Degree Project in Architectural Lighting Design
Second Cycle 15.0 hp

Sustainable Lighting Strategies for Nytorps Gärd
A Case Study

JOSEPH HUTT
ABSTRACT

This paper focuses on exterior lighting strategies for suburban green areas in Stockholm, using the Nytorps gärde case study as an example. The research methodology employed includes a literature review, a survey, quantitative measurements, and expert interviews. The study highlights the importance of sustainable urban spaces, the inherent conflict in meeting the needs of both people and the ecosystem and proposes strategic measures for green spaces, including a proposed solution for a footpath involving low energy consumption and reduced feelings of threat, whilst at the same having a minimal light pollution footprint.

The importance of involving and considering the nocturnal environment in urban planning is emphasised, with a proposal for light/night planning at a strategic level. Local and general strategies are proposed as are implementing good light pollution discipline and lighting controls. The thesis aims to provide lighting design guidance for the proposed development while advocating for the preservation of darkness, the importance of listening to women and girls in shaping the nocturnal environment, and a proposal for time-based light interventions that respect the dark environment.

KEYWORDS

Perceived safety, darkness, sustainability, light pollution, suburban park, lighting strategy

TUTOR

Yousef Tavakoli
TABLE OF CONTENTS

ACKNOWLEDGEMENTS

1.0 INTRODUCTION
1.1 INTRODUCTION
1.2 EXISTING SITE
1.3 PROPOSED DEVELOPMENT

2.0 METHOD
2.1 METHODOLOGY
2.2 METHODOLOGY FLOW CHART

3.0 RESULTS AND ANALYSIS
3.1 EXISTING LIGHTING
3.1 URBAN THEORY
3.2 DARK INFRASTRUCTURE
3.3 PERCEIVED SAFETY AND LIGHTING
3.4 SURVEY
3.5 CONVERSATIONS

4.0 ACTION
4.1 ACUPUNCTURE POINTS
4.2 SWOT ANALYSIS
4.3 INTERVENTION

5.0 SUMMARY
5.1 DISCUSSIONS
5.2 CONCLUSIONS

6.0 SOURCES
6.1 BIBLIOGRAPHY
6.2 LIST OF TABLES
6.3 LIST OF FIGURES

All figures own work unless otherwise stated
ACKNOWLEDGEMENTS

Many Thanks to:

My thesis tutor, Federico Favero, and all members of the KTH lighting department for their insight and wisdom over the past 10 months.

Yousef Tavakoli for the guidance with my thesis

Taylor Stone, Kim Höglund, Maarten De Pourcq and Caroline Boman for being generous with their time.

Tord M Larsson and the exterior lighting department at Bjerking for the office space and company

Ragge for help in the dark

Heartfelt thanks to Karin, Olmo, Otis and Lotten.
1.1 INTRODUCTION

In 1929 public lighting in Stockholm began to be left on throughout the night, previously it had been switched off before midnight. (Garnert, 1998) This means that parts of Stockholm city centre have been continually illuminated for nearly a century. There is current debate that calls for a reassessment of our relationship to electric lighting (Eklöf, 2023) and our relationship to darkness. (Stone, 2019) There are concurrent debates about the politics of space and democratic access to it of which public exterior lighting can play a key part. (Listerburn, 2015). The negative effects of artificial light at night (ALAN) on the ecosystem, are presently underestimated (Jägerbrand, A. K., & Helldin, J.-O, 2020) but there are now attempts at a local level to develop strategies to mitigate it. (Stockholms Stad, 2022).

This thesis explores lighting strategies for Nytorps gärde, an open green area in suburban Stockholm. The space is earmarked for development with work scheduled to start in 2027. The proposed development would involve up to 900 new apartments, educational, recreation and retail spaces, plus a new road and footpaths. (Stockholms Stad, 2023)

This thesis is focusing on sustainable design to address perceived safety, gender inclusivity, nighttime usage, and the preservation of the dark environment. The case study analyses the existing lighting and provides discussion points for the proposed development through the prism of three United Nations Sustainability Goals: Goal 5 (gender equality), Goal 11 (sustainable cities and communities), and Goal 15 (life on land). By examining residents' perspectives, urban theory, and current research on exterior lighting, the thesis aims to answer the research question: How can sustainable lighting design be implemented at Nytorps gärde in order to address issues of safety, inclusivity, and nighttime usage while respecting the dark environment? The thesis seeks to provide lighting design guidance for the proposed development, considering the inherent conflict between human needs and ecosystem preservation.
1.2 EXISTING SITE

Figure 3

Fredriksson, J (2014). Nytorps gärde from the air. CC BY-SA 3.0

Figure 4

Site Map of current conditions. Illustrator image based on Google maps
1.3 PROPOSED DEVELOPMENT

Figure 5

Site plan of the proposed development.

Note: The West of the site will see the highest concentration of development with a square, a “park square”, residential buildings, a preschool, a sports hall and developed parkland. The stretch on the north will also see a new local road. There will be more trees planted in the East of the space and perhaps a small stage in the area “Gärdesplatsen”. Adobe illustrator image based on Google maps

2.0 METHOD

2.1 METHODOLOGY

LITERATURE REVIEW

The Literature review concerns academic research and theoretical writing on urban space, lighting strategy and perceived safety. In addition light pollution and our relation to darkness is also analysed. Key points are summarised into a condensed table format and discussed. The literature review will help inform lighting strategies for the park.

SURVEY

An online survey (APPENDIX H) was posted in several local community Facebook groups. A total of 257 adults over the age 18 completed the survey, of these 197 were female and 56 male. The groups were “Härliga Hammarbyhöjden”, “Kärrtorp, Kära Kärrtorp”, “Bästa Björkhagen” and “Dalen, Dear Dalen”. In addition a link to the questionnaire was posted in two special-interest
local facebook groups, one opposing the proposed development on Nytorps gärde, “Skydda Nytorps gärde” (Protect Nytorps gärde), and one positive towards the development, “Ja Till Förtätning i Söderort” (Yes to densification in Southern Stockholm). The questions aimed to gain insight into how people use the space, and if their movements are altered after dark.

QUANTITATIVE MEASUREMENTS

Illuminance measurements were taken between the site with a Clas Ohlsson MT-906 Luxmeter. (APPENDIX B) Luminance measurements were taken of the existing light sources and background to assess contrast. (APPENDIX C) Information from Stockholm City Council concerning luminaire type and placement formed the basis of the fixture placement diagram. (APPENDIX A)

CONVERSATIONS

Conversations with stakeholders involved in the planning and implementation of exterior lighting were undertaken in person. These include Maarten De Pourcq, the head of Stockholm City’s traffic office, which is responsible for the lighting of roads, cycle paths, parks and other exterior public spaces in Stockholm, lighting Designer Kim Höglund, who lectures on sustainability issues concerning lighting and Caroline Boman of Bjerking, who is an experienced lighting planner working on large-scale projects in Stockholm. Discussions also took place with the tutor involved in the thesis, lighting designer Yousef Tavakoli. (APPENDIX E)

PROCEDURE

The research process informed the thesis development and direction. The existing fixtures were identified as high contrast, prompting luminance measurements to assess contrast levels (see APPENDIX B). The survey (see APPENDIX H) yielded a strong response from females and highlighted the site’s significant light pollution, emphasising the importance of perceived safety in the literary analysis. Additionally, the survey identified problem areas for targeted improvements or action. Originally intended as a general strategy document for parks in Stockholm, the thesis then evolved into a site-specific case study. It further analysed lighting-strategy issues for the site and proposed an intervention based on research findings, showcasing the conflicting interests between human needs and environmental preservation.

LIMITATIONS

Stockholm City have a “smart” lighting strategy and are continuing to upgrade light sources to LED with a Zhaga connection. (Stockholm City, 2021) It is difficult to predict the technological changes in public lighting by the time all fixtures are upgraded to LED.
Stockholms own strategy document predicts lighting fixtures with some element of machine learning which could negate the need for pre-determined lighting control schedules. Changing demographics, use, movement and perception of the space will all effect how post-development Nytorps gärde will be understood by the local residents. A concept for a lighting design intervention informed by the research process sits between the results section and the discussion.

2.2 METHODOLOGY FLOW CHART

Figure 6

Methodology Flow Chart

RESEARCH QUESTION
How can sustainable lighting design be implemented in Nytorps Gärde, a suburban green area undergoing proposed development, to address issues of perceived safety, gender inclusivity, and nighttime usage, whilst also respecting the dark environment?

NYTORPS GÄRDE:
Analysis
Existing lighting
Proposed development

SURVEY & INTERVIEWS
Perceived safety
Light and darkness
Open responses
Interviews

LITERATURE REVIEW:
Perceived safety
Darkness Infrastructure
Lighting Design strategies
Urban Theory

ACTION

DISCUSSION STRATEGY
3.0 RESULTS AND ANALYSIS

3.1 URBAN THEORY

“The Image of the City” (Lynch) was used as a tool to understand the current conditions on Nytorps gärde, (map FIG. 08) but critics point out that the nocturnal city is neglected in his approach (Bordanno). Electric light alters the legibility and way-finding function in urban spaces and this, along with the movement of people should be considered (Del Negro). Natural surveillance, a variety of users at different times of the day, (Jacobs) and design solutions that encourage social interaction (Gehl) lead to socially sustainable urban spaces, which appears to be a key factor in creating a socially sustainable space. The topography of space is important for feelings of perceived safety (Barker, 2022). Open sight lines have a positive effect whilst enclosed areas can have a negative effect. Light has the possibility to greatly impact our perception of a nocturnal space and in planning both lighting and landscape, a cohesive approach needs to be used. A specific site may therefore be perceived as unsafe due to different factors, of which the presence of lighting would have minimal effect.

Figure 7

A Lynchian analysis of the Nytorps gärde site

Notes: There are several nodes on the periphery of the site where footpaths meet the streets and footpaths in the nearby residential areas. The main footpath circles the site running parallel to the edges of the site. A lit path dissects the space over the brow of the small raised wooded area (3) in the centre. Desire paths traverse the space creating organic links between different zones. A large hospital building is visible from a large part of the space (1) Whilst the orange glow from the football
**Table 1**

*A summary of the findings from the urban theory literary analysis*

<table>
<thead>
<tr>
<th>Source/Author</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Lynch, 1960)</td>
<td>Paths, edges, districts, nodes, and landmarks are essential elements of city images.</td>
</tr>
<tr>
<td></td>
<td>City image or mental map is individual</td>
</tr>
<tr>
<td>(Del-Negro, 2016)</td>
<td>Electric light alters wayfinding and legibility, causing mental maps of spaces to differ between nocturnal and diurnal states.</td>
</tr>
<tr>
<td></td>
<td>Urban lighting strategies often lack scope and fail to consider the perception of urban elements and movement of people.</td>
</tr>
<tr>
<td></td>
<td>A Lynchian analysis is a good starting point for lighting the city at night, but designers and planners can reshape the nocturnal image.</td>
</tr>
<tr>
<td>(Bordanno et al, 2019)</td>
<td>Lynch's understanding of the city and design interventions are primarily focused on the day lit city.</td>
</tr>
<tr>
<td>(Jacobs, 1969)</td>
<td>Natural surveillance creates safe and cohesive communities.</td>
</tr>
<tr>
<td></td>
<td>Unpopular parks without surveillance are perceived as unsafe and prone to transgressive behavior.</td>
</tr>
<tr>
<td></td>
<td>Successful parks have diverse users at different times engaged in various activities.</td>
</tr>
<tr>
<td>(Gehl, 1971)</td>
<td>Public spaces should fulfill the needs for human interaction and stimulation.</td>
</tr>
<tr>
<td></td>
<td>Low-intensity social contact, encountering and hearing people, leads to communication and deeper relationships.</td>
</tr>
<tr>
<td>(Barker et al, 2022)</td>
<td>Sightlines and potential escape routes contribute to feelings of perceived safety in parks.</td>
</tr>
<tr>
<td></td>
<td>Fenced or enclosed areas are often unpopular and may create a sense of insecurity.</td>
</tr>
<tr>
<td></td>
<td>Lighting can enhance accessibility but should be balanced with ecological considerations.</td>
</tr>
<tr>
<td></td>
<td>Wider structural societal issues and strategies like park staffing or planned activities are also important for park safety.</td>
</tr>
</tbody>
</table>
3.2 DARK INFRASTRUCTURE

All the literary sources emphasise the importance of dark infrastructure measures. Each sees a value in protecting the dark environment for both socio-cultural and environmental reasons. The UK government report (The Royal Commission on Environmental Pollution, 2009) is a broad call to arms containing different elements, including an analysis explaining the harmful effect of ALAN on the environment and more existential yearnings related to a connectedness to the natural world. Both Stone and Eklöf seek a reappraisal of our relationship to darkness as a starting point in dealing with light-pollution issues, a shift in our attitude to lighting perhaps leading to less requirement for light at night. The International Dark Sky Association (IDA, n.d.) offer motivations and solutions to preserve the night environment, whilst Sordello’s intentions are similar in establishing “dark corridors” and offering a 4-step process in restoring darkness. The results of the literature study establish that the dark environment has to be a consideration in planning sustainable exterior lighting.

Table 2

Summary of findings from a literary review on dark infrastructure

<table>
<thead>
<tr>
<th>Source/Author</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Artificial Light at Night (ALAN) has negative effects on biodiversity and disrupts the circadian systems of living organisms.</td>
<td>(IDA, n.d) (Eklöf, 2023)</td>
</tr>
<tr>
<td>The establishment of &quot;dark corridors&quot; is proposed to limit the negative effects of light pollution on biodiversity.</td>
<td>(Sordello et al, 2021)</td>
</tr>
<tr>
<td>A 4-step process is recommended for identifying, preserving, and restoring dark infrastructure to mitigate light pollution.</td>
<td>(Sordello et al, 2021)</td>
</tr>
<tr>
<td>A government report in the UK emphasizes the importance of darkness for cultural heritage and connecting with the natural world.</td>
<td>(UK Govt., 2009)</td>
</tr>
<tr>
<td>Viewing darkness as a positive force can lead to a more holistic approach to addressing artificial light at night.</td>
<td>(Stone, 2017)</td>
</tr>
<tr>
<td>Urban acupuncture, a small-scale intervention approach, can be applied to revitalize and improve the nocturnal environment.</td>
<td>(de Solà-Morales Rubió, 2000; Stone, 2021)</td>
</tr>
</tbody>
</table>
3.3 PERCEIVED SAFETY AND LIGHTING

The literature survey highlights the enduring interest in fear of crime and perceived safety in public spaces among women and girls (Johansson and Haandrikman, 2001). Although sexual assault is more likely to occur in private rather than public spheres (Pain, 1997), women often modify their routes due to perceived safety concerns (Valentine, 1989), indicating a potential failure in creating socially sustainable public spaces. This was also expressed in the survey (figures 9&10), with 136 women stating that the availability of daylight affected their movements. Increased illumination alone is not a solution for enhancing perceived safety (Arup, n.d.; Svechkina et al, 2020) and may paradoxically contribute to negative perceptions due to increased contrast. Light quality, such as avoiding monotonous lighting (Johansson et al., 2010), and the ability to reveal shape and texture (Arup, n.d.) are also considered important factors. Prospect and refuge theory suggests that lighting can help reveal potential sites of concealment (Appleton, 1975; Nasar and Fisher, 1992). However, it is crucial to note that lighting alone cannot solve structural problems, and comprehensive planning should consider societal factors and the voices of women and girls (Pain & Koskela, 2000; Arup, n.d).
### 3.3 PERCEIVED SAFETY AND LIGHTING

**Table 3**

*Summary of findings from a literary review on perceived safety, light and landscape*

<table>
<thead>
<tr>
<th>Findings</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Women have a complex relationship with fear of crime, and social cohesion and belonging are important factors in mitigating fear for all genders.</td>
<td>(Johansson and Haandrikman, 2001)</td>
</tr>
<tr>
<td>Gestures and feelings of being followed are often unreported or unquantified in crime statistics, highlighting the limitations of relying solely on data.</td>
<td>(Blöbaumm &amp; Hunecke, 2005)</td>
</tr>
<tr>
<td>Sexual assault is more likely to occur in private spaces than in public ones, contributing to the vulnerability and fear experienced by women in public areas.</td>
<td>(Pain, 1997)</td>
</tr>
<tr>
<td>Women often alter their behavior in the urban environment by avoiding certain areas or changing their paths to mitigate perceived safety risks.</td>
<td>(Valentine, 1989)</td>
</tr>
<tr>
<td>Prospect and refuge theory explains interactions with the landscape and their impact on perceived safety, emphasizing the importance of seeing without being seen.</td>
<td>(Appleton, 1975)</td>
</tr>
<tr>
<td>The placement of lighting fixtures can reveal or hide certain elements of the environment, influencing the understanding and perceived safety of a space.</td>
<td>(Nasar and Fisher, 1992)</td>
</tr>
<tr>
<td>Design choices aimed at improving safety through lighting and landscaping may not address underlying issues that contribute to fear of crime.</td>
<td>(Pain &amp; Koskela, 2000)</td>
</tr>
<tr>
<td>Increased illuminance levels do not necessarily result in increased perceptions of safety among women and girls. Design processes in urban planning should consider the inclusion of minority groups and incorporate nocturnal strategies. Light quality, including the ability to detect shape and texture, is important in enhancing perceived safety.</td>
<td>(Arup, n.d)</td>
</tr>
<tr>
<td>Increased illumination levels beyond 5-10 lux have limited impact on perceived safety, and site-specific solutions are necessary. Factors such as time of day, daylight conditions, crime level, and population density influence perceptions of safety.</td>
<td>(Svechkina, Trop &amp; Portnov, 2020)</td>
</tr>
<tr>
<td>Monotonous, unnatural, or unpleasant lighting is a significant factor in feelings of perceived safety. Light quantity and quality may have varying relevance at different points along a path.</td>
<td>(Johansson et al., 2010)</td>
</tr>
<tr>
<td>Greenery, footpath, and lighting design must be considered together to ensure safe and accessible routes for all societal groups after dark. Women and girls express concerns about perceived safety, highlighting the importance of adopting a feminist perspective in urban planning and lighting.</td>
<td>(Rahm,, Sternudd, &amp; Johansson, 2020)</td>
</tr>
</tbody>
</table>
3.4 SURVEY RESULTS

268 respondents answered questions regarding their movement and use of Nytorps gärde under both nocturnal and diurnal conditions. The complete range of questions and data from the survey is available in APPENDIX H. Of those 265 that gave their biological sex, there were 207 women and 58 men. It is clear from the larger proportion of female respondents that perceived safety and lighting in the night environment is a topic of interest for many women.

Both women and men tend to visit Nytorps gärde during the earlier evening hours, with a higher preference for the 18-20h time slot. (Q3 APPENDIX H)

The response to question 11 (Figure. 8) shows that the presence of more people using the space during darkness may positively influence women's willingness to use Nytorps gärde. Men's responses appear to be more varied.

Figure 8
Graph showing answer to Question 11. Would you use Nytorps gärde more often under darkness if there were more people present in the space? (254 answers)

Figure 9
Graphic showing the gender imbalance in respondents to the survey
Questions 4 and 5 (Figure 9, Figure 10) focused on how light affects movement and usage of the space. 167 of 254 said that the availability of daylight affected when they used the space. 136 women answered that the availability of daylight affected their movement, whilst 31 of those were men.

The findings from both questions highlight that a significant majority of women respondents recognised the influence of daylight availability on their usage of Nytorps gärde. In contrast, a smaller proportion of men respondents acknowledged this influence. This indicates that daylight availability plays a more significant role in shaping women's decisions and preferences regarding when to use the area compared to men.
Question 6 and 7 asked: How safe do you feel under DAYLIGHT and DARK hours on Nytorps gärde? Rank your safety score on a scale from 1 (SAFE) to 5 (UNSAFE) (Table 4)

Both females and males reported feeling relatively safe during daylight hours on Nytorps gärde. The majority of respondents rated their perceived safety as 1 (safe) during daylight hours. There is a gender imbalance in safety score after darkness sets in. Females reported feeling less safe during the dark hours compared to males. A drastically smaller number of females rated their safety as 1 (safe), while larger numbers of females rated their safety as 2, 3, 4, or 5. Females generally expressed lower feelings of safety during nighttime compared to males. It is undetermined whether this is site-specific or if it correlates with a wider pattern of females feeling unsafe during dark periods of the day.

Table 4

Table showing answers to questions 6 and 7

<table>
<thead>
<tr>
<th>Safety Ranking</th>
<th>Daylight Females</th>
<th>Night Females</th>
<th>Daylight Males</th>
<th>Night Males</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (Safe)</td>
<td>155</td>
<td>24</td>
<td>30</td>
<td>9</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>27</td>
<td>4</td>
<td>15</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>62</td>
<td>1</td>
<td>14</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>55</td>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td>5 (Unsafe)</td>
<td>35</td>
<td>38</td>
<td>20</td>
<td>5</td>
</tr>
</tbody>
</table>

Note: (APPENDIX H). How safe do you feel under both daylight and dark conditions on Nytorps gärde? Rate from 1 (safe) to 5 unsafe (264 answers)

Figure 11

The top 6 places avoided when dark

Note. Question 8: Are there any areas of Nytorps Gärde that you avoid after dark? You can choose several alternatives
1st) 128 votes (Pool, Area 9, see figure 14)
2nd) 120 votes (Lit footpath by pool, Area 12. See figure 16)
3rd) 102 votes (Unlit path, Area 15)
4th) 92 votes (Park, Area 7)
5th) 86 votes (Unlit path, Area 6)
6th) 83 votes (Unlit path, Area 16)
Question 8 asked which areas are avoided after dark, (see figure 11) The results highlight certain areas within Nytorps gårde that are perceived as less safe or less desirable during nighttime. Area 12 is an asphalt path (fig. 16 overleaf) that is lit, but which more people avoid than some of the unlit areas of the space. This shows that there could be other factors involved in residents avoiding specific areas at night, and that perhaps lighting alone is not a solution.

Question 9 (figure 13) asked which areas could be improved by the addition of new lighting or the improvement of existing lighting. The top 4 results were all sections of the path on the South side of the space which is unlit. The West of the space will be greatly impacted by the development (Area 3, 6) Whilst the East (Area 11,16, Figure 12) will be relatively unchanged. It will remain an open space for social events, and the documentation states that the development aims to increase biodiversity in this area.

Figure 12

Area 16, Unlit footpath on the South side of the field.

Figure 13

The top 4 places respondents to the survey thought could be improved with light.

Notes: Areas 3 and 6 will be impacted by the new development

1st) 118 votes (Area 3)
2nd) 113 votes (Area 6 and 16)
3rd) 97 votes (Area 11)
Figure 14

*View of the pool (Area 9) from the wooded path (Area 12) facing West.*

Figure 15

*View of the brow of the hill on the wooded path (Area 12) approaching from the North heading South.*

Figure 16

*Looking East towards the unlit path along the edge of the woods. (Area 15)*
In contrast to Area 12, the unlit forest path, the survey reveals that less people avoided Area 13 and 14 (figure 17) at night than the lit path through the woods. 43 of 211 respondents avoided this space (Area 13) and 55 people avoided (Area 14) after dark, as opposed to the 114 that avoided the lit footpath through the woods. (figure 16 overleaf)

![Figure 17](image17)

*Figure 17*

*Area 13 and 14. Unlit path*

![Figure 18](image18)

*Figure 18*

*Areas avoided after dark*

*Notes. 43 of 211 respondents avoided area 13 after dark. 55 of 211 avoided area 14 after dark*
3.5 CONVERSATIONS

Conversations with four different parties involved in planning exterior lighting projects revealed that lighting controls/dimming are seldom used in park lighting projects. (Appendix E) This is due to several factors including norms, budget, product availability and client requirements. All were individually positive towards either dimming or switching off lighting fixtures when spaces were not in use or seldom used under specific time periods. Sports facilities are often installed with an on/off lighting control scheme according to opening times. Maarten De Pourcq is the head of the lighting department at the Stockholm Traffic Office (Trafikkontoret TK) which is responsible for exterior lighting for roads, cycle paths, footpaths and public squares in Stockholm. De Pourcq stressed the difficult balance required in assessing the needs of the environment and perceived safety issues. There is also often different parties involved in installing exterior lighting which may have different guidelines and interests. TK is presently developing a lighting strategy which seeks to offer clearer guidelines for exterior lighting in Stockholm. All three lighting designers interviewed stated that it is dependent on the individual or project as to what stage the lighting designer enters the project. Tavakoli stated lumen per watt as an important criteria for clients and therefore a popular choice is COB (chip on board) fixtures. This technology can be used for energy-efficient installations. The LED chip is visible which can lead to visual discomfort which can in turn lead to lower feelings of perceived safety, which is a negative factor in designing socially sustainable lighting for parks.
4.0 ACTION

4.1 ACUPUNCTURE POINTS

The results highlighted potential issues both for the proposed development and the existing conditions. “Darkness Acupuncture” (Stone, 2019) techniques could provide localised improvements to problem areas. Figure 18 outlines 4 different sites with recommendations.

Figure 18
Graphic of proposed development with acupuncture points
Adobe illustrator image based on Google maps

The Pool.
Most avoided area after dark. Increase sightlines and alternative routes out. Lighting designer involved as a consultant to work with Landscape Architect. Space be repurposed out of season or to ensure it is used throughout the year.

Forest cycle path.
2nd most avoided space despite lighting. Lower contrast with good visual comfort. Motion sensor active 10. Could this path be moved or rerouted?

The West.
Lighting consultant to oversee the whole project to ensure all exterior lighting coordinated to establish a clear lighting hierarchy, avoid clutter and ensure lighting follows good practice as to light pollution and perceived safety. Dimming or switching off of light sources when not needed.

The South East Path
Planned intervention, lit natural elements create a temporal, poetic and ethereal atmosphere. Changes the nocturnal image of the space. More attractive environment will increase footfall leading to increased perceived safety. Use light to selectively reveal texture and detail. Good visual comfort from 2700K fixtures and low illuminance level minimising hard contrasts.
Area 16, the unlit South East path, was chosen due to it being one of the most avoided space that will not be impacted to a significant degree by the proposed development. It came sixth in the survey of avoided spaces but the first five choices will most likely be radically altered by development. According to the survey Area 16 was also joint second when the respondents were asked which area would be the most improved by the addition of lighting. The other top choices will become building sites during the future development.

The project document (Stockholms Stad, 2023) states that it aims to increase biodiversity and encourage women and girls to use the open space north of Area 16. In line with Jacobs social surveillance (1969) as a motor for safe and cohesive social spaces, the intervention will aim to make the space more attractive for all the local population and help encourage use. The South East path has open nightlines and good prospects for escape but the dark wood offers possibility for concealment.

In the suggested intervention the stated increase in biodiversity could be enabled by the planting of more greenery in the open grass space between the path and the woods. The lighting will be temporal, lighting up at dusk and gently fading to dark at 22:00 under dark periods of the year. The chosen site creates an opportunity for residents to create a new nocturnal image for the space. The installation will be poetic and ethereal, inviting users to explore the site and allow them to feel the night creep in.

A SWOT analysis (pg.23, figure 20) was conducted to evaluate the pros and cons of an intervention.

Figure 19

The South East path
4.2 SWOT ANALYSIS: INTERVENTION ON THE SOUTH EAST PATH

Figure 20

*S.W.O.T analysis for intervention on the South East path*

**STRENGTHS**
- Encourage use of the South path
- Create a spectacle. Park as destination
- Easier Navigation
- Less lighting points than conventional solution
- Lower energy consumption than conventional solution
- Reduces feeling of threat by breaking up the dark shadows in the undergrowth
- (prospect/refuge theory)
- Forms a new nocturnal image of the space
- Not high rate of reported crime and would encourage both “eyes on the street” and “life between buildings”
- Minimal light pollution footprint
- Contributes to socially sustainable space.

**WEAKNESSES**
- Vertical illuminance for facial recognition
- Installation costs
- Need for ground analysis and tree inventory.

**OPPORTUNITIES**
- Rethink how we light for the darkness and safety
- Testbed for lighting controls in a public space
- Opportunity to analyse perceived safety with alternative lighting strategy

**THREATS**
- Local reaction
- Municipal reaction
- More complex electrical installation/ground work?
4.3 INTERVENTION

Figure 21

Light intervention test on South East Path. Light picks out vertical natural elements to break up the dark space.

Figure 22

Light intervention test on South East Path. Light picks out vertical natural elements to break up the dark space.
Figure 23

Section and plan view Photoshop illustration showing shielded narrow/medium directional fixtures on 4 metre poles set back from the path. The directed light selectively lights natural elements.
Figure 24

Plan view of fixture placement

Figure 25

Section view ZZ of potential pole and fixture placement
Figure 26

*Photoshop conceptual illustration of the South East Path.*

Notes: Light fixtures behind a tree on green space between existing tree line and path.
5.0 SUMMARY

5.1 DISCUSSION

The survey revealed a gender imbalance in the number of respondents, this could be seen to reflect the importance of perceived safety as an issue for women and girls. The literature review also highlighted these concerns (Valentine, 1989) and informed us that women and girls alter their behaviour or route as a reaction to their feelings of perceived safety. This was reflected in the survey where over half of the females (136 of 266) altered their route under darker hours. A socially sustainable space should feel accessible and safe for all societal groups. Lighting alone cannot solve these problems but can contribute to improving usability. It can also make an environment more attractive or unattractive, thus contributing to increasing or decreasing users of the space. More users in a space can help foster more cohesive communities through natural surveillance (Jacobs) or deeper social interaction (Gehl) and this might go some way in mitigating the gender fear gap.

The literary review shows that greater illuminance does not necessarily lead to increased levels of perceived safety. Paradoxically, the large contrasts between dark and lit areas caused by bright light sources could lead people to avoid the area. (Arup) (Appendix C) The topography of the land should be a consideration when planning light as enclosed spaces (Barker), lack of prospect (Appleton) and hiding places (Nadar) all effect perceived safety. The survey revealed the top two most avoided places after dark were firstly the pool (see figure 28), an enclosed space with low prospect for escape and a plethora of places for concealment. The lit forest path was second, (see figure 27) the path runs parallel to the pool and has obscured sight lines, low prospect for escape, high contrasts between light and shadow and opportunities for concealment. The lit wooded path

Figure 27
Area 12. View of the brow of the hill on the wooded path

Figure 28
Area 9. View of the pool from the wooded path (Area 12)
was avoided by more people after dark than unlit areas. Although the survey did not reveal why this space was avoided, the new project would offer the opportunity to alter sight lines, the layout of the pool area and even rerouting the path to offer to improve perceived safety. Lights interaction with greeneries, how it reveals form and texture, light intensity and light distribution all need to be considered in relation to the unique conditions of each part of the site in order to improve perceived safety.

The conversations with stakeholders (Appendix E) revealed that lighting controls are underused in exterior projects which could be due to norms, budget constraints or client requirements. All were positive towards greater use or more pilot projects. De Pourcq mentions that the Traffic Office is currently developing a lighting strategy that would offer better guidance to actors involved in installing exterior lighting. At present different authorities have different responsibilities which can lead to an uncoordinated approach. Clearer guidelines and more expert involvement could help create a more coherent lighting environment. The new development will have transit routes, sports areas, park areas, and exterior lighting from residential and retail spaces. All these elements may have different guidelines and criteria and not necessarily be installed by lighting designers or planners. Perhaps greater pressure from national government on local authorities to consider the dark environment, including wider implementation of lighting controls.

As the current site is already light polluted (Appendix G), it is unclear if any kind of dark infrastructure can be restored. A sustainable lighting project must ultimately consider the effect of ALAN on the ecosystem. In the case of Nytorps gård a lighting control schedule should be utilised, switching off the lighting under hours of darkness after 22:00 hours. This would drastically reduce both energy consumption and reduce the impact of ALAN on the dark environment. A closer analysis of movement patterns in the space could help inform a detailed lighting control scheme with fixtures being switched off or dimmed according to user frequency.

It was unclear from the results of the literature study as to how much of the nocturnal environment is planned. A criticism of Lynch (Bordanno) was that he neglected to account for the nocturnal environment and the impact of electric light on legibility, way finding and image forming. A proposal for further investigation would be to what extent the nocturnal environment is considered in urban planning. Is lighting a solution which transforms a diurnal environment into a legible nocturnal one? Could a lighting designer or nocturnal planner have some impact on shaping urban planning if involved early on in a project?

It would have been useful to have more detailed data on the movement patterns of people navigating through Nytorps gård, including gender, age, demographic and attitudes to the space in both nocturnal and diurnal situations. Data relating to start and finish points in their journey could also have provided more evidence as to what areas to target for intervention. Different voices from outside local area Facebook groups would also be useful in building a wider picture of movement through the space. The literary review on perceived safety and lighting qualities
contained research from different locations on the globe, and concerned different urban settings. It would have been beneficial to have Scandinavian studies that reflected the topography and daylight conditions of Swedish suburbs. The design intervention is untested but intended to be seen as a vehicle to question how footpaths in green areas are lit.

5.2 CONCLUSIONS

The thesis explores implementing sustainable lighting design strategies on Nytorps gärde to address perceived safety, gender inclusivity, nighttime usage, and the preservation of the dark environment. A feminist approach to urban planning and lighting design is crucial for achieving gender equality and fulfilling SDG5. The intervention aims to improve lighting quality, creating an attractive environment that encourages nighttime usage. By incorporating a lighting control scheme, energy consumption is reduced, aligning with SDG11's goal of sustainable cities and communities. Additionally, considering the dark environment and minimising the impact of ALAN contributes to SDG15's target of protecting biodiversity and natural habitats. The intervention aims to have a positive effect on accessibility and sustainability in Nytorps gärde.

The research findings and proposed design intervention have implications for exterior lighting projects in Swedish green areas. Suggestions include:

1. Adopt a feminist perspective in urban planning and lighting design to address the concerns of women and girls and promote gender inclusivity.
2. Coordinate various actors involved in exterior lighting planning through a lighting strategy or coordinator to improve energy efficiency, reduce light pollution, and create harmonious lighting projects.
3. Prioritise lighting quality to enhance perceived safety and create a sense of place, avoiding overly bright or monotonous lighting that may cause discomfort.
4. Implement lighting controls such as dimming and motion sensors to save energy and preserve the dark environment, based on site analysis.
5. Conduct an Environmental Impact Assessment to assess the effects of artificial light on the space.
6. Consider the impact of landscape features on the nocturnal environment when planning paths and determining the necessity of lighting. Paths with good prospects and clear sightlines may require minimal lighting intervention to ensure perceived safety.

These suggestions can inform future exterior lighting design projects, promoting sustainability, inclusivity, and perceived safety in Swedish suburban green areas.
6.0 SOURCES

6.1 BIBLIOGRAPHY


Hille Koskela, Rachel Pain, Revisiting fear and place: women’s fear of attack and the built environment, Geoforum, Volume 31, Issue 2, 2000, Pages 269-280, ISSN 0016-7185


### 6.2 LIST OF TABLES

**Table 1** A summary of the findings from the urban theory literary analysis

**Table 2** A Summary of findings from a literary review on dark infrastructure

**Table 3** Summary of findings from a literary review on perceived safety, light and landscape

**Table 4** Table showing answers to questions 6 and 7
6.3 LIST OF FIGURES

Figure 1 (Cover image) Path on Nytorps Gärde

Figure 2 The South East of Nytorps Gärde. April 2018

Figure 3 Fredriksson, J (2014). Nytorps Gärde from the air. CC BY-SA 3.0

Figure 4 Site Map of current conditions. Illustrator image based on google maps

Figure 5 Site plan of the proposed development.

Figure 6 Methodology Flow Chart

Figure 7 A Lynchian analysis of the Nytorps Gärde site

Figure 8 Graph showing answer to Question 11

Figure 9 Graphic showing the gender imbalance in respondents to the survey

Figure 10 Graph showing answer to Question 4

Figure 11 Graph showing answer to Question 5

Figure 11 The top 6 places avoided when dark

Figure 12 Area 16, Unlit footpath on the South side of the field.

Figure 13 The top 4 places respondents to the survey thought could be improved with light.

Figure 14 View of the pool (Area 9) from the wooded path (Area 12) facing West.

Figure 15 View of the brow of the hill on the wooded path (Area 12) approaching from the North heading South

Figure 16 Looking East towards the unlit path along the edge of the woods. (Area 15)

Figure 17 Area 13 and 14. Unlit path

Figure 18 Graphic of proposed development with acupuncture points

Figure 19 The South East path

Figure 20 S.W.O.T analysis for intervention on the South East path

Figure 21 Light intervention test on South East Path

Figure 22 Light intervention test on South East Path

Figure 23 Section and plan Photoshop Illustration

Figure 24 Plan view of fixture placement

Figure 25 Section view ZZ of potential pole and fixture placement

Figure 26 Photoshop conceptual illustration of the South East Path.

Figure 27 Area 12. View of the brow of the hill on the wooded path

Figure 28 Area 9. View of the pool from the wooded path (Area 12)
APPENDIX A: Fixtures

Existing Fixture plan on Nytorps Gärde. Test site marked with a circle

![Image of the illuminance test site]

**Table showing Illuminance Measurements in Lux. Readings taken at 0 metres on the ground.**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Manufacturer</th>
<th>Model</th>
<th>Colour Temperature</th>
<th>Effect</th>
<th>Height</th>
<th>Light Source</th>
<th>Lumen Output</th>
<th>CRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>☒</td>
<td>Leipziger Leuchten</td>
<td>Gustav</td>
<td>3000K</td>
<td>30W</td>
<td>4m</td>
<td>LED</td>
<td>2350</td>
<td>85.7</td>
</tr>
<tr>
<td>☒</td>
<td>Selux</td>
<td>Saturn</td>
<td>2800K</td>
<td>70W</td>
<td>4m</td>
<td>Metal Halogen</td>
<td>N/A</td>
<td>82.8</td>
</tr>
</tbody>
</table>

**APPENDIX B: Illuminance Measurements**

<table>
<thead>
<tr>
<th></th>
<th>15.5</th>
<th>6.5</th>
<th>0.8</th>
<th>0.5</th>
<th>0.5</th>
<th>1</th>
<th>2.5</th>
<th>6</th>
<th>9.5</th>
<th>14</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.5</td>
<td>15.5</td>
<td>5.5</td>
<td>1.5</td>
<td>0</td>
<td>0</td>
<td>1.1</td>
<td>1.8</td>
<td>6.5</td>
<td>11.8</td>
<td>11</td>
</tr>
<tr>
<td>12.5</td>
<td>12.5</td>
<td>4.5</td>
<td>1.5</td>
<td>0</td>
<td>0</td>
<td>1.0</td>
<td>0</td>
<td>4.5</td>
<td>10.5</td>
<td>10</td>
</tr>
</tbody>
</table>

ABOVE: Table showing Illuminance Measurements in Lux. Readings taken at 0 metres on the ground.

Mean illuminance level: 5.2 lux

Vertical illuminance: 0.9 lux

Uniformity = E (minimum) / E (maximum) 0.032
Luminance measurements taken using luminance meter standing under one light pointed at the other.

1. Light source: 1137 cd/m²
   Background: 0.019 cd/m²
   Lit surface: 49 cd/m²

2. Light source: 991 cd/m²
   Background: 0.091 cd/m²
   Lit surface: 47 cd/m²
APPENDIX D: EXISTING STRATEGIES, LEGISLATION AND STANDARDS

Stockholm City Council, Stockholms Stad, have a traffic office, Trafikkontoret, which is responsible for public lighting on roads, footpaths and squares. They follow the rules set out in a document from the national traffic authority, Trafikverket the national body responsible for roads. (VGU, 2022). In the document is guidance as to how to light park footpaths dependent on traffic density, this is not a law and can be changed in a dialogue with the responsible lighting planner. The classification is often defined by the client to the lighting consultant (Tavakoli, 2023), in this case the client would be Trafikkontoret. Different elements of public lighting planning fall under different local administrative bodies. The city area administrative district, stadsdelsförvaltningen, could be responsible for public lighting on children parks, whilst the sports administration, idrottsförvaltningen, or city area administrative district, could be responsible for sports facilities. There are no restrictions or regulations regarding lighting on private land apart from that relating to nuisance lighting which is covered by Sweden’s environmental code (Miljöbalkan, 1998) and Swedish planning laws (PBL, 2011).

The Stockholm Traffic Office have internal guidelines regarding lighting such as keeping colour temperature under 3000K and that fixtures are well shielded (Trafikkontoret, 2023).

<table>
<thead>
<tr>
<th>Class</th>
<th>Horizontal illuminance</th>
<th>Additional requirement if facial recognition is necessary</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\bar{E}$ $^a$ [minimum maintained]</td>
<td>$E_{\text{min}}$ [maintained]</td>
</tr>
<tr>
<td></td>
<td>lx</td>
<td>lx</td>
</tr>
<tr>
<td>P1</td>
<td>15,0</td>
<td>3,00</td>
</tr>
<tr>
<td>P2</td>
<td>10,0</td>
<td>2,00</td>
</tr>
<tr>
<td>P3</td>
<td>7,50</td>
<td>1,50</td>
</tr>
<tr>
<td>P4</td>
<td>5,00</td>
<td>1,00</td>
</tr>
<tr>
<td>P5</td>
<td>3,00</td>
<td>0,60</td>
</tr>
<tr>
<td>P6</td>
<td>2,00</td>
<td>0,40</td>
</tr>
<tr>
<td>P7</td>
<td>performance not determined</td>
<td>performance not determined</td>
</tr>
</tbody>
</table>

$^a$ To provide for uniformity, the actual value of the maintained average illuminance shall not exceed 1.5 times the minimum $E$ value indicated for the class.

**NOTE 4** A high colour rendering contributes to a better facial recognition.
APPENDIX E: CONVERSATIONS

Kim Höglund. Lighting Designer.
Yousef Tavakoli, Lighting Designer
Caroline Boman, Lighting Planner
Maarten De Pourcq, Exterior lighting head, Stockholm Traffic Office
(Trafikkontoret)

All conversations were conducted in person and had an open format, the conversations centred around the planning process in Stockholm, the use of lighting controls, lighting strategies for parks, the role of lighting designers in projects, and how these issues are approached in projects. The stakeholders involved were all involved in lighting design and planning. Two Stockholm based lighting suppliers were also contacted via email who remain anonymous.

Kim Höglund is a lighting designer with an interest in light pollution and sustainability issues. She states The Nytorps Gärde site should prioritise the needs of the local population. Good lighting design discipline should be followed in regard to light pollution but as the site is near a large nature reserve many species will have moved to the darker area. Höglund states that there is a dialogue with local residents in zonal developments like the Nytorps Gärde project but it is not certain that lighting consultants will be involved. Höglund stresses that it is often up to the lighting planner to state a case to be involved in the dialogue or how early they are involved in a project. Höglund volunteers that there is not a wide range of products with a wide dimming range on the market. This is due to the LED drivers dimming capabilities. Höglund ventures that the technology for nighttime dimming is available but underused. She states that change comes from the requirements put on manufacturers from their clients, not from technology.

Höglund proposes a rethink of lighting design philosophy, with a greater emphasis on sustainability and the end user than aesthetics. She stresses the importance of analysing the movement patterns and user interaction with the space to pose questions for the implementation of exterior lighting.

Maarten De Pourcq is the lighting department head at Stockholm City Traffic Office (Trafikkontoret TK). TK is responsible for exterior lighting on streets, parks and squares in Stockholm City. De Pourcq explains that the balance between perceived safety and the needs of environment is a difficult one. He explains that establishing lighting hierarchies can be difficult as different actors are responsible for the commissioning, installation and management of exterior fixtures. He explains that TK is responsible for lighting in foot and cycle paths in green areas but the local area authority may be responsible for play parks and sports grounds.

TK has two ongoing initiatives relevant to this thesis. Together with Stockholm City’s Environmental Administration, TK are involved in forming a lighting strategy for Stockholm, its focus is both social and environmental sustainability. The strategy aims to have a coordinated
structure for the purchasing, installation and of exterior lighting in Stockholm. TK want more standardisation to reduce costs, increased circularity to extend products life times and implement dimming to reduce energy costs. The second initiative aims to make the management structures involved in managing exterior lighting more effective, as their are different parties responsible for exterior lighting this would give TK more control over lighting planning and allow for a more effective strategic approach.

All fixtures commissioned by TK are Zhaga compliant. This offers the capability for installing lighting control nodes at a later date. De Pourcq estimates that of the 150,000 exterior fixtures that TK manage only 60,000 are LED. A strategic decision must be taken about how lighting controls will be implemented and that more funds must be allocated in order to realise this. TK continues to replace non LED fixtures with Zhaga compliant LED fixtures.

Caroline Boman is lighting planner at the exterior lighting department at Bjerking, a Swedish civil engineering consultants. She has 23 years experience and is involved in the planning and implementation of large scale building developments throughout Sweden. Boman states that in an urban context it is generally the needs of human that is prioritised although environmental issues are considered. Lighting is often used as a preventative measure to minimise violent crime and vandalism. She also states that clients will consider both light pollution and perceived safety but the responsibility for solutions lies with the consultant. Boman considers that lighting controls are currently rarely used in urban green areas but that sports grounds are often operated on timer, with the lighting shut down between 23:00 and 06:00. Boman considers the lack of lighting controls is due to both resources and current norms. Boman thinks there should be more pilot sites with shutdown or dimmed lighting at specific times, using the example of footpaths in sparsely used green areas and parks outside large urban cities could be switched off at night.

Yousef Tavakoli is lighting designer with experience in exterior lighting projects, he mentioned that buyers prioritise energy efficiency, which is the lumen per watt given for a fixture or installation. This can lead to the prevalence of Chip on Board fixtures. (COB). As COB fixtures feature an exposed LED chip, the luminaries could be a causative factor in creating visual discomfort. Tavakoli states there is also a shortage on the available park fixtures that use indirect light. He states that it is dependent on the project as to how early the lighting designer becomes involved, whilst stressing that in many cases it would have been beneficial to come in earlier.

I spoke to two unnamed suppliers of exterior lighting in Stockholm, one Swedish manufacturer had fixtures that dim to 5% and that lighting controls was seldom used in exterior applications. Another supplier and manufacturer mentioned there are drivers called “Dim to Dark” which can be reduced down to 0.01% output. The latter mentioned that one manufacturer has fixtures that dim to 10% but they recommend not dimming to less than 20% due to a less efficient power factor.
All those interviewed said there was just cause for either shutting lighting down completely or dimming after location and user habits. Greater implementation of lighting controls would require more resources for both planning and implementation. A site specific control scheme would also require time to conduct an analysis and design.

APPENDIX F: CRIME STATISTICS

Localised crime statistics are unavailable for Nytorps Gärde but statistics are available for the whole district with which the space is situated. Under the local district administration of Skarpnäck. A report by Stockholm Police and Stockholm City Council (Polisen, 2021) on crime in the local area stated that men are over represented as victims of violence in the public domain and that assaults occur predominantly from late afternoon until midnight and is quite even throughout the week but with a peak on Fridays during 2021. Stockholm City council have conducted an annual perceived safety survey which offers insight into fear of crime in the city. The survey in 2020 showed that fear of crime was lower (7%) than the city average( 9%) (Stockholm City Safety Survey, 2020) but strikingly 39% of school age girls in the district feel quite or very unsafe going home alone late at night (time of year, dark or light not specified). 80% of he respondents of this project’s survey respondents identified as female. (APPENDIX H)

APPENDIX G: LIGHT POLLUTION

SQM: Sky quality meter. A scale form 16 to 22 to measure the luminance of the night sky. 16 is where the sky is the brightest and 22 the least bright. The site was measured as having a rating of 17.99 mag./arc sec² (lightpollutionmap.info)

The Bortle scale is a way to grade the level of light pollution. 1 is the least light polluted and 9 being the most heavily polluted. Nytorps Gärde places on 9 bordering on 8. (cleardarksky.com, 2020)
APPENDIX H: SURVEY RESULTS

TOTAL RESPONSES: 268

Question 1. How old are you? (266 answers)

Question 2. What is your gender? (265 answers)

Question 3. When do you use Nytorps Gärde for recreation, e.g. exercise, dog walking, meeting friends (265 answers)
Question 4. Does the availability of daylight effect when you use Nytorps Gärde? (264 answers)

Question 5. Does the availability of daylight effect when you use Nytorps Gärde? e.g. Would you choose a different route from Björkhagen to Kärrtorp after dark? (266 answers)
Question 6 and 7. How safe do you feel under DAYLIGHT and DARK hours at Nytorps Gärde? Rank your safety score on a scale from 1: (SAFE) to 5: (UNSAFE) (265 answers)

Question 6. Daylight Conditions

Question 7. Daylight Conditions
Question 8: Are there any areas of Nytorps Gärde that you avoid after dark? You can choose several alternatives. (219 answers)
Question 9: Do you think that there are some specific areas that could be improved by the addition of lighting or the improvement of the existing lighting? (224 answers)
10. If you go out onto Nytorps Gärde when it is dark, what time do you usually go? (234 answers)

11. Would you use Nytorps Gärde more often under darkness if there were more people present in the space? (254 answers)

Question 12. How would you describe the light levels on Nytorps Gärde, give a rating on a scale from 1: (Bright) to 5: (Dark) (247 answers)
APPENDIX I: INTERNATIONAL DARK SKY ASSOCIATION

Lighting recommendations from the Dark Sky Association

- Only be on when needed (Lighting Control Scheme)
- Only light the area that needs it (Considered target for light
- Be no brighter than necessary (How much illuminance is needed)
- Minimize blue light emissions (Under 3000K and choose fixtures with lower blue wavelengths)
- Eliminate upward-directed light (Fixture choice and angle)