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# Perceived personal safety in relation to urban woodland vegetation – a review


## *Abstract*

Urban woodland vegetation provides people with many aesthetic, ecological and psychological benefits, but can also generate problems concerning people's perception of safety. This paper reviews existing knowledge about perceived personal safety in relation to vegetation, particularly woodland vegetation, in urban green spaces such as parks and residential areas. Individual and social factors, but also vegetation character, maintenance and design, proved to be important for perceived personal safety. Vegetation-related aspects identified as being of particular importance include landscape design, possibilities for overview and control, vegetation density, and vegetation character and maintenance. Vegetation of an open character with low density undergrowth might have positive effects on perceived personal safety without reducing other benefits. Issues for future research include context-based studies to consider several aspects of vegetation and their interactions.


**Key words**: Fear; Fear of crime; Landscape design; Landscape planning; Vegetation development

## Introduction

Woodland vegetation is common in urban green spaces such as parks and residential areas today. One reason is the naturalistic "ecological woodland style" common within landscape design in the 1970s-1980s in the UK, the Netherlands and Sweden (Jorgensen et al., 2007). Such vegetation includes a mixture of trees and shrubs of various species, with one or more layers of understory vegetation. The ideal was nature and old cultural landscapes (Gustavsson, 2004), but insufficient maintenance can lead to dense, untidy vegetation. According to Jorgensen et al. (2007), woodland plantings in the UK are in need of development to increase perceived safety.

This paper reviews existing knowledge regarding the influence of natural and naturalistic urban woodland vegetation on people's perceived personal safety.

Woodland vegetation in urban areas provides many benefits, e.g. for human wellbeing and health (Hartig et al., 2003; Berman et al, 2008). Through adding biodiversity in urban environments, vegetation can improve mental health (Fuller et al., 2007) and add pedagogic and social benefits (Miller & Hobbs, 2002). Areas with trees by multi-family housing may become meeting places, improving social connections between residents (Coley et al., 1997; Kuo et al., 1998; Sullivan et al., 2004). Woodlands close to housing are also important for children's everyday play (Florgård & Forsberg, 2006).

People tend to find natural-looking woodlands attractive (Schroeder & Anderson, 1984; Burgess et al., 1988; Jorgensen et al., 2007). Europeans generally prefer forest vegetation with diversity in tree species, variation between areas and naturalistic forest edges (Edwards et al., 2011). Moreover, natural green areas need to be easily accessible, within a few minutes' walk (Coles & Bussey, 2000), to increase use and limit stress-related diseases (Grahn & Stigsdotter, 2003; 2010). However, there are differences in people's experiences and needs, indicating that although green space with a natural or wild character is important close to residential areas, there is also a need for variation to promote individual choice (Jorgensen et al., 2007), safety and preference for all users (Schroeder & Anderson, 1984; Burgess et al., 1988).

Perceived personal safety is an experienced feeling, distinct from actual safety, security or risk, and therefore needs to be approached differently. Feeling unsafe outdoors is often connected to the fear of crime, but also other factors. However, “fear of crime” is commonly used as a concept concerning unsafe perceptions in a wider sense. For example Pain (2001, p. 902) defines fear of crime as “the wide range of emotional and practical responses to crime and disorder made by individuals and communities”. Sparks et al. (2001) connect fear of crime to worries about e.g. the behaviour of young people outdoors, while Day et al. (2003) describe it as the result of complex relations between factors such as reactions to violence and crime, myths about crime, and the construction of male and female identities. Perceived personal safety must be considered a complex phenomenon, affected by much more than the environment.

Fear associated with the presence of woodland vegetation in parks and residential areas has been described by e.g. Jacobs (1961), Burgess et al. (1988), Madge (1997) and Jorgensen et al. (2007). Such low perceived safety has many negative consequences, possibly affecting people more than actual risk and crime. Women in particular may be limited in choosing their desired lifestyle (Keane, 1998) and the elderly may lose the possibilities for a physically active life (Li et al., 2005). Fear of crime has been linked to low levels of physical and mental health and low quality of life (Chandola, 2001; Strafford et al., 2007; Jackson & Stafford, 2009).

The character of vegetation can be an important factor affecting perceived personal safety. Madge (1997) found that park users, particularly women, avoided areas with poor lighting, dense understory vegetation or a high density of trees. Studies have shown that lawns and trees in

residential areas may be associated with high perceived personal safety (Kuo et al., 1998; Kuo & Sullivan, 2001; Kuo, 2003), while a more natural and wild character in certain situations has been described as frightening (Burgess et al., 1988; Bixler & Floyd, 1997; Jorgensen, 2004; Jorgensen et al., 2007). However, aiming for more simple concepts such as lawns and limbed-up trees risks a reduction of the many benefits of woodland vegetation. Furthermore, if vegetation is cut down, increased maintenance problems might emerge. Woodland vegetation, with several layers and free-growing ground vegetation, is often both preferred and feared (Schroeder & Anderson, 1984; Burgess et al., 1988; Jorgensen, 2004; Jorgensen et al., 2007). Despite completely different green space characters being described as the safest (urban parks) and the most attractive (dense forests), it might be possible to combine these two qualities through developing woodland vegetation into more open characters (Schroeder & Anderson, 1984).

Urban settings have often been the study object in the vast research field of perceived personal safety and fear of crime. However, few studies have examined perceived personal safety in parks and other green areas, particularly in residential green areas. The complex dual role of urban woodland vegetation, as valuable but also threatening, shows the need for knowledge on how it can be planned, designed and managed to improve perceived personal safety without reducing other benefits.

In order to identify possibilities for combining safety aspects with other benefits of urban woodland vegetation, existing knowledge on perceived personal safety in urban green spaces first needs to be reviewed. Therefore this paper examined aspects affecting perceived personal safety in relation to vegetation in general, and urban woodlands in particular. The overall focus was on

vegetation and woodlands in urban green spaces such as parks and residential areas. Two specific questions studied throughout the analysis were: What overarching factors affect people's perception of personal safety outdoors? and What qualities connected to woodland vegetation have been found to affect the perception of personal safety?

## Methods

A literature review on perceived personal safety in urban woodland vegetation was conducted in March 2012. The starting point was a literature search using the search engine Scopus (www.scopus.com) and combining the search words 'safety' and 'fear' with 'vegetation', 'woodland' and 'parks' (Table 1). This yielded a total of 2098 articles, but after assessment of the relevance of these articles for the two research questions, only 10 remained (Table 2). As a second step, the reference lists of these 10 articles were used to locate additional relevant literature, using the so-called snowballing method. This process yielded 46 sources of direct interest to the present study, of which nine concerned perceived personal safety in residential open spaces and 37 personal safety in public areas such as parks and urban forests. The relevant literature found was analyzed for information on aspects of fear or safety in urban green spaces with particular focus on woodland vegetation qualities for increased perceived personal safety. The literature review was also used to identify factors reported to have an impact on perceived personal safety outdoors.

## Factors affecting people's perception of personal safety outdoors

Among the theories and models describing the factors behind perceived safety and fear, three types of factors are commonly described: individual, social and environmental. Studies of how the physical environment affects personal safety must therefore be conducted with awareness of all these factors. However, it may be difficult or even impossible to separate the effects of the different types of factors from each other. Models for individual (psychological) and social (social-demographic) factors in fear of crime have been developed by Van der Wurff et al. (1989) and refined by Farrall et al. (2000). The psychological model contains four components: attractivity (seeing oneself or one's possessions as a possible victim or target), evil intent (view of other people's intentions), power (between oneself and others) and criminalizable space (situation in time and space). The social factors identified by Van der Wurff et al. (1989) were: age, gender, level of income and education, household size, professional or study activity, and number of acquaintances within the local area. Farrall et al. (2000) proposed combining individual and social variables, adding e.g. time lived in the neighbourhood, owning one's own dwelling and health during the past year, to account for more of the individual variance.

The cultural and environmental context is a social aspect of importance for perceived personal safety, although most studies within the research field have examined large-scale urban areas with socio-economic problems in the USA or the UK. However, culture, level of urbanization and type of urban area may affect perceived personal safety. For example, Maas et al. (2009) found that green areas were associated with low social safety mainly in highly urbanized areas. What is perceived as acceptable concerning other people's behaviour and vegetation maintenance level can be more limited in semi-public residential green areas than in public parks (Westover,

1985; Lindgren & Nilsen, 2012) and the distance to the home may also have a influence (Jorgensen et al., 2007). The Nordic countries are commonly described as safe. For example, Sweden, Denmark and Finland have a smaller proportion of people feeling unsafe outdoors than for example the USA, the UK, Germany and Australia (van Kesteren et al., 2007). Koskela (1997) found that the cultural understanding of Finland as safe led to women not avoiding unsafe places and having a "spatial confidence" (Koskela, 1997, p. 121) not found in the US and the UK (Pain, 1997). However, the same types of places were considered unsafe by women in the US and the UK as in Finland (Koskela, 1999).

Much research has focused on women's fear of crime in public spaces, while men are commonly described as less afraid than women (Valentine, 1992; Farrall et al., 2000; Jorgensen et al., 2002). Women's fear has been considered an expression of how gender roles affect the perception of, and access to, public space (Valentine, 1992). Women see themselves more as potential victims, are often particularly afraid of walking outdoors alone after dark (Farrall et al., 2000) and describe themselves as less safe than men when passing woodland vegetation (Jorgensen et al., 2002). However, men's fear has also gained attention recently. Bronlow (2005) found that young men, just like young women, are afraid in public spaces. However, showing their fear would be against the social construction of being male. This points at a possible hidden problem of fears about personal safety among men.

There may also be differences concerning the environments that women and men perceive as unsafe. Women may pay more attention to elements in the physical environment, while men's

fear is more constant and less environment-related (Bronlow, 2005, p. 589), but still makes them avoid places where they do not feel in control (Day et al., 2003). Koskela (1999) describes women as more afraid of empty or isolated places and men as more afraid of socially active places, which indicates that women expect help from others more than men.

Differences between social and ethnic groups may also be important for the perception of personal safety (Madge, 1997; Pain, 2001). Madge (1997) found that ethnic minorities in a UK study felt more unsafe than others, and that their concerns included fear of dogs and racially motivated attacks. Pain (1997) noted that although social class appeared not to affect the level of fear among women, it did affect the places associated with fear. So called working class women did not avoid public spaces as much as other women, probably due to limited economic possibilities for private transport.

Age has often been connected to perceived personal safety and avoidance of places outdoors, but the relationship is complex. Older women in particular have been described as afraid, but also older men (Beaulieu et al., 2007). A British study showed that fear limits park use by the elderly more than for young people (Madge, 1997). However, Jorgensen and Anthopoulou (2007) found that older people felt no more unsafe than younger among park users in Sheffield, although the elderly described themselves as more vulnerable were they to be attacked. Pain (1997) showed that young women limited their own mobility outdoors more than older women, due to fear of violent and sexual crimes.

While some variation in people's perceived personal safety can be connected to social factors such as culture, gender and age, there are also large individual differences, and social and individual factors can be highly interconnected. For example, children given access to play in woodlands have a more positive attitude to such vegetation, including less fear, as adults (Milligan & Bingley, 2007). Furthermore, perception of personal safety changes with life experiences, such as becoming a parent (Koskela, 1997; Valentine, 1992) or being the victim of crime (Koskela, 1997; Beaulieu et al., 2007). An individual can thereby change the way in which he or she perceives environments in terms of safety.

Individual factors can be critical for how safety problems are approached in the physical environment. Johansson et al. (2011) studied the perception of lighting along a path through green areas and found that women were more afraid than men, but also that individual "environmental trust" (comparable with "spatial confidence" (Koskela, 1997)) had great influence. Schroeder and Anderson (1984) noted in their study of people's perception of personal safety and aesthetics in urban park environments that there always appeared to be some informants with totally different perceptions than the majority.

The effect of the physical environment on perceived personal safety is not fully understood, but it can be expected to be one of several aspects involved. Physical aspects affecting perceived personal safety are often described as small-scale features of which people who experience fear are aware, called "micro-design features" (Valentine, 1989), "cues" (Pain, 1997) or "proximate cues to fear" (Nasar et al., 1993). Physical changes can increase perceived personal safety,

198 although the reason why people are afraid might not have environmental origins. It is also
199 possible that people do not view the physical environment as the problem. Burgess et al. (1988)
200 found that park users in London rarely proposed physical solutions to unsafe parks, but focused
201 on improved social relations and park personnel. Social constructions such as the image and
202 reputation of an area can also be of major importance, related to the physical environment
203 (Koskela & Pain, 2000; Kullberg, 2010).

204

205 **Perception of personal safety in relation to woodland vegetation**

206 Several studies add to the picture of certain green spaces being perceived as unsafe, particularly
207 after dark (Burgess et al., 1988; Valentine, 1989; Madge, 1997; Koskela & Pain, 2000). In the
208 literature, four main aspects of how woodland vegetation affects perception of personal safety are
209 identified: 1) landscape design, 2) possibilities for overview and control, 3) vegetation density,
210 and 4) vegetation character and maintenance. These four aspects interplay and together describe
211 perception of personal safety in woodland vegetation and how it can be improved.

212

213 **The landscape design**

214 The overall landscape design appears to be important concerning vegetation in a spatial context.
215 It is possible that when vegetation is seen as part of a readable, unified design, it is perceived as
216 safer than vegetation elements which appear more disparate. Shaffer and Anderson (1985)
217 studied personal safety and attractiveness in parking lots adjacent to commercial and multi-family
218 residential structures and found that increased vegetation was positive for attractiveness, but for

the scene to be perceived as safe the vegetation needed to be well-maintained and appear to be part of a readable landscape design.

Closed areas in parks and other open spaces are often perceived as unsafe (Madge, 1997; Jorgensen et al., 2002). Closures can form hidden areas, something that women commonly associate with fear of sexual violence (Madge, 1997). Jorgensen et al. (2002) explored the parameters of closure further, testing three types of spatial structures: completely closed (vegetation on both sides of a path), partially closed (vegetation on one side and a single tree on the other) and no closure (vegetation on one side only). The results showed that the more open the structure, the safer the perception, but that overall landscape design is complex, and also interplays with other aspects. Landscape design features such as the vegetation scale and its relation to other elements in the surrounding landscape will need more attention in future research about perceived personal safety.

**Possibilities for overview and control**

A probable explanation why closed areas are considered unsafe is the association with lack of control, with fewer possibilities for overview and escape. Overview allows the individual to see other people close by and to evaluate whether they pose a potential threat. Increased visibility and recognition from a distance may explain why, for example, improved lighting has a positive effect on personal safety outdoors (Painter, 1996).

The role of overview and control in relation to perception of personal safety can be connected to the prospect-refuge theory proposed by Appleton (1975), commonly cited in studies of the physical environment's effect on perceived personal safety (e.g. Fisher & Nasar, 1992; Nasar et al., 1993; Luymes & Tamminga, 1995; Herzog & Kutzli, 2002). The prospect-refuge theory is based on Darwin's habitat theory, according to which people prefer environments where they perceive greater chances for survival. Features in a landscape signal either good prerequisites for survival or not, determining whether the landscape is spontaneously preferred or not, and in places associated with survival it is possible to overview the surroundings (prospect) and to hide (refuge). People should therefore feel safest in environments where they can see without being seen (Appleton, 1975; Luymes & Tamminga, 1995). This can be considered in woodland vegetation design and maintenance.

Fisher and Nasar (1992) developed Appleton's theory by pointing out that like the potential victim, the potential offender prefers environments which offer prospect and refuge, so spaces which offer prospect and refuge but are closed off from the surroundings may allow an offender to trap a victim. Therefore, Fisher and Nasar (1992) proposed that perception of safety in an environment is not only connected to the level of prospect and refuge, but also to the possibility for *escape*. Escape may require physical exit routes from potential threats, or proximity to other people who can help in the event of an attack. Fisher and Nasar (1992) tested their theory in a study on a college campus and found that the fear of crime is higher in environments providing potential offenders with a good refuge but potential victims with poor possibilities for prospect and escape. The latter can increase worries about how to avoid a threatening situation and thus lead to fear (Blöbaum & Hunecke, 2005).

Prospect-refuge theory has led to concrete proposals on developing vegetation for increased personal safety. Based on this and other theories, Luymes and Tamminga (1995) developed principles for the planning and design of urban greenways according to which it is important to be able to see and be seen by other people, make one's own choices and be in control of the surrounding environment, read it and be alone without being isolated. Luymes and Tamminga (1995) also point out that some paths should be designed for night-time use, with uniform lighting  used in an efficient way, and others not. Several routes should be provided. Vegetation along paths should provide free sight between knee and eye height, and vegetation causing shadows and potential hiding places should be cut or moved. Creating increased activity, for example by organizing user groups to establish a presence, can deter crime and improve perceived personal safety. Luymes and Tamminga (1995) also emphasize the importance of involving users in planning, design, maintenance and surveillance.

Herzog and Kutzli (2002) used Appleton's theory to test two types of overview connected to: visual access (being able to see the entire environment) and penetration (being able to see deep into an environment, ease of movement). Both types of overview were associated with high perceived safety in natural environment and both could be improved through vegetation management. Herzog and Kutzli (2002) used photographs of environments with different combinations of vegetation and allowed a group of students to assess the settings. The results revealed that the perception of fear was connected to possibilities to overview parts of an environment and ease of movement within it. Being hidden by vegetation gave a feeling of being

trapped, leading to fear. According to Herzog and Kutzli (2002), visual access and overview can be improved by having well-maintained and smooth ground surfaces, limbed-up trees and carefully placed vegetation in order not to impede visibility or movement.

Possibilities to escape and overview might limit unsafe perceptions in green environments. However, the importance of overview is still not fully understood. For example Jorgensen (2004) criticized Appleton's theory for basing preference on evolution only, such as the reflex to escape in the event of danger, while individual preferences are more complex. A few studies have also reported only minor importance of overview for improved personal safety. Jorgensen et al. (2002) showed the importance of the interplay between the overall landscape design and the vegetation structure and character. It is possible that having openness on one side gives such apparent possibility to escape that dense vegetation on the other side becomes a barrier to potential threats. In a closed space with vegetation on both sides, however, it can be important to see through the vegetation to find possibilities for escape and identify potential threats. Such complexity was observed in a Swedish study of young women's perceptions of a park in Stockholm (Cele, 2009). The women did not think that increased overview, either by improved lighting or low cut shrubs, would make them use the park at night. Instead, they thought low cut shrubs would make them more exposed to unwanted eyes and would make the park less beautiful (Cele, 2009).

**Vegetation density**

The two types of overview according to Herzog and Kutzli (2002), visual access and particularly penetration, can both be expected to increase with low vegetation density. Density in this case

mainly concerns how dense or covering the vegetation is at eye level or between knee and eye level, and has been cited in several studies as important for perception of personal safety (Schroeder & Anderson, 1984; Coles & Bussey, 2000; Jorgensen et al., 2002; Bjerke et al., 2006; Herzog & Bryce, 2007). For example Jorgensen et al. (2002) found that naturalistic, dense vegetation was perceived as unsafe. While penetration or density as an aspect of safety perceptions has not been thoroughly studied, in terms of perceived visual accessibility an understory height of only 54 cm has been found to cause substantial perceived obstruction (Roovers et al., 2006). It is unclear whether perceived personal safety is also affected at the same height, but since penetration and ease of movement (Herzog & Kutzli, 2002; Herzog & Bryce, 2007) are expected to have a great effect on perceived personal safety, there is reason to expect a strong connection.

Opinion differs within the literature regarding whether having low density vegetation reduces aesthetic values and people's preferences. Research has shown that high visual access and penetration (Herzog & Kutzli, 2002) and a sense of mystery whereby the environment promises more if one moves further into it (Kaplan & Kaplan, 1989) have a positive effect on people's preferences for green environments. Kaplan and Kaplan (1989) and Herzog and Bryce (2007) emphasize that mystery in natural environments should not be misinterpreted as obstructed view and surprise. Instead, people tend to prefer environments where the visual accessibility is good, but where there are also elements of mystery (Herzog & Bryce, 2007). Good visual access in woodland vegetation can add to mystery deeper inside the environment and may therefore increase both safety and preference (Herzog & Bryce, 2007). This means that increased visual

329 access through decreased density of woodland vegetation might favour both. Gustavsson (2004)
330 emphasizes for example the aesthetic value of revealing interior vegetation qualities.

331

332 The possibility of combining attractiveness with safety in woodland vegetation through low
333 vegetation density is also mentioned by Schroeder and Anderson (1984), who conducted studies
334 where students assessed photographs of park environments. Dense vegetation was most often
335 seen as the most attractive, while parks with an urban character were seen as the safest. However,
336 it was expected that these two parameters could be combined, with increased penetration and
337 decreased density, by reducing shrubs and raising tree canopies in woodland vegetation while
338 preserving the natural character (Schroeder & Andersson, 1984).

339

340 Vegetation that is only moderately dense or varies in density can meet the demands for mystery
341 and penetration, providing more attractive areas that are also safer. Coles and Bussey (2000)
342 claim that it is important for urban woodlands to be kept well maintained and with an open
343 structure if they are to be appreciated and perceived as safe. This is supported by findings by
344 Bjerke et al. (2006) showing that landscapes with moderately dense vegetation are preferred to
345 landscapes with either more open or more dense vegetation. To meet the needs of many and be
346 attractive for recreation, green areas should provide a variety of vegetation types and degrees of
347 density (Bjerke et al., 2006).

348

It has also been suggested that perception of personal safety is affected by the interplay between landscape design and vegetation structure or density (Jorgensen et al., 2002). Despite dense understory generally being perceived as unsafe when considering vegetation structure only, in that study it was reported to be the safest when there was woodland vegetation on one side only. When woodland vegetation was on one side and a tree on the other, the vegetation structure had little effect. Landscape design and vegetation density can therefore be expected to interact and affect personal safety in combination. This shows that there might be possibilities for varying woodland planting density in the understory without negative effects on perceived personal safety if the landscape design is considered. The safest understory in the study by Jorgensen et al. (2002) was perceived to be one without shrubs, which points to the importance of visual penetration, but with a flowering field layer.

**Vegetation character and maintenance**

To understand why green spaces such as parks and woodlands are sometimes associated with fear, it can be important to examine the character and maintenance of the vegetation. It has been proposed that fear about personal safety is linked to people's fear of 'wild' forest and nature in general (Burgess et al., 1988; Bixler & Floyd, 1997; Jorgensen, 2004; Jorgensen et al., 2007). If fear of the wild is a reason, the character of vegetation and not just its effect on the view could be important. Jorgensen (2004) and Jorgensen et al. (2007) conclude for example that areas with ecological plantings are perceived as unsafe because they differ greatly in character from parklands in the style of the English Landscape movement, which is predominant and preferred in Western green spaces. Jorgensen et al. (2007) found that residents in housing areas with such

vegetation were more likely to identify unsafe places in their local area than residents in other areas. They therefore proposed the use of well-tended landscapes, such as decorative public plantings, close to people's homes, although emphasizing the equally urgent need among many urban dwellers for nearby "accessible wilderness-like areas" (Jorgensen et al., 2007, p. 285). However, Özgüner and Kendle (2006) found that park users in Sheffield considered themselves to be equally safe in parks with a natural character and in those where the vegetation is more formal. Hence, it is not clear what effect the character of park vegetation has on perceived personal safety.

Negative effects on perceived personal safety may be based on assumptions about what can happen in woodland shrubbery with an untidy appearance. According to Jorgensen et al. (2007, p. 280), clusters of shrubby vegetation in residential areas may be considered to provide "a haven for anti-social activities". Activities such as vandalism and littering and physical signs of these or users associated with them, such as youths, commonly cause fear (Day et al., 2003), not least in park environments (Burgess et al., 1988). This may contribute to people feeling unsafe and to threatening behaviour becoming increasingly accepted (Valentine, 1989). The importance of removing such signs of disorder has been emphasized in the influential "broken windows theory", according to which signs of disorder are part of a downward spiral that can lead to a lowering of standards and an increase in crime and fear of crime (Wilson & Kelling, 1982). Despite criticism of the theory, the connection between perceived disorder and low perceived safety is commonly cited. The importance of a well-kept impression for safety and comfort has been shown in some studies of woodland vegetation (Shaffer & Anderson, 1985; O'Brien, 2005; Jorgensen et al., 2007). Jorgensen et al. (2007) suggested that maintenance for variation and signs

394 of cultivation would improve safety and preference in residential areas with woodland vegetation.
395 O'Brien (2005) found that low perceived personal safety in woodlands in the UK was connected
396 with an absence of signs of care and management, or even impressions of neglect and abuse.

397

398 **Discussion and recommendations for further research**

399 This review shows that perceived personal safety in urban woodland vegetation is influenced by a
400 number of individual and social factors, but also by factors in the environment, including
401 vegetation. It is possible to develop urban woodland vegetation to counteract perceptions of lack
402 of safety. The literature concerning perceived personal safety in relation to woodland vegetation
403 indicates four aspects as being of special interest for further studies: landscape design,
404 possibilities for overview and control, vegetation density, and vegetation character and
405 maintenance. These aspects interact in affecting perceived personal safety and cannot be totally
406 separated from each other. For example, landscape design improvements such as well-planned
407 and well-designed vegetation might also lead to improved possibilities for overview and control,
408 and density and landscape design can be expected to interact (Jorgensen et al., 2002). Safety-
409 improving changes to woodland vegetation can include a more open character with less density in
410 the undergrowth, which can lead to improved visual control and visual penetration and a more
411 well-maintained impression (Schroeder & Anderson, 1984; Coles & Bussey, 2000; Bjerke et al.,
412 2006). Low density in the vegetation undergrowth can therefore be seen as a key component for
413 increased perceived personal safety, while still retaining woodland vegetation character and
414 benefits. Overall, the literature indicates the importance of careful design and management for
415 urban woodland vegetation to be perceived as both safe and attractive, while retaining or
416 improving the many benefits of such vegetation for people.

Besides the role of vegetation, it is also important to be aware that many different factors add to an individual's perception of personal safety in urban green areas. Better knowledge is needed not only concerning the role of vegetation, but also of social factors such as gender, age and socio-economic background. Individual factors pose a challenge for future research and development, and more information is needed about different people's lack of perceived personal safety and the origins of their fear in order to understand individual variance. For example, it may be important to provide variation in green environments through design and maintenance for increased individual options (Bjerke et al., 2006; Jorgensen et al., 2007; Edwards et al., 2011) and to develop urban woodland vegetation towards increased multi-functionality for different user groups (Florgård & Forsberg, 2006).

There is a need for further research on perceived personal safety in urban woodland vegetation, how the different aspects interact and how such knowledge can lead to improvement. The particularly limited amount of research concerning residential green areas highlights the need to study such areas and their particular conditions explicitly. Studies conducted on personal safety aspects in public spaces such as parks cannot be expected to be fully applicable in a residential context (Lindgren & Nilsen, 2012).

The four aspects affecting perceived personal safety in urban woodland vegetation (landscape design, possibilities for overview and control, vegetation density, vegetation character and maintenance) do not act singly but have important interactions, which are generally not

considered in previous studies. Thus future research should be directed at testing these interactions in developing vegetation concepts. More careful descriptions of various aspects, including different vegetation types, are needed to fully reveal the complexity of perceived personal safety in relation to urban woodland vegetation. The set of variables presented in this paper includes complexity not only in environmental factors but also in individual and social factors, directing future research towards qualitative, context-based studies.

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Table 1. Summary of the initial literature search

| **Search word** | | **Search word** | **Number of articles found** | **Number of relevant articles found** | **Articles found. Numbers correspond to titles in Table 2.** |
|---|---|---|---|---|---|
| **safety** | AND | **parks** | 1168 | 3 | 2, 4, 10 |
| **fear** | AND | **parks** | 153 | 4 | 1, 2, 7, 10 |
| **safety** | AND | **vegetation** | 622 | 4 | 3, 4, 5, 6 |
| **fear** | AND | **vegetation** | 62 | 4 | 3, 5, 6, 9 |
| **safety** | AND | **woodland** | 74 | 4 | 2, 3, 4, 8 |
| **fear** | AND | **woodland** | 19 | 2 | 2, 3 |
| | | | **2098** | **21** | |

Table 2. The articles found in the initial literature search

| | |
|---|---|
| 1 | Bixler, R., & Floyd, M. (1997). Nature is scary, disgusting, and uncomfortable. *Environment and Behavior*, 29(4), 443-467. |
| 2 | Jorgensen, A., & Anthopoulou, A. (2007). Enjoyment and fear in urban woodlands – Does age make a difference? *Urban Forestry & Urban Greening*, 6(4), 267-278. |
| 3 | Jorgensen A., Hitchmough, J., & Dunnett, N. (2007). Woodland as a setting for housing-appreciation and fear and the contribution to residential satisfaction and place identity in Warrington New Town, UK. *Landscape and Urban Planning*, 79(3-4), 273-287. |
| 4 | Jorgensen, A., Hitchmough, J., & Calvert, T. (2002). Woodland spaces and edges: Their impact on perception of safety and preference. *Landscape and Urban Planning*, 60(3), 135-150. |
| 5 | Kuo, F. E., Bacaicoa, M., & Sullivan, W. (1998). Transforming inner-city landscapes: Trees, sense of safety, and preference. *Environment and Behavior*, 30(1), 28-59. |
| 6 | Lindgren, T., & Nilsen, M. (2012). Safety in residential areas. *Tijdschrift voor Economische en Sociale Geografie*, 103(2), 196-208. |
| 7 | Madge, C. (1997). Public parks and the geography of fear. *Tijdschrift voor Economische en Sociale Geografie*, 88(3), 237-250. |
| 8 | O'Brien, E. A. (2005). Publics and woodlands in England: well-being, local identity, social learning, conflict and management. *Forestry*, 78(4), 321-336. |
| 9 | Shaffer, G. S., & Anderson, L. M. (1985) Perceptions of the security and attractiveness of urban parking lots. *Journal of Environmental Psychology*, 5(4), 311-323. |
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