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Environment, Behavior, and Design Research on Urban Forests

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To many people the term *urban forest* seems incongruous and contradictory. But a look around any major city quickly reveals that trees and other vegetation are an important feature in many urban settings. For example, an aerial photo survey of Dayton, Ohio, showed that 22% of the city's land area is covered with trees, and that 35% is covered with other kinds of vegetation (Sanders & Stevens, 1984). According to one overall estimate, 30% of the average city in the United States is covered with trees, a proportion larger than the average tree cover for countryside (Dwyer, Deneke, Grey, & Moeller, 1983).

Some professionals prefer to identify as urban forests only those areas of vegetation that approximate the traditional image of a forest, that is, essentially natural ecosystems located within urban surroundings (Figure 1). Even with this restricted definition, urban forests are a major component of some metropolitan areas. For example, the forest preserve system surrounding Chicago occupies over 10% of the land area in a county with almost 6 million people (Wendling, Gabriel, Dwyer & Buck, 1981).

In this chapter, I use a broad definition of the urban forest, to

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FIGURE 1. Some urban forests, such as this forest preserve in the city of Chicago, closely resemble the traditional image of a natural forest.

include virtually any occurrence of woody vegetation in populated places (Grey & Deneke, 1986). Besides city parks (Figure 2), this may include trees:

> . . . along city streets and sidewalks, riverbanks and transportation corridors, powerlines and pipelines, in forest preserves, cemeteries, golf courses, nature centers, vacant lots and fields, arboreta, conservatories, yards and estates, and municipal watersheds. (Dwyer, 1980, p. 11)

Management of urban forest environments is complicated by the diverse character of the settings; the multiplicity of public and private landowners, planners, and agencies; and the intricacies of local politics and public involvement (Dwyer, 1980; Dwyer & Schroeder, 1982). In recent years, urban forest managers have been caught between the increasing recreational use of urban forest resources and the decreasing budgets for managing those resources. This dilemma has created a need for more efficient ways to manage urban forests for the benefit of urban residents. Researchers in the social science and design disciplines have responded to this need with studies of the human perceptual and behavioral aspects of the urban forest.



FIGURE 2. Although city parks such as this one are not natural ecosystems, they may still be thought of as urban forests.

In this chapter, I summarize recent (since 1980) environment, behavior, and design research on urban forests, and I suggest some future directions that this research might take. I have included work that focuses specifically on urban forest and open-space settings and that deals with human perception, preference, and behavior with respect to these settings. I have not included references to nonurban natural settings or nonvegetated urban settings, or to the physical and biological aspects of urban forest management, except where these are particularly relevant to human–environment issues in urban forests.

MAJOR RESEARCH TOPICS

The literature pertaining to the human aspects of urban forestry is diverse and multidisciplinary. To impose order on this diversity, I have identified some major topics that have characterized the last several years of work in this field. These topics are not independent, and references cited under one topic are often relevant to other topics as well.

Benefits and Values Associated with Urban Forests

To manage forests effectively for public benefits, urban foresters need to know what those benefits are. Failure to identify all the benefits provided by urban forests may result in some benefits' being lost through misguided management. Also, to justify budgets and expenditures for urban forest management, managers need to show that the benefits provided by the forest are important to the public. Urban forestry budgets must compete for scarce funds with city services, such as street maintenance, police, and fire protection. Without specific information on the importance of urban forest benefits, local governments may simply assume that urban forests are not very important.

Identifying Kinds of Benefits. Many of the benefits of urban forests can be measured in physical or biological terms. Moderation of temperature extremes, improved air quality, noise abatement, and erosion control are frequently cited benefits of urban vegetation (Grey & Deneke, 1986). But the most important benefits of urban trees may, in fact, be found in the effects they have on people's subjective experiences, moods, and feelings.

The literature on landscape assessment consistently shows that environments with natural elements such as trees and water are highly preferred to urban scenes lacking these elements (Ulrich, 1986). The presence of natural features in urban environments enhances residents' overall satisfaction with their living conditions (Kaplan, 1982; Marans & Fly, 1981). Recent studies have attempted to learn more precisely how vegetation affects people's moods and emotional states. For example, when viewers' responses were measured by mood and feeling rating-scales in one recent study, nature scenes resulted in higher levels of attentiveness and interest, whereas urban scenes tended to increase sadness and fear (Ulrich, 1981). Studies of physiological responses to the visual environment (Ulrich, 1981; Ulrich & Simons, 1986) have shown that scenes with vegetation promote more relaxed and less stressful states than do urban scenes lacking vegetation (Figure 3).

Perceived park benefits seem to fall into two distinct categories: *passive* natural benefits obtained from viewing aesthetic elements such as trees; and *active* recreational and social benefits obtained from using environments for sports and play (Hayward & Weitzer, 1984; Ulrich & Addoms, 1981). Park programs frequently emphasize active sports, but passive aesthetic enjoyment may actually be the greatest benefit of urban forests (Figure 4). This enjoyment can provide a sense of relief and escape from urban life for city residents (Hayward & Weitzer, 1984; Ulrich, 1986). Infrequent users of parks and nonusers also obtain sub-

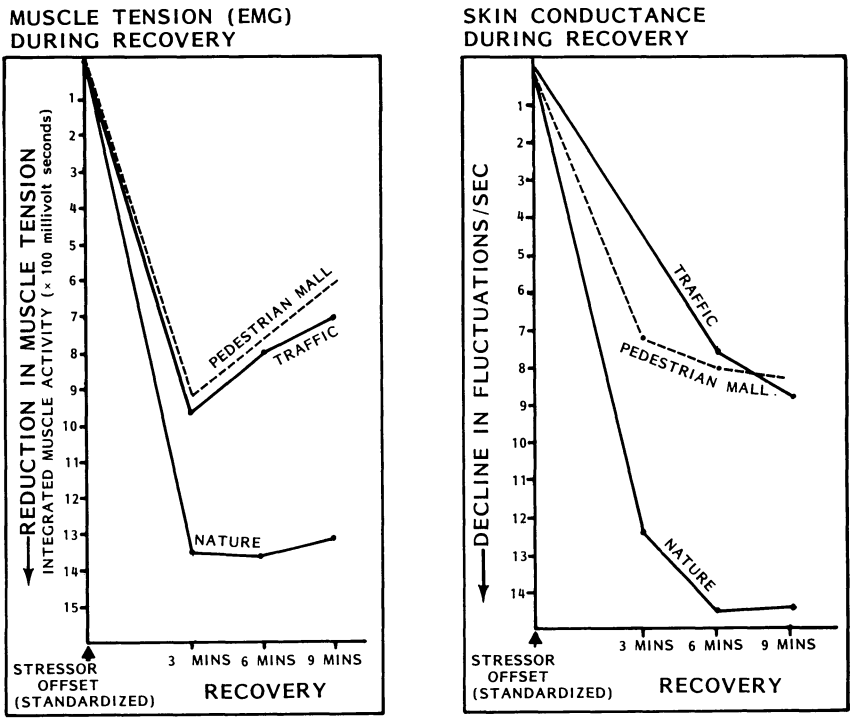


FIGURE 3. Physiological measurements show that nature scenes promote recovery from stress much better than scenes with mainly artificial features (Ulrich & Simons, 1986).

stantial benefits by observing parks from the street or through windows, and by just knowing the parks are there to use if needed (Kaplan, 1980, 1981; Ulrich & Addoms, 1981). The importance of window views of urban nature is suggested by a study in which hospital patients with a view of a wooded scene recovered from surgery more quickly and with fewer complications than patients whose windows looked out onto a brick wall (Ulrich, 1984).

A survey of gardeners (Kaplan, 1983) showed that the most important perceived benefit of gardening was the feeling of peacefulness and tranquility it produced. At the same time, gardening provided people with the fascination of being involved in a natural process. Observing and feeding wildlife, which is often associated with urban forests, probably provides similar opportunities for fascination and involvement. In one survey, almost half the respondents reported engaging in wildlife-related activities (mainly bird feeding) close to home (Shaw, Mangun, & Lyons, 1985).

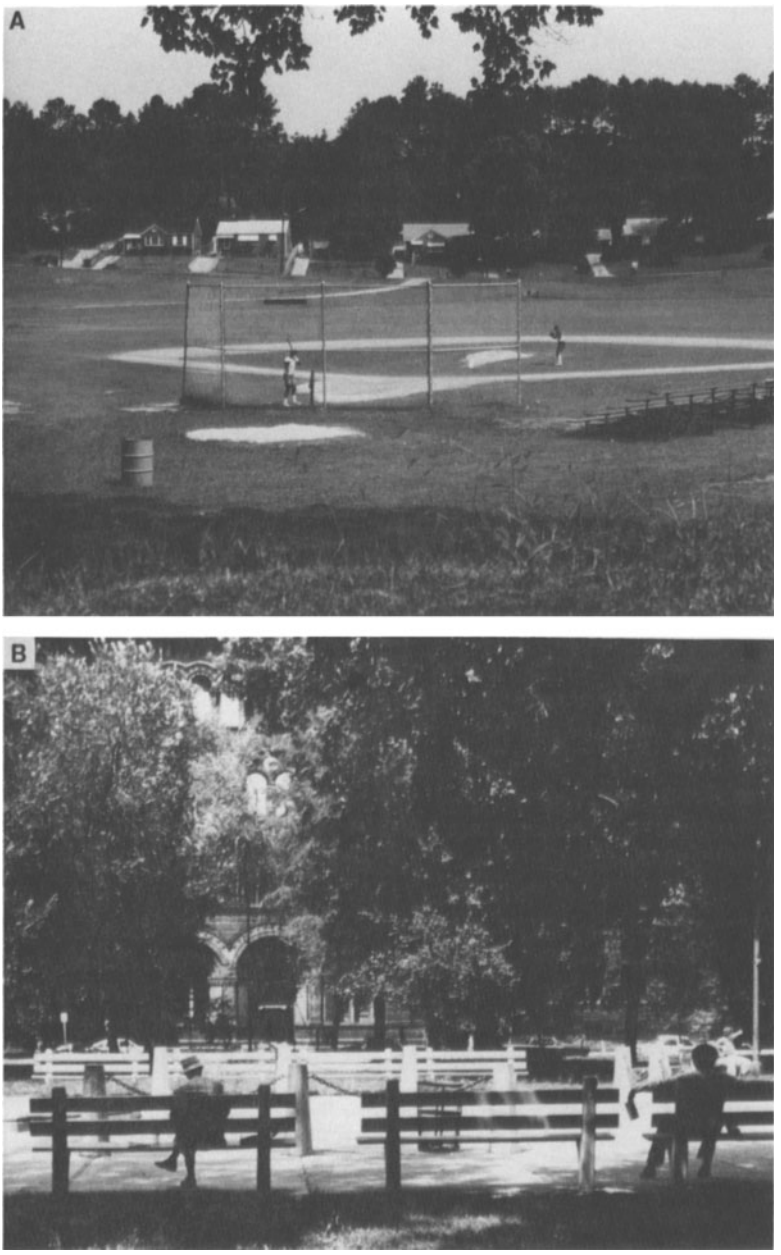


FIGURE 4. Many park programs are structured around athletic activities and facilities (A). Relaxation and refuge from city surroundings, however, may be the most important value of urban forests (B).

In a more theoretical vein, Kaplan (1984c) suggested that two characteristics of natural settings that may foster restorative effects on human beings are "fascination" (that is, the ability to promote effortless attention) and "coherence" (or the property of making sense). To the extent that urban forests possess these characteristics, they may be able to provide benefits usually associated with more remote natural sites.

Aside from improving the quality of neighborhoods, active involvement in tree-planting programs seems to enhance a community's sense of social identity, self-esteem, and territoriality, and it teaches residents that they can work together to choose and control the condition of their environment (Ames, 1980).

Economic Measures of Benefits. Urban managers faced with the hard realities of municipal budgets often find it useful to place dollar values on the benefits produced by urban forests. For insurance and tax purposes, formulas exist for appraising the value of a tree based on the size, species, and condition of the tree (Grey & Deneke, 1986; Morales, Micha, & Weber, 1983). These formulas, however, have no theoretical or empirical basis and do not provide valid economic measures of the benefits produced by urban forests.

Three economic methods have been used for measuring the value of urban forest benefits. The hedonic pricing method infers the value of urban forest resources by observing the changes in residential property values associated with proximity to a park (Hagerty, Stevens, Allen, & More, 1982) or with trees on the property (Anderson & Cordell, 1985; Morales *et al.*, 1983). The travel cost method measures the costs that users incur to reach a site, and it infers the value of the site from those costs (Darragh, Peterson, & Dwyer, 1983). The contingent valuation or direct-questioning method has been used to ask people to state the amount they would be willing to pay to preserve vegetation in a land-use-planning context (Coughlin & Strong, 1983).

Each of these three methods has its shortcomings (Allen, Stevens, & More, 1985). For example, the travel cost method does not count aesthetic benefits to nearby residents who do not actually enter the park; the hedonic pricing method does not measure benefits to users living far from the park; and the contingent valuation method is subject to difficult psychometric measurement and validation problems, because of the hypothetical nature of the questions posed to the respondents.

Perception of Urban Forest Environments

Environmental perception studies have sought to identify the characteristics and features that enhance the perceived quality of urban for-

est sites. As noted above, landscapes with natural elements such as trees and water are generally preferred over artificial landscapes (Ulrich, 1981, 1986). Viewers' preference ratings of photographs of urban scenes show that preference decreases with increasing development intensity. Increasing the amounts of vegetation and improving the quality of landscape maintenance increase preference (Anderson & Schroeder, 1983). Views of parks with natural features are consistently preferred to residential and commercial landscapes (Herzog, Kaplan, & Kaplan, 1982; Ulrich & Addoms, 1981).

Several studies have found that the most preferred features of urban parks and forest preserves include trees and forested areas, water, good maintenance, and peace and quiet (Schroeder, 1982; Schroeder & Anderson, 1984; Young & Flowers, 1982). Features that detract from the attractiveness of a park include manufactured objects (e.g., fences and parking lots), poor condition of vegetation, urban surroundings adjoining the park, litter, graffiti, crowding, and large, monotonous fields (Schroeder, 1982; Schroeder & Anderson, 1984).

Vegetation may be a universally preferred environmental feature, but not all kinds of vegetation are equally preferred. Perhaps the most universally liked setting is an open stand of large trees, with evenly mowed grass beneath. This configuration is typical of many American community parks, and it seems to be aesthetically appealing to a wider range of people than are either very open scenes or dense impenetrable forests (Kaplan, 1984a). Consistent with this finding, a study of perceived tree density in municipal parks (Schroeder & Green, 1985) showed that intermediate tree densities of 40–65 trees per acre were more attractive than higher or lower densities (Figure 5). Vegetation in a park may also influence the perception of the size or spaciousness of the site. Seemingly spacious environments can be created in relatively small parks by using vegetation to mask surrounding urban features and by providing paths to allow movement into the area (Talbot & Kaplan, 1986).

Besides vegetation, urban forests usually contain artificial structures and facilities. Although these often detract from the aesthetic quality of a landscape, not all types of artificial features are equally unattractive. A high degree of contrast or incongruity between a structure's color, texture, size, or shape and its natural setting were found to decrease the preference for park scenes in the Northeast (Wohlwill & Harris, 1980). Similarly, incongruity and crowding of structures decreased the attractiveness of forested subdivisions in Colorado (Vining, Daniel, & Schroeder, 1984).

Vegetation can significantly enhance the quality of more developed



FIGURE 5. Most people prefer park settings with intermediate tree densities (B) over settings with very few trees (A) or too many trees (C).



FIGURE 5. (*Continued*)

urban settings, such as parking lots (Shaffer & Anderson, 1985) and residential streets (Buhyoff, Gauthier, & Wellman, 1984; Lien & Buhyoff, 1986; Schroeder & Cannon, 1983). Larger trees on streets are preferred over smaller trees, perhaps because of the overarching canopy and shade they provide (Figure 6). Open, parklike stands of large trees were also preferred in surveys of nature preference at multiple-family housing sites (Kaplan, 1982, 1985). Residents of these sites also expressed a liking for natural, unmanaged settings close to their homes.

Most studies of urban forest perception have focused on the visual landscape, but sounds and noises are also an important feature of most urban environments. The physics of noise abatement due to vegetation has been well studied, but there is little information on the perceived relationships between noise and vegetation. A recent study suggested that fittingness or congruity plays a role, too (Anderson, Mulligan, Goodman, & Regen, 1983). Natural sounds, such as birdsong and wind, were perceived to enhance the quality of forested sites, whereas unnatural sounds, such as traffic, detracted. For unvegetated, downtown sites, however, traffic was perceived as the most enhancing sound. Heavily vegetated sites appear to be much more sensitive to both the enhancing and the detracting effects of sounds, perhaps because they arouse stronger expectations about what kinds of sounds are appropriate.

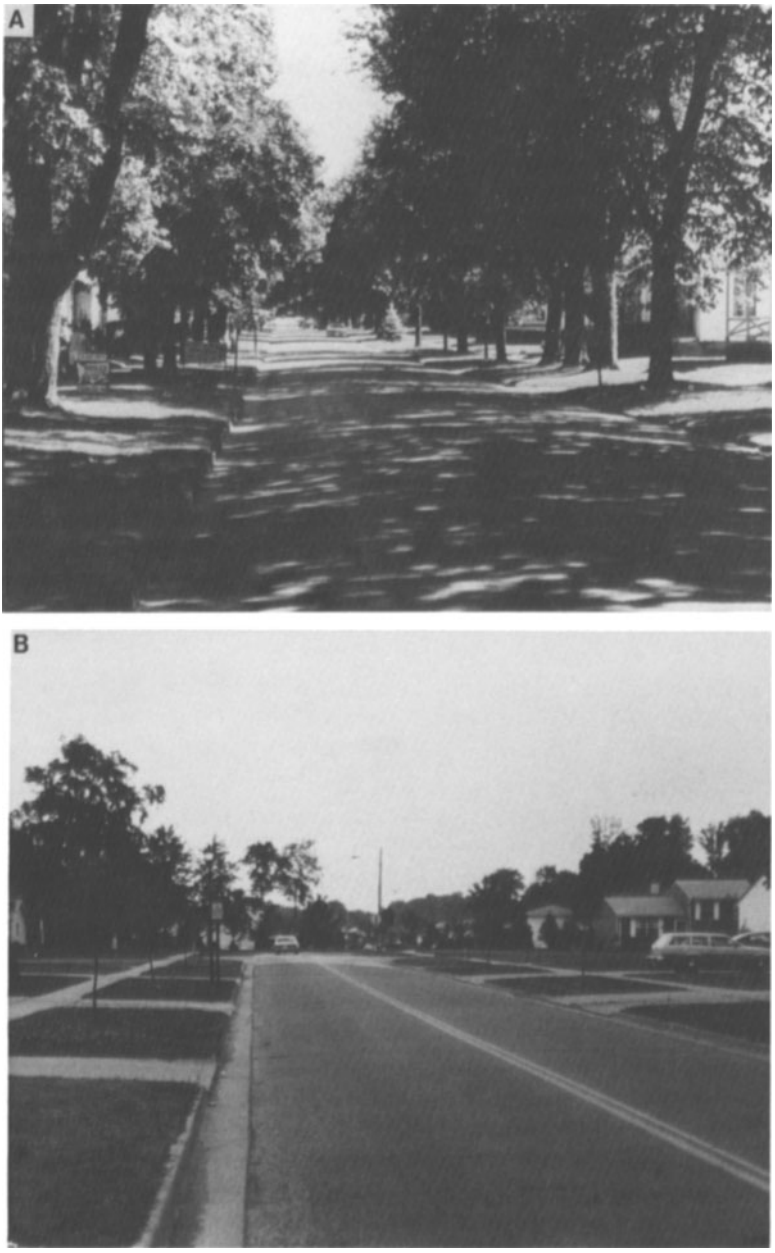


FIGURE 6. Streets with large trees and an over-arching canopy (A) are perceived as much more attractive than streets with small trees or no trees (B).

On-Site Behavior in Urban Forests

Studies of overt behavior in urban parks and forests require very different research methods from studies of perception and preference. One approach is to look for indirect indicators of use, such as amount of wear and width of trails (More, 1980), which give a rough idea of how many people use an area. Questions on surveys may also provide some insight into how people use forest sites. For example, a survey of users in Chicago-area forest preserves (Young & Flowers, 1982) revealed surprisingly short visits: 53% of the respondents said that they planned to stay an hour or less. Most visitors were frequent users of the forest preserves, and the most common activity reported was simply "relaxing."

The best way to obtain accurate information about numbers of visitors and kinds of behaviors, however, is through direct observation. Observation studies require careful planning and long periods of time in the field, but the information gained may be well worth the effort (More, 1984). Observations can provide important insights into the group structure and context of recreation activities in urban parks that may be missed in surveys about recreation participation (Hutchison & Fidel, 1984).

A detailed study of two northeastern parks (More, 1985a) revealed not only that the parks were heavily used, but that they were used at all times of the day and night and in all kinds of weather. The users included a very broad cross section of the urban populace. Although a wide variety of activities was observed, the most common activities were ordinary ones such as walking, talking, and observing.

Observation of vehicles entering Chicago-area forest preserves (Dwyer, Schroeder, & Buck, 1985) revealed very stable patterns of use over time (Figures 7 and 8). About 75% of the variance in total daily use was explained by the month of the year, the day of the week, and the weather. Stable patterns of use over different times of day were also observed, although the patterns were different for different locations and for different days of the week.

It is difficult to generalize from the few observational studies of urban forest behavior that have so far been completed, especially given the tremendous diversity of activities and users that characterizes urban parks. One promising suggestion is to define categories of parks that display similar use and behavior patterns. More (1985b) suggested that such categories could be based on the parks' size, activity resources, amenity resources, and aesthetic quality.

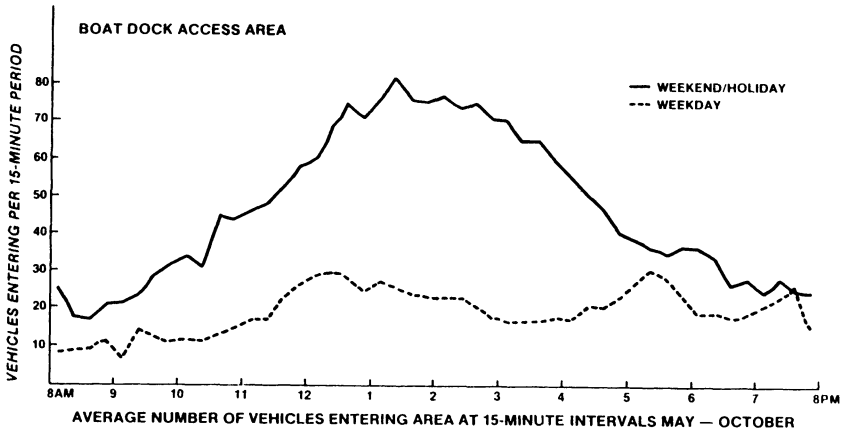


FIGURE 7. The number of vehicles entering a Chicago-area forest preserve shows a stable pattern over the day (Dwyer, Schroeder, & Buck, 1985).

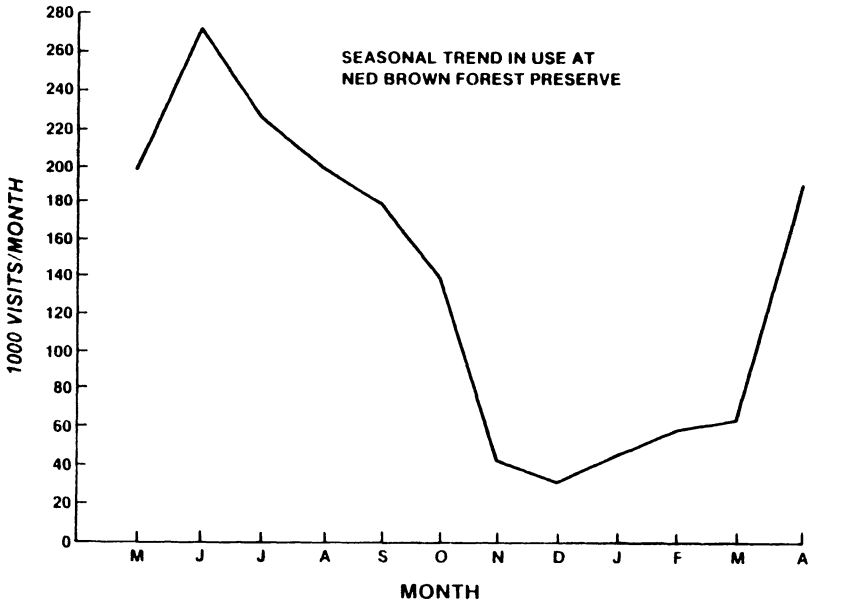


FIGURE 8. Numbers of visits to a Chicago-area forest preserve increase rapidly during the spring and peak in early June (Dwyer, Schroeder, & Buck, 1985).

Destination Choice Behavior

Several studies have examined how people decide which urban recreation sites they will visit. Travel time or distance to the site seems to be a primary consideration. For example, 37% of Chicago-area forest-preserve visitors travel 2 miles or less from home or work to the forest, and about half reported a travel time of 10 minutes or less (Young & Flowers, 1982). Distance has consistently appeared as a dominant factor in models predicting choice of Chicago-area urban-forest recreation sites (Darragh, Peterson, & Dwyer, 1983; Peterson, Dwyer, & Darragh, 1983) and urban forest trails (Lieber & Allton, 1983).

The perceived attributes of urban forest sites also influence choices, but the process is difficult to model. In one study, some attributes had a consistent effect on the probability of a park's being chosen, but other attributes had effects that varied according to the type of site (Peterson *et al.*, 1983). This finding suggests that there are different categories of urban forest sites, and that the choice process is "nested" (Peterson, Stynes, Rosenthal, & Dwyer, 1985). That is, a visitor first decides which type of site to visit (e.g., forest preserve, botanical garden, or indoor conservatory) and then chooses an individual site within the category.

Choices among urban-forest recreation sites are influenced by the amount of information that people have about the sites available to them. Many people are unaware that certain parks exist and are unfamiliar with the locations, features, and facilities of the parks they are aware of (Spotts & Stynes, 1985). Surveys have shown an especially low level of awareness for distant parks, new parks, and less developed parks. Many respondents in these surveys were unfamiliar with the locations and facilities of even some major city parks (Spotts & Stynes, 1984).

Widespread lack of information about urban parks complicates the task of modeling the choice process. When knowledge variables are incorporated into park choice models, it appears that distance from the park is the best predictor of both awareness and visitation rates. Thus, it is possible that the effect of distance on urban park trips is due as much to differences in awareness as to differences in travel cost (Stynes, Spotts, & Strunk, 1985).

Safety, Crime, and Conflict

Although crime and social conflict are problems in all kinds of recreation areas, they are often a particularly acute concern in urban parks and forests. One survey, for example, identified drinking and drug use,

fear of crime, teenagers, and clashes with rangers as significant concerns of Chicago forest preserve users (Young & Flowers, 1982). Social conflict includes a wide range of behaviors, from violent crimes such as murder and armed robbery, to "nonviolent" offenses such as vandalism and drug use, to behaviors that, although not illegal, may be threatening or offensive to other users (Chubb & Westover, 1980).

Design and behavior research has focused on people's subjective perceptions of crime and safety. Interviews of users in three regional parks in Michigan and Minnesota showed that most users were satisfied with park rules and with the level of compliance and enforcement (Westover, 1985b). Minorities, low-income visitors, frequent visitors, and young males were more likely to perceive rules as unfair, and to report observing rule violations. Exposure to rowdy or inappropriate behavior decreased the perceived effectiveness of law enforcement. Although most users felt the parks were generally safe, over 40% reported experiencing fear or engaging in avoidance behavior at some time (Westover, 1985a). It appeared that avoidance behaviors were successful in reducing the visitors' level of fear.

Viewers' ratings of park photographs showed that features of the physical park environment may influence levels of perceived risk (Schroeder & Anderson, 1984). Long-view distances, open grassy areas, and water were associated with high safety, and dense vegetation, graffiti, and litter decreased perceived safety (Figure 9). Undeveloped, heavily forested environments were perceived as the most scenically attractive but the least safe sites; and open athletic fields were perceived as least scenic but most safe. Parks and picnic areas that had substantial tree canopy overhead, but little foliage at eye level to interfere with visibility, were perceived as both safe and scenic (Figure 10).

A similar study of urban parking lots showed that lots with vegetation were perceived as safe only when the vegetation was well maintained and was part of a landscape design (Shaffer & Anderson, 1985). Perceived safety was also enhanced when vegetation did not block the visibility of entrances to buildings.

On urban trails, perceptions and concerns about safety were related to the level of interaction that users expected to experience with other people (Lieber & Fesenmaier, 1985). Where there was a possibility of threatening encounters with other people, trail users indicated that the most effective means of allaying fear would be to increase the presence of law-enforcement personnel and to move trail heads away from parking areas. Cutting vegetation to increase visibility was seen as a very undesirable policy.

Recent field experiments have tested whether depreciative behav-



FIGURE 9. Graffiti and poor maintenance create the perception that a park is dangerous.



FIGURE 10. A park with a substantial tree canopy but little vegetation blocking the view at eye level may be perceived as both safe and aesthetically attractive.

iors can be controlled by management actions and environmental conditions. One study showed that appeals to campers to help reduce littering led to an increase in antilittering behavior (Christensen & Clark 1983). Another study showed that carving on picnic tables was more frequent at sites where there was previous carving and where authority was less salient (Samdahl & Christensen, 1985). These experiments were conducted in nonurban campgrounds, but they suggest approaches that could also be used to address these problems at urban forest sites.

Sources of variation in Preference and Behavior

It is often said that "beauty is in the eye of the beholder," meaning that different kinds of people have different standards of preference. But environmental preference studies often show a very high level of agreement between very diverse groups of people. For example, in one study, a group of white male members of a rural Georgia civic club and a group of predominantly young black female temporary employees of an urban Atlanta nature center gave very similar preference ratings to a set of urban scenes (Anderson & Schroeder, 1983).

More detailed examination of environmental preferences, however, has revealed that some individuals do vary from the consensus (Kaplan, 1984a; Schroeder, 1983). For example, in a study of the perceived safety and the scenic quality of urban parks (Schroeder & Anderson, 1984), the majority of raters thought that natural-appearing scenes with dense vegetation were the most attractive, but some raters gave their highest ratings to more developed and manicured parks. Also, the majority thought that heavily wooded parks were the most dangerous, but a minority felt that densely wooded parks were among the most safe.

It is natural to wonder whether variations in preference and behavior are related to identifiable characteristics of urban residents. If different preference and behavior patterns can be identified for different segments of the urban population, then managers could more effectively manage urban forest resources for the benefit of their users. This section reveiws what has been learned recently about the sources of variation in urban forest perception and behavior.

Ethnicity. Blacks are the largest ethnic minority in American cities. There have been several studies about their recreation activity patterns (O'Leary & Benjamin, 1982; Stamps & Stamps, 1985; Wendling, 1980), but most of this research has not focused on the environments in which the activities take place.

In general, black Americans appear to be less interested than white

Americans in nature and the outdoors, and to have less knowledge about environmental concerns and wildlife (Kellert, 1984). Several studies seem to suggest that blacks are more oriented to urban environments than to natural ones. An Indiana survey showed that blacks used city and town rather than forest, farm, and water environments for most of their recreation (O'Leary & Benjamin, 1982). Blacks in Lansing, Michigan, were found to be less aware than whites of the parks available for outdoor recreation in that city (Spotts & Stynes, 1984). In a survey of fifth-grade children attending an urban nature center, black children emphasized the fun and play aspects of the experience, and white children emphasized natural qualities of the environment such as plants and animals (Metro, Dwyer, & Dreschler, 1981). Black visitors at an interpretive center were more interested than whites in attending a program that placed nature within the context of the urban environment (Fritschen & Stynes, 1980).

Interviews with low- and moderate-income blacks (Talbot & Kaplan, 1984) suggested that blacks differ from whites not so much in a lack of interest in enjoying the outdoors, as in the kind of outdoor environments they enjoy. Blacks preferred orderly, well-maintained areas with built features over more natural and densely wooded areas, a preference that may have been associated with fear of physical danger.

Hispanic Americans are another significant minority in many cities, but there has been very little research on their use of urban parks. On-site observations of parks in Chicago neighborhoods (Hutchison & Fidel, 1984) revealed that Mexican-Americans did less jogging, walking, and biking, and more stationary and sports activities, than Anglo-Americans. The Mexican-Americans' use of parks was characterized by large multifamily groups with a mixture of ages. This pattern may be related to the family- and group-oriented culture of the Mexicans, and to the traditional use of the plaza in Mexican cities.

Residential Background. Differences in recreational use and preference for outside environments may be related to differences in the residential backgrounds of different urban groups. A national survey showed that residents of large cities had a lower level of understanding of and personal interest in wildlife and the outdoors than suburbanites (Kellert, 1984). An analysis of college students' ratings of photographs of urban parks and forests (Schroeder, 1983) revealed that the raters with urban backgrounds were more likely to prefer developed city parks, and that the raters with suburban and rural backgrounds were more likely to prefer natural-appearing forests. In open-ended responses to photographs of urban parks and forests (Schroeder, 1982), urban re-

spondents mentioned vegetation, water, and fields less frequently as preferred features than did nonurban respondents, and they were less likely to mention artificial features as undesirable. Urbanites also expressed more interest in the ability to engage in activities at the sites. This response is consistent with that in a survey (Ulrich & Addoms, 1981) showing that active recreation and socializing were more important as park benefits for people with urban backgrounds than for nonurban people.

Gender. Male and female users differ in their use of urban parks (Westover, 1986). Observational studies have shown that males are more frequent users of central-city parks than are females, and that the proportion of female users changes during the day, being highest during midday and lowest in the morning and evening (More, 1985a). Males are more likely to engage in active sports, and females are more likely to engage in passive activities, such as sitting and reading (Ulrich & Addoms, 1981). Differences in use patterns between males and females may be influenced by fear of crime. Females are more likely than males to report that city parks are unsafe and to express more fear of crime, a finding suggesting that females require more visible, formal law enforcement in order to feel secure in parks (Westover, 1985b).

Age. Some research results suggest that nature and urban forests are less important to older than to younger urbanites. In a national survey, people over 35 years old expressed a lower interest in and affection toward the outdoors than did people aged 18–35 (Kellert, 1984). In a study of the visual quality of residential streets, the level of upkeep of the street was the most important predictor of elderly people's preference, and natural elements were not a significant factor (Nasar, 1981).

Other research, however, suggests that urban forests may, in fact, be important to the elderly. Interviews of older park users (Godbey & Blazey, 1983) showed that parks may help create a positive state of mind among old people. Their park use is often part of a regular routine rather than a break from daily routine. Elderly users tend to accommodate their use of the park to conditions such as safety and special events, rather than fitting their use pattern to their own personal schedules.

At the other end of the age continuum, forest experiences and preferences of schoolchildren visiting an urban nature center were studied by Metro *et al.* (1981). Most of the children had been in a forest before with family or another group and had enjoyed the experience. Exploring was the most frequently reported experience. Most children said they felt safe in the forest. The most frequently perceived danger was from wild animals.

A comparison of preferences of senior citizens and sixth-grade children in a Minnesota town (Stiegler, 1985), suggested that urban forests are perceived quite differently by elderly people and children. The seniors saw urban forests as more similar to natural forests than did the children. The majority of the children preferred natural forests to urban forests, but the majority of the seniors preferred urban forests.

Education. College education seems to be associated with greater concern about, appreciation of, interest in, and understanding of animals and nature (Kellert, 1984). Professional training and experience in resource or park management may also influence perceptions and preferences. In a study of preferred tree density in parks (Schroeder & Green, 1985), staff members at an arboretum preferred higher tree densities than did other groups of raters, and employees of suburban park districts preferred the lowest density. Landscape architecture students' ratings of urban scenes have also been observed to diverge somewhat from other groups' preferences (Anderson & Schroeder, 1983).

Activities. It seems obvious that people's preferences for urban park environments should depend on what they intend to do there, but there has not been much research relating environmental preferences to specific recreation activities. In a survey of urban-forest trail-users, clear differences were found between people using the trails for different activities. Bicyclists strongly preferred paved trails, and hikers, joggers, and cross-country skiers preferred wood chips. Skiers liked hilly trails, and joggers disliked them. Skiers and hikers liked frequent changes in trailside scenery, and joggers had a strong preference for trails close to home (Allton & Lieber, 1983; Lieber & Allton, 1983). More information of this sort concerning other kinds of urban forest sites would be useful for designing environments to serve specific activities.

Disabled Users. Urban forests may be important in serving the outdoor recreation needs of disabled people because they are potentially more accessible than backcountry forest sites. There has been very little research on the general environmental preferences of disabled people, but some recent studies provide useful insights into the question of the accessibility of recreation resources to the disabled. Attempts to make urban parks more accessible have focused on physical barriers to park use, but social barriers may be just as serious a problem (West, 1981). In a survey of disabled park users, about half of the respondents who perceived negative reactions to their disability subsequently reduced their level of recreation participation. These individuals might be helped by programs to develop their coping strategies and maintain their positive self-concepts despite social stigma experienced in public parks (West, 1984).

APPLICATION OF RESEARCH TO MANAGEMENT SYSTEMS

Research on urban forests is useful only to the extent that it can contribute to the planning and management of vegetation in cities. At its most basic, urban forest management involves the planting, maintenance, protection, and removal of trees in cities (Grey & Deneke, 1986). These activities occur not in isolation, however, but in a broader context of land use and recreation planning, which has the goal of improving the quality of life by relating human needs to environmental and spatial resources (Gold, 1983a). In this section, I review examples of how design and behavior research has been or could be used in the process of planning and managing urban forests.

Public surveys can provide information on how the public perceives the importance of management objectives and the performance of the agency in meeting those objectives (O'Leary, 1982). Surveys have been used to document the importance of urban trees to residents; to identify opinions about where trees should be located, what kinds of trees are preferred, and what services should be provided; and to reveal sources of dissatisfaction with tree management programs (Getz, Karow, & Kielbaso, 1982; Schroeder & Appelt, 1985).

Surveys not only can provide guidance for designing new parks and facilities but can also assess the success of the design after the park is completed (Kaplan, 1980, 1981). Surveys using photographs and other visual simulations have proved useful in obtaining public input into the design process for community redevelopment and in evaluating the public response to alternative design proposals (Smardon, 1985). Knowledge about public motives and perceptions has provided a basis for publicity efforts to correct lack of information and misinformation in the public's image of a park (Hayward & Weitzer, 1983), and to broaden the appeal of interpretive programs (More, 1983).

Research can identify weaknesses in established planning mechanisms. For example, a survey of residents of urban neighborhoods (Talbot, 1982) showed that certain physical characteristics of neighborhoods, including tree density, affected people's satisfaction with where they lived. Most of these characteristics, however, were not among the standard variables used for zoning urban land uses. Coughlin, Mendes, and Strong (1984) observed that many communities have programs for protecting trees, but that these are concerned only with maintaining adequate numbers of trees and not with placing trees in locations where they will create the greatest community benefit. These planning mechanisms could be improved by taking advantage of what has been learned in research on public percpetions and the benefits of urban forests.

A case study of land-use planning in a Pennsylvania township (Coughlin & Strong, 1983) demonstrates how the measurement of vegetation benefits can be an integral part of the planning process. Scenic areas of the township were identified by the residents, and the value of vegetation was measured with a contingent valuation survey. This study was concerned with the urbanization of forest and farmland and assumed that the benefits of vegetation on a parcel of land would be completely lost if the parcel was developed. This assumption could be revised based on recent research, to include the benefits of preserving and managing vegetation on developed parcels of land.

Recently, several urban-forestry-management systems have been proposed that would integrate vegetation management into the routine planning process. These systems would set standards for environmental characteristics in specific areas of a city (Sanders & Rowntree, 1984), would monitor and map tree diversity levels to prevent vulnerable single-species populations of trees (Sanders, 1981), and would estimate and map popular satisfaction rates for vegetation across city neighborhoods (Sanders, 1984). All these proposals could take advantage of the currently available procedures for measuring public perceptions of the urban forest. Palmer (1984) proposed that social and perceptual assessments of neighborhoods be combined with physical and biological data to define planning units in the urban forest. These units would play the same role in urban planning that timber stands play in forest planning.

Microcomputer data bases, developed for inventorying urban forest resources, are becoming increasingly important as management tools in urban forestry. Inventories that record the location, size, and species of street trees can provide data for predicting the aesthetic quality of urban streets (Lien & Buhyoff, 1986). A "scenic beauty equation" could easily be built into a street-tree data base to allow managers to locate streets in need of aesthetic improvement and to predict the visual impact of changes in street tree populations. Inventory methods that will assist in the management of trees in parks are also being developed, and these can be linked to perceptual models based on research about public preferences for trees in landscapes (Schroeder & Green, 1985).

IMPLICATIONS FOR FUTURE RESEARCH AND APPLICATION

Trees and other vegetation provide an effective means of improving the perceived quality and the livability of urban environments. Continuing research on the environment, behavior, and design aspects of urban forestry should emphasize those topics and issues that will most en-

hance the ability of urban forest managers to use vegetation to improve urban living.

Research on benefits suggests that the most significant benefits of urban forests may be "passive," that is, benefits of aesthetic enjoyment and enhanced environmental quality obtained from simply observing the forest or just knowing it is there. More research is needed if we are to understand the importance and significance of experiencing urban vegetation in people's daily lives. This research should be ecological in character; that is, it should study people's behavior and experience in their real-world daily activities. Even brief and casual encounters with vegetation may have significant impacts on the quality of everyday life, and innovative research approaches will be needed to study these effects.

Qualitative studies of the significance of urban trees for individuals would help to fill out our understanding of urban forest benefits. The quality of life is partly a function of the emotional attachments that people form to specific places and to special features of their surroundings. Individual trees may be associated with memories of significant places and events and may thus become the objects of strong feelings (Tyznik, 1981). In-depth interviews with individuals about the meaning and significance of trees to them could be both fascinating and useful.

At the same time, research that identifies and measures tangible indicators of urban forest benefits would greatly strengthen the arguments for spending public funds to manage urban trees. More research is needed on the physiological and health effects of vegetation, and on the relation of vegetation to indicators of social welfare, such as crime, vandalism, and mental illness.

Further research is needed on variations in preferences for outdoor environments across different segments of the urban population. One of the most important dimensions of variation in urbanites' preferences for parks appears to involve the developed versus the natural character of a site. Different people prefer different levels of development, and parks with different levels of development may provide distinctly different kinds of benefits (Figure 11). The Recreation Opportunity Spectrum (ROS), currently used for forest-recreation planning in the United States, classifies recreation opportunities on a continuum from primitive to urban (Clark & Stankey, 1979). The ROS, however, was developed in the context of nonurban forest planning, and it does not capture the variation in the character, uses, and values of parks and forests within the urban context (Kaplan, 1984b). Further research on the perceived naturalness of urban forest sites, the preferred levels of development, and the benefits of natural versus developed sites could lead to a system similar to the ROS, but more suited to the urban context.

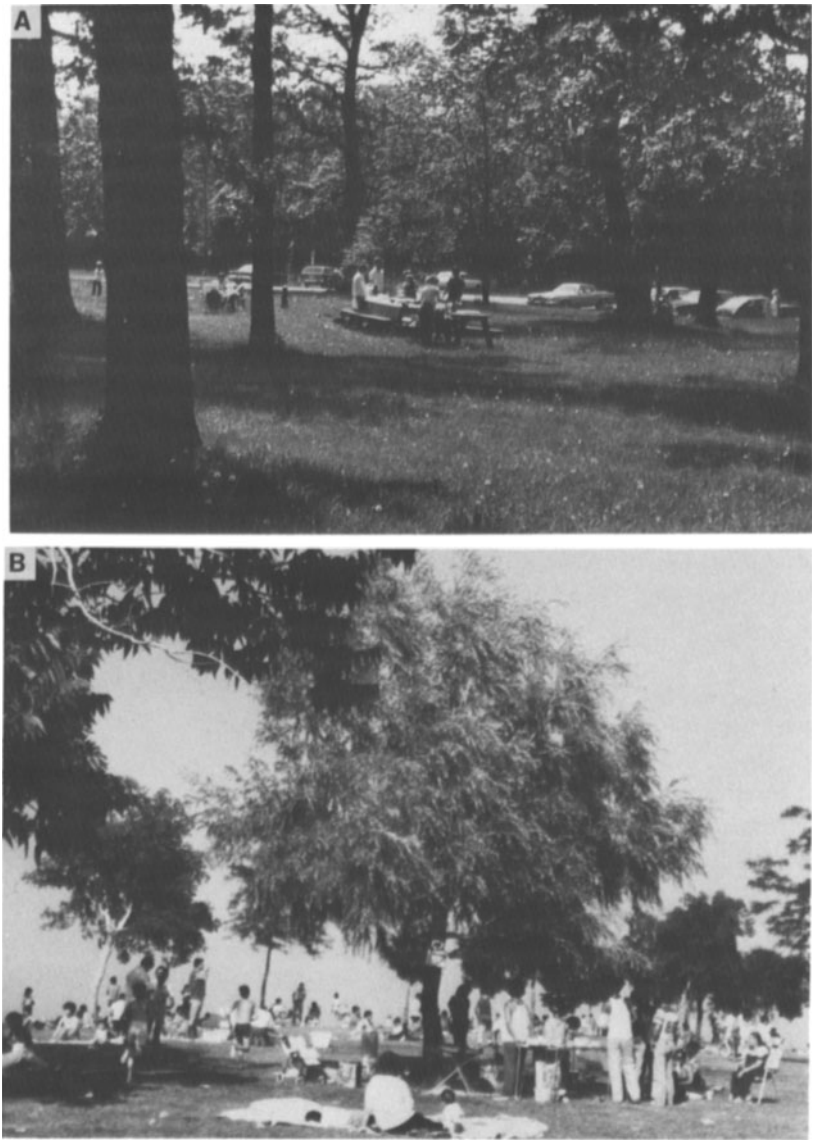


FIGURE 11. Some people prefer to picnic in a rustic and secluded forest location (A). Others may prefer the same activity in a more highly developed and heavily used city park (B).

The role of researchers in urban forestry should not be only to provide information to managers, but also to provide managers with methods for obtaining their own information. Urban resources and urban populations are so diverse and so rapidly changing that the research results from one situation may often not generalize to other situations. Researchers should try to get managers directly involved in doing research on their own sites and users, so that they can answer specific questions and evaluate the consequences of alternative management actions. Field experiments that test the effectiveness of management actions—for example, to control litter and vandalism—would be a good context for cooperative work between researchers and managers.

The growing use of microcomputers in management and research offers many opportunities for making research results usable by and accessible to managers. Interactive programs that predict levels of use at urban forest preserves (Dwyer *et al.*, 1985) and the distribution of choices over sets of parks (Schroeder & Louviere, 1986) have proved effective in conveying research results to managers who are unfamiliar with the technical aspects of regression and logit models. Researchers should be alert for opportunities to tie their research into existing or proposed computerized-management-and-planning systems for urban forests.

Research on urban forest managers themselves may be useful in uncovering the institutional structures within which urban forest management takes place. Urban forestry is carried out in a multitude of municipal governments, and we do not have a clear overall picture of who the managers are, what their background and training are, what problems and conflicts they encounter in doing their work, and how they resolve those conflicts. A better knowledge of the urban forest managers would help us to see how research can fit into the overall picture of urban forest management.

Researchers and managers may also be able to learn by observing management practices in other countries. Many European countries with large urban populations and limited forest resources have had centuries of experience in managing forest environments. Studies of forestry practices in Germany (Schabel & Dwyer, 1985) and the Netherlands (Dwyer & Strong, 1986) suggest that some of the intensive management practices used in those countries could also be applied in American cities (Figure 12).

Not all interactions between trees and people are pleasant. Falling branches and trees can cause property damage, severe injury, and death. The problem of liability at public recreation sites is becoming a serious concern for urban forest managers. Public agencies, no longer

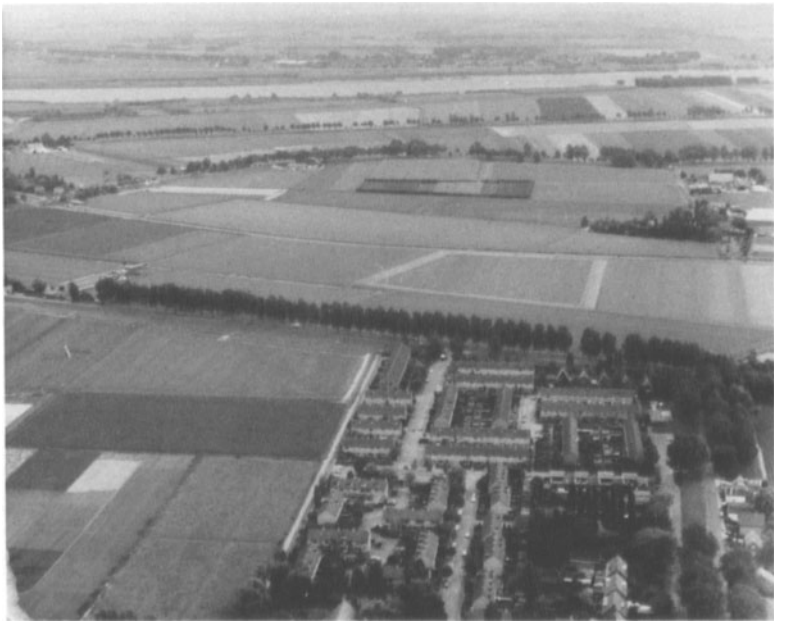


FIGURE 12. Strict land-use controls and intensive planning in the Netherlands have led to innovative uses of trees in heavily populated landscapes.

protected by the doctrine of sovereign immunity, must undertake risk management programs to reduce the danger of severe injury at their sites (Gold, 1983b). Damage and injury from falling trees and branches may lead to staggering court settlements against public agencies. Urban foresters need to understand their legal responsibilities for inspecting and removing potentially hazardous trees from public parks and rights-of-way (Anderson & Eaton, 1986). Research on the legal aspects of urban forest management would be very timely now.

In this chapter, I have reviewed recent progress in several areas of research on design, perception, and behavior in urban forest environments, and I have tried to suggest some useful directions for further work. The ultimate test of the value of this research will be whether it leads to better environments for people. It is still not clear what impact environment, behavior, and design research has had on the quality of urban forest environments, but at the very least, research has helped to increase managers' awareness of the importance of the human and social aspects of managing these resources. The best future prospects for truly useful work in this area will be found in a close partnership be-

tween researchers and managers that identifies, studies, and ultimately solves problems of urban forest management.

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