low-use levels, in particular of those involved in faster moving activities such as bicycling and jogging (Arnberger *et al.*, 2005). This inaccuracy was introduced during the interpretation process, when videotape interpreters checked the tapes as fast as possible and consequently overlooked some users at low-use levels. For this study, therefore, the cameras were positioned above 4–10 m above ground, providing a wide vision field, and the recorders were set at a speed that leads to the average user of the fastest user type appearing in several frames of the film.

The following data were captured from the videotapes: date and day of the week, time of visit, location of station, direction of movement, number of persons in a group, activity type, child or adult and number of dogs. No differentiation was made between male and female users and between mountain bikers and bicyclists. Besides recreation activities, video interpreters also recorded snow accumulation of more than 10 cm on the ground at each hour of observation, i.e. 'heavy snow'. This was the case on 81 days between November and March. Bicyclists, using trails not cleared of snow, will be referred to as 'winter bicyclists'.

Counts by human observers

Human observers counted visitors from 08.00 a.m. to 07.00 p.m. (05.00 p.m.) on 8 days in spring, summer and autumn in 2004. The counts took place on four, randomly selected, workdays and four Sundays. The observers were employees of the municipal forest management agency, who were trained in the use of the counting forms by the authors. These observers documented the number of visitors, as well as activity type, group size, direction of journey, child or adult, number of dogs and actual time of day. These personal observations were undertaken at side entrances to the forest, where no video cameras were installed (Figure 1).

Estimation of the total annual use

For the estimation of the total annual number of visits between October 2003 and October 2004, the results of long-term permanent video monitoring and temporally selective counting by human observers were combined (equation 1). For this extrapolation process, only visitors entering the forest were taken into account. The visitor numbers for entrance points without video observation ($C_{H,Year}$) could be extrapolated for all days of the year from the ratio between video counts ($C_{V,Days}$ = 5124 visits) and personal observation counts ($C_{H,Days}$ = 8648 visits), observing all relevant entrances on the sampling days where both methods were applied. The addition of yearly video count results ($C_{V,Year}$ = 148 945 visits) and extrapolated yearly counting results ($C_{H,Year}$ = 251 381

visits) resulted in ~400 300 visits to the forest. This procedure was also applied for the extrapolation of the amount of activity types, except for snow-dependent activities such as winter bicycling, because of the side entrances not being monitored by human observers in winter.

$$C_{(H,Year)} = C_{(H,Days)}/C_{(V,Days)} \times C_{(V,Year)}, \quad (1)$$

where C_H = counts by human observers and C_V = counts by video observation.

For the analyses of temporal use patterns, video monitoring results from the two main access points were used. Data were aggregated for 'workdays' and 'weekends', the latter included Saturdays, Sundays and other holidays. Chi-square tests and *t*-tests were used to test for significant differences of temporal use patterns and group sizes between activity types. A significance level of $P < 0.05$ was chosen.

Results

Share of activity groups and group size

The main user groups of all visitors entering the forest were walkers (67.7 per cent), joggers (12.3 per cent), dog walkers (9.7 per cent), bicyclists (7.9 per cent) and Nordic walkers (2.2 per cent, i.e., a total of 8630 people). Other marginal user groups were skaters, cross-country skiers, visitors with sledges and skis, horse riders, etc. Recreational winter bicyclists accounted for 0.5 per cent of all users recorded under snowy conditions at the video stations.

Overall, recreation use of this forest was characterized by high shares of single users. In particular, winter bicyclists (mean = 1.1), bicyclists (mean = 1.2), joggers (mean = 1.2) and dog walkers (mean = 1.4) were predominantly single users, while walking (mean = 1.8) and, to a lesser extent, Nordic walking (mean = 1.6) were done in groups. The group sizes of walkers, Nordic walkers and dog walkers differed significantly from each other activity group at the $P < 0.05$ level using *t*-tests, while no significant differences were found between the group sizes of joggers, winter bicyclists and bicyclists.

Temporal use pattern

The yearly use patterns of all activity groups were significantly different at the $P < 0.001$ level using chi-square statistics (Figure 2). While the main visiting period for Nordic walkers, joggers and bicyclists was the summer with an extreme

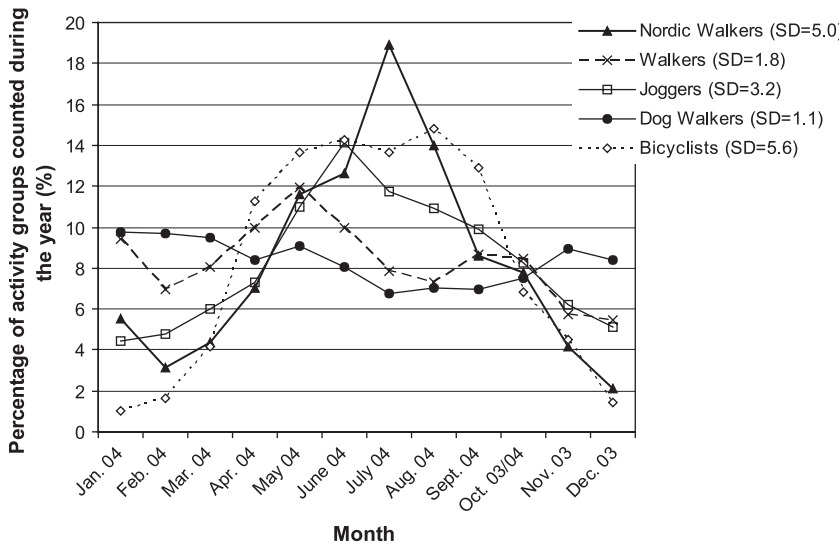

Figure 2. Yearly use patterns by activity types (SD = standard deviation).

Nordic walker peak in July, it was spring for the walkers. In contrast, dog walkers showed more or less no variability in visiting rates over the year, indicated by the low standard deviation.

The user composition differed significantly between conditions with and without snow, χ^2 = 3274.92, degrees of freedom (df) = 4, $P < 0.001$. About 22 per cent of dog walkers and 18 per cent of walkers were observed under conditions of heavy snow cover, but only 10 per cent of joggers and 11 per cent of Nordic walkers. Marginal shares of bicyclists (3 per cent) were recorded, mainly on the paved and snow-cleared road running through the forest. Almost 26 per cent of these bicyclists, i.e. winter bicyclists, used hiking trails not cleared of snow. For walkers and dog walkers, no significant differences in daily user numbers could be observed for days with and without snow, while for joggers, Nordic walkers and bicyclists this difference was significant at the $P < 0.001$ level using *t*-tests.

Overall, Sundays showed around twice as much use as workdays; however, the use intensities of activities groups were significantly different for the day of the week (Table 1). Walkers and winter bikers were mainly weekend users, while higher shares of the other user groups were recorded during workdays. During conditions with snow, a shift from workday to weekend use could be observed for all activity groups except dog walkers.

Across the activity groups, the daily use progressions varied significantly for both workdays and weekends at the $P < 0.001$ level using chi-square tests (Figures 3 and 4). At weekends only, the daily use progressions of Nordic walkers and joggers were not significantly different, χ^2 = 20.87, df = 14, $P = 0.105$.

Intra-activity comparisons of weekend and workday use progressions revealed significant differences for all activity groups at the $P < 0.001$ level. In particular, the weekend and workday use patterns of Nordic walkers as well as joggers varied extremely. At weekends, both groups appeared mainly in the late morning, while on workdays, more use occurred in the evening. In contrast, one peak for use by walkers and dog walkers was counted in the afternoon on both workdays and weekends. Bicyclists' use patterns on workdays were more similar to jogging and Nordic walking activities, while at weekends, their visiting patterns were more comparable to those of dog walkers.

Similar to snow-free days, significant differences in the daily use progressions of both weekends and workdays were observed at the $P < 0.001$ level using chi-square tests (Figures 5 and 6) across all activities during snowy conditions. Only the use patterns of winter bicyclists overlapped with bicyclists at weekends, $\chi^2 = 10.65$, df = 10, $P = 0.385$. Intra-activity comparisons between weekend and workday use progressions revealed significant differences for all activity groups at the $P < 0.001$ level using chi-square tests.

Temporal use patterns depending on group size

Compared with workdays, all activity groups, except Nordic walkers and snow bicyclists,

Table 1: Shares of activity types by weekends and workdays and on days with snow cover based on video monitoring

	Year		Snow cover	
Activity types	Weekends	Workdays	Weekends	Workdays
Nordic walkers	43.2%	56.8%	48.9%	51.1%
Joggers	41.6%	58.4%	49.9%	50.1%
Winter bicyclists			55.6%	44.4%
Bicyclists	41.6%	58.4%	52.7%	47.3%
Walkers	52.2%	47.8%	60.0%	40.0%
Dog walkers	44.1%	55.9%	43.5%	56.5%
Chi-square tests between weekend and workday shares of activity types	χ^2 = 1216.58, df = 4, $P < 0.001$		χ^2 = 319.84, df = 5, $P < 0.001$	

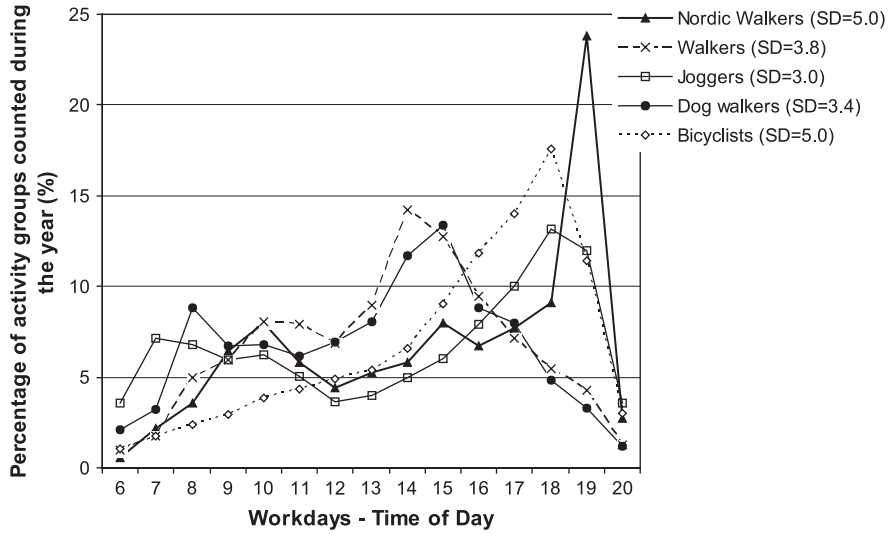

Figure 3. Daily use patterns of activity types on workdays (SD = standard deviation).

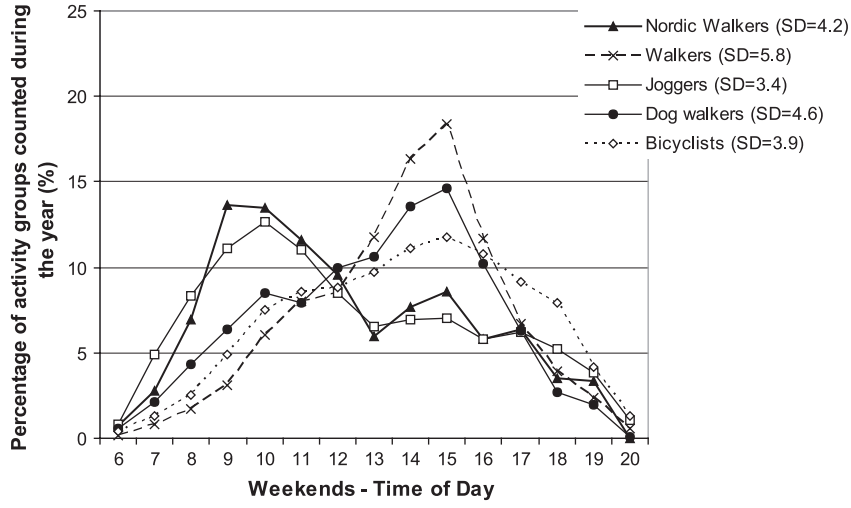

Figure 4. Daily use patterns of activity types on weekends (SD = standard deviation).

visited the forest in larger groups at weekends (Table 2). Inter-activity comparisons between workday and weekend use progressions of single persons as well as groups, consisting of at least two persons, revealed significant differences at the $P < 0.05$ level using chi-square statistics. Single dog walker and single Nordic walker use overlapped at weekends only; $\chi^2 = 8.69$, df = 14, $P = 0.850$.

For each activity group, intra-activity comparisons of daily use progressions showed significant differences between singles and groups for workdays as well as weekends at the $P < 0.05$ level using chi-square tests (Figures 7 and

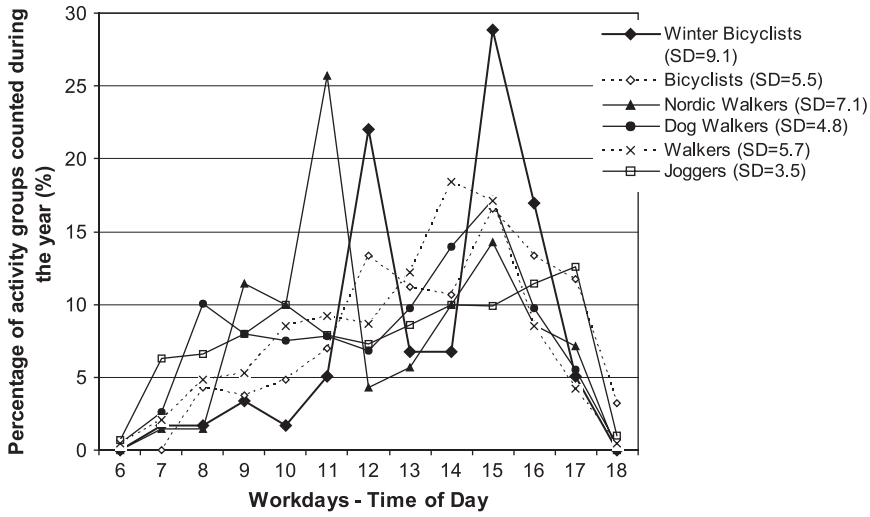

Figure 5. Daily use patterns of winter bicyclists and other activities on workdays during snowy conditions (SD = standard deviation).

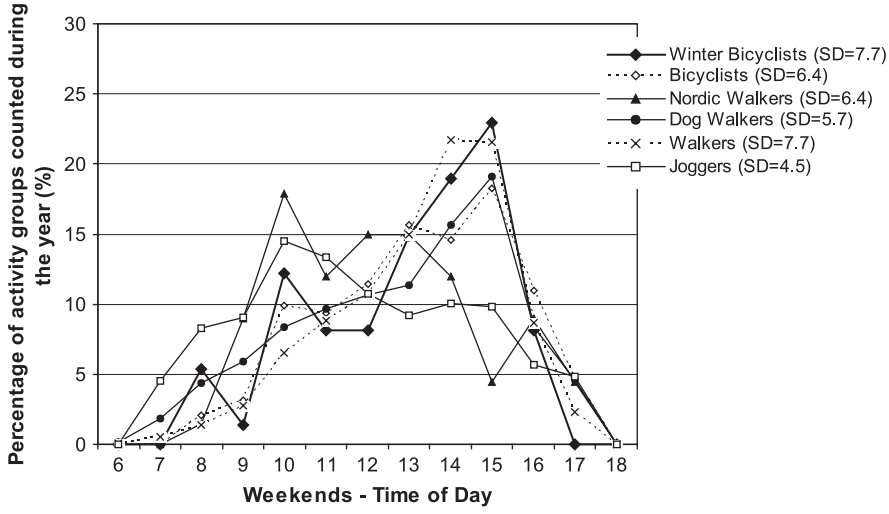

Figure 6. Daily use patterns of winter bicyclists and other activities on weekends during snowy conditions (SD = standard deviation).

8). Across all activity groups, standard deviations indicated that use by individual persons is more evenly spread over the day than group use for both workdays and weekends. At weekends, rather similar daily use progressions of single, and groups of, joggers were observed, while Nordic walkers and bicyclists showed higher variations in time according to group size. Single walkers and dog walkers used the morning hours more, while groups appeared in the afternoons (daily progressions according to group size of bicyclists and walkers are not displayed). On workdays,

Table 2: Mean group size of activity types by weekends and workdays based on video monitoring

Activity types	Weekends	Workdays	*t*-value
Nordic walkers	1.55	1.61	0.713
Winter bicyclists	1.12	1.09	0.498
Joggers	1.18	1.16	1.961*
Bicyclists	1.22	1.13	10.355***
Walkers	1.85	1.71	7.065***
Dog walkers	1.56	1.29	15.585***

***$P < 0.001$; *$P < 0.05$.

group use by joggers, bicyclists and in particular Nordic walkers was predominant in the evening hours. For walkers and dog walkers, single use was stronger in the early morning hours, while groups visited the forest in the afternoon. This comparison was not carried out for days with and without snow because 80 per cent of winter bicyclists were single users.

Discussion

Temporal forest use

This study used long-term video monitoring to investigate whether distinctive recreational activities in an urban forest are related to different dimensions of time, including season of the year, day of the week and time of the day according to the day of the week. Based on the activity visitors were engaged in, the rates of participation varied significantly across all time dimensions (Table 1, Figures 2–8), except for daily use progressions at weekends. Even within each activity, completely different daily progressions of use, depending on the day of the week were observed. Thus, the forest serves different activity groups at different times.

Cyclical timetables, including holidays and seasons, as a complex combination of weather, diverse trail conditions and day length, are likely to influence leisure (Dwyer, 1988; Scott, 1997). This influence, however, is different for the individual activities in the forest. The variations in the yearly use progression indicate that faster moving activities, i.e. jogging, bicycling and Nordic walking, depend more on weather conditions than walking and, in particular, dog walking activities because of the need to walk the dog (Figure 2). During times of heavy snow cover, the user composition is homogeneous because of the very low participation rates of bicyclists, joggers and, surprisingly, Nordic walkers. Initially, we had assumed that Nordic walking would be much more attractive than jogging under such conditions due to the lower speed and the poles used preventing users from falling down (Vuori, 2003). Annual holidays between July and August and other summer activities such as swimming and bicycling may have caused the decline in participation rates of walkers, joggers and dog walkers (Dwyer, 1988; Ploner and Brandenburg, 2003), while the contrasting use patterns of Nordic walkers may be shaped by different leisure timetables, low interests in substitute activities or tolerances for higher temperatures.

The weekend is the dominant time when outdoor recreation activities in the forest are pursued, which was also the result of several studies on forest use (Dwyer, 1988; Janowsky and Becker, 2003; Arnberger, 2006); however, the rates of participation are different for the activity groups and are additionally influenced by the season (Table 1). The need to walk the dog daily and the habit of jogging, Nordic walking and cycling daily contributes to higher workday use, while the shift toward more weekend use can be a result of limited daylight during snow periods, particularly preventing visitors engaged in sporting activities from workday evening use.

The different workday and weekend use progressions reflect the respective influence of work and school schedules on specific outdoor activities. Workday leisure activities are much more coupled to the timetables of the social system than weekend ones. For the working population, therefore, workday activities must be adjusted to the free time available after work and before sunset. Nordic walking and jogging require only short periods of time to satisfy visitor demands for physical exercise and, consequently, can be easily pursued after work. Opposite to workdays, the lack of time and work constraints at weekends allows forest users a greater degree of freedom to participate in leisure activities whenever they want (Scott, 1997), which is reflected by the use patterns of Nordic walkers and joggers. The weekend use patterns document that the preferred time for pursuing their activities seems

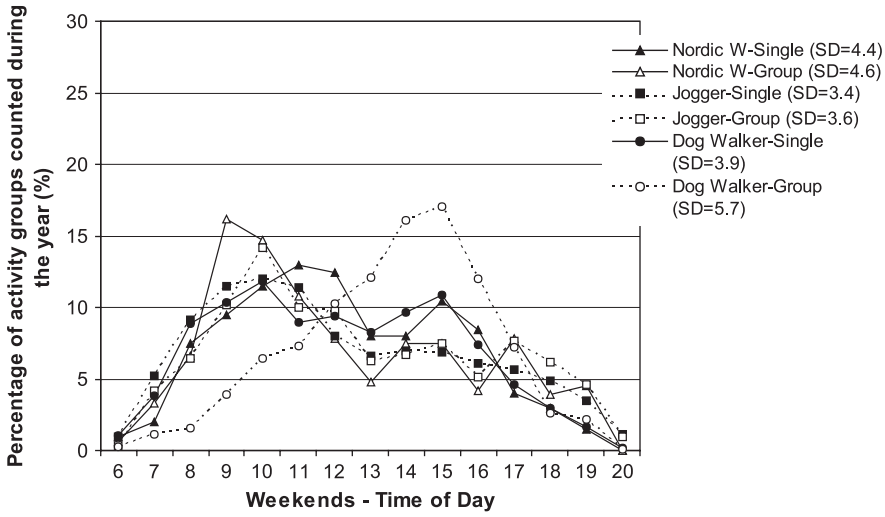

Figure 7. Daily use patterns of Nordic walkers, joggers and dog walkers on weekends depending on group size (SD = standard deviation); not shown – bicyclists: singles SD = 3.6, groups SD = 4.6; walkers: singles SD = 4.0, groups SD = 6.4.

to actually be the late morning instead of the evening hours. At the same time, they avoid the high-use pressures and hottest conditions during the weekend afternoons. In contrast, winter bicycling occurs during the peak uses of the afternoons on workdays and weekends, thus overlapping with the use patterns of walkers and dog walkers (Figures 4 and 5). Although a physical activity, those participating in winter bicycling select different times for pursuing their activities than joggers and Nordic walkers.

Use pattern depending on group size

For all activity groups, the relationships between time of the day and rates of participation are different for singles and groups for weekends and workdays (Table 2, Figures 7 and 8). This segmentation, which has, so far, been neglected in research on urban forest use, brought further insights into visitor behaviour. Group use requires some coordination of individual time schedules (Scott, 1997) and the synchronization is easier on weekends because people have more time than on workdays. This is shown by the higher weekend group sizes of all activity groups, except winter bicyclists and Nordic walkers.

For workdays, group use is more concentrated in the afternoon and evening hours than single use. One suggests that at least one partner is constrained by working or school times, while single use seems to be less influenced by institutional timetables, documented by the rather stable use levels throughout the day and the lower standard deviation across all activities.

Based on the increase in group size, for walking and dog walking activities, it seems to be easier to find partners for weekend use than it is for sporting activities, in particular for winter bicycling which is predominantly done alone, regardless of the day of the week. Partners for this activity are apparently not existent, maybe because of the specific bike needed and the greater demands on skills and physical condition. For Nordic walkers, the same group size on workdays and at weekends may indicate use by a consistent team, such as a married couple. This assumption may be supported by the patterns of their workday use, occurring within a small time slot between 07.00 p.m. and 08.00 p.m. Scott (1997) suggests that synchronizing individual time schedules is made less problematic by developing a 'regular' calendar of activity, and this can be more easily done by a couple.

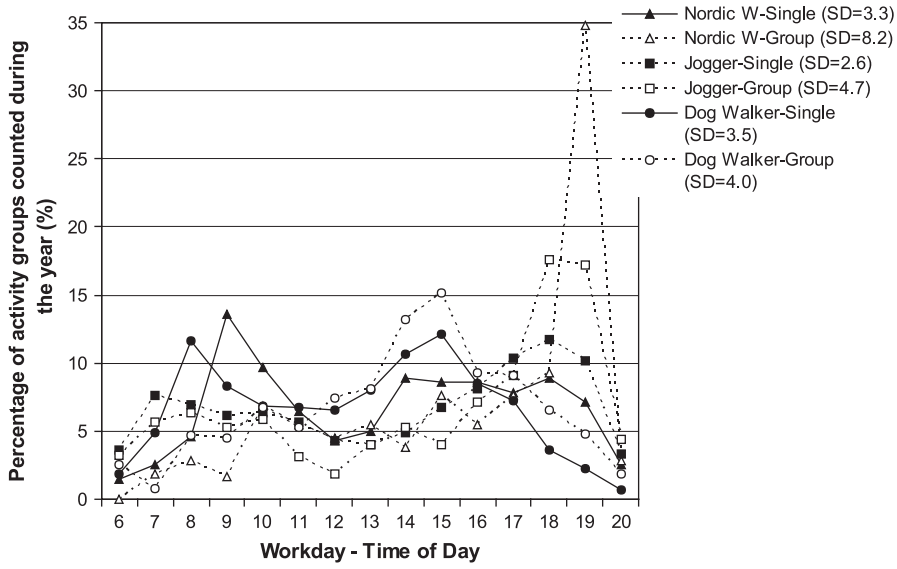

Figure 8. Daily use patterns of Nordic walkers, joggers and dog walkers on workdays depending on group size (SD = standard deviation); not shown – bicyclists: singles SD = 4.6, groups SD = 6.8; walkers: singles SD = 3.0, groups SD = 4.4.

Inter-activity comparisons revealed that single dog walkers and single Nordic walkers showed the same daily use progression at weekends. Time requirements for the activity itself, leisure timetables and user demands, such as for lower trail-use frequencies and weather conditions, must be similar for both short-term walking activities.

Characterizing emerging activities

Nordic walkers accounted for ~2.2 per cent of all visitors to this urban forest. Even if the share of this new activity form is not high, it documents that Nordic walking is an additional activity carried out in urban forests, increasing the multiple-use character of shared forest trails. In several studies on urban forest use in Central Europe, no Nordic walkers were observed, even though these studies were conducted recently (Arnberger and Brandenburg, 2002; Roovers *et al.*, 2002; Arnberger and Hinterberger, 2003; Janowsky and Becker, 2003; Arnberger, 2006). Nordic walking seems to be a daily short-term activity, comparable to jogging. Weekly and daily use patterns and participation rates during snowy conditions roughly correspond, in particular, at weekends (Table 1, Figures 2–8). This indicates that user characteristics, probably people being employed full-time because of workday evening use of groups, the influences of the general timetables of the society, weather and trail-use conditions needed for theses activities, as well as time requirements of the activity itself, might be similar. While temporal use patterns, except summer use, are comparable to jogging activities, the group size of Nordic walking was significantly higher with a 60 per cent share of group use. Obviously, social aspects are more relevant for the Nordic walking activity (Vuori, 2003; Krämer *et al.*, 2004).

So far, recreational winter bicycling has not been documented in the literature about urban forest use. Video monitoring has shown that this activity occurs in this forest, but the number of users engaged in winter bicycling is rather small. Based on group size and temporal use patterns, in particular at weekends, winter bicycling can be seen as a variation of bicycling, dominated by single use because of its specific requirements regarding skills and technical equipment. Obviously, no social aspects are connected with this

activity, maybe because this activity makes it hard to carry on a conversation. Compared with Nordic walkers, more people who are not employed full-time seem to be engaged in this activity because of workday afternoon use.

Potential for user conflicts

Video monitoring was also used to assess the potential and extent for user conflicts in the forest caused by the temporal overlap in use between the new activities and traditional ones. Most forest use occurred during weekend afternoons, largely due to the overlap of walkers' and dog walkers' use patterns (Figure 4). The almost complete absence of Nordic walkers (and joggers) during these high-use times would not significantly increase the potential for user conflicts. On workday evenings, however, conflicts may arise between groups of Nordic walkers and bicyclists during the warmer season, particularly as the morphology of the forest with its steep trails is an invitation to bicyclists to speed. Such conflicts between walking and bicycling activities have been documented in several studies (Watson *et al.*, 1991; Ramthun, 1995; Cessford, 2003). Because of similar times of appearance, some conflicts might also occur between joggers and Nordic walkers. During times with snowy conditions, this conflict potential is almost irrelevant due to their low participation rates and their different workday use progressions. In contrast, the use pattern of winter bicyclists coincided with walking and dog walking activities in the peak use periods in winter. However, as noted, the number of winter bicyclists observed was low, and conflicts may occur only because of the steep and slippery trails and concentrated use due to limited daylight (Figures 5 and 6).

Conclusion

By means of 1-year video monitoring, recreational activities could be identified and quantified. Based on the parallel observation of activity groups, it was also possible to characterize the emerging activities of Nordic walking and winter bicycling. Video observation revealed that specific time periods are associated with distinct outdoor recreation activities and the relationship between time and patterns of use was different for individuals and groups across all activities. The timetables of the social system have a different influence on specific activity groups, and this influence is higher on groups than on individuals. Consequently, in areas with mixed uses, the identification and tracking of activities and their group sizes during the year is one of the key pieces of information for proactive management and understanding urban forest use. As such, long-term video monitoring seems to be a key decisive advance over previous visitor monitoring techniques in providing the information which urban forest management needs, especially for new recreation activities, where there is little extant information.

Based on the video monitoring, times of heavy and low use in the forest could be identified, allowing management to schedule personnel plans and adjust trail management efforts. A considerable amount of bicycling activities, including winter bicycling, was observed on trails which are closed for this activity. Trail controls seem to be necessary, in particular during the times of heavy use on weekend afternoons and under constraining trail-use conditions such as snow cover. The setting up of improved trail signage would assist forest management in regulating bicycle use. Due to the high-use levels, forest management should also pay attention to winter use. Serving winter visitor needs can include having more trails and parking places cleared of snow, more trail controls to avoid user conflicts and the provision of extra trails for winter bicyclists.

Serving the needs of Nordic walkers, forest management can establish sign-posted circulation routes of about 6 km in length (Krämer *et al.*, 2004) which are situated close to parking lots, public transport stops or to settlements, enabling workday evening use. Natural trails with different degrees of difficulty and places for stretching exercises should be offered. The installation of lightening allowing for year-round evening use along one circulation trail can be taken into consideration to get more people regularly involved in this activity which is beneficial to one's health.

Several limitations of this study have to be mentioned. In order to guarantee the visitors' anonymity, information about gender and age was not obtained. Because human observers counted visitors only at access points from spring to fall,

it was also not possible to assess the total amount of winter activities occurring under snowy conditions. The study provided information about the potential for user conflicts, however, not about the amount of actual conflicts. Therefore, future research should use questionnaires to investigate whether there are any differences in the use patterns of Nordic walkers and winter bicyclists due to gender, age and employment status. Investigations should address whether the simultaneous forest use by Nordic walkers and joggers results in any conflicts between these groups and whether group sizes are linked to socio-demographic characteristics. A replication of the study is needed to test whether the findings about Nordic walkers' and winter bicyclists' use patterns would also hold in other urban and rural forests.

One of the main questions for area administration might be whether Nordic walking activities are increasing and whether this will lead to higher use levels in urban forests. When considering the results gained by SPECTRA (2005), documenting an additional increase in Nordic walking participation rates between 2004 and 2005 in Austria, only 1 year after this study, one can assume that the Nordic walkers' use levels observed between 2003 and 2004 do not represent this forest's ceiling. When bearing in mind the trend toward higher participation rates of women in outdoor recreation (Henderson, 2004), one can suggest that Nordic walking, which is mainly carried out by women (Krämer *et al.*, 2004; SPECTRA, 2005), can lead to higher use levels in forests. However, a visitor monitoring in the following years would be necessary to confirm these statements.

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