TIME FOR SHIFT CHANGE IN THE FABRIC OF EXISTENCE

Exploring the role of darkness and artificial light for humans and biodiversity

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Abstract

This thesis departs from the loss of biodiversity due to artificial light at night. The diurnal human has taken over all hours of the day instead of the natural light once, meaning that space and time have become limited for the nocturnal living species. Earlier research concern how darkness and artificial light affect either animals, insects, and plants, or humans' health. The combination of the two, however, remains largely unresearched. Therefore, this geographical thesis dives into this gap by exploring humans *and* biodiversity in relation to darkness and artificial light. Building on that exploration, the aim was further to formulate generative ways forward in the matter.

A qualitative method was conducted, consisting of a self-written Darkness Diary and walking interviews with a moth-expert, a bat expert, and a light designer and light artist. The theory of all-ecology was applied as an ontological stand and a geographical toolbox. Non-representational theory (NRT) was further applied as a guide in the exploration of experience. The Darkness Diary yielded experiences of darkness as an enabler of profound presence, and experiences of artificial light as a source of stress and exhaustion, knowing the effects of the overuse. The walking interviews showed the complex "timetable of needs" of the moths (nocturnal *Lepidoptera*) and brown long-eared bat (*Plecotus auratus*), with darkness as a requirement and artificial light as a trap or a blockage. The twilight emerged as a central theme in both the Darkness Diary and the interviews.

The walk with the lighting designer and light artist emphasised the importance of acknowledging outdoor spaces as shared, and that individual awareness about light pollution must be increased and met by political and economic initiatives. The Darkness Diary filled in with thoughts on generative ways by the concept of '*leave space*' (as a built upon all-ecology's understanding of 'take space'), the importance of *time*, and the attitude towards darkness, claiming that we need to *embrace* it to enjoy the fruits of it.

Overall, this thesis highlights the importance of *where* and *when* there are darkness and lights: space and time matter. Adding on the *how*, and by acknowledging our (as in everyone) circadian rhythms, this thesis implies that there is a fundamental need for a shift change in the fabric of existence.

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Sammanfattning

Den här uppsatsen tar avstamp i förlusten av biologisk mångfald, och då specifik förlusten av biologisk mångfald på grund av överflödigt artificiellt ljus under dygnets mörka timmar, även kallat ljusföroreningar. Den daglevande människan har utvidgat sina timmar från de naturligt ljusa till att inkludera dygnets alla timmar, vilket resulterat i minskat handlingsutrymme för den nattlevande flora och fauna. Tidigare forskning inom ämnet har fokuserat antingen på hur djur, insekter och växter påverkas av artificiellt ljus på natten, eller på hur människan påverkas av det samma. Kombinationen biodiversitet och människa ihop har dock inte undersökts, även om vi på lever samma jord. Därav dyker den här uppsatsen ner i det glappet genom att undersöka mörker och artificiellt ljus i förhållande till människan *och* biodiversitet. Utöver att undersöka, var syftet med den här uppsatsen att formulera möjliga vägar framåt för en bättre samlevnad under dygnets mörka timmar.

En kvalitativ metod utfördes, bestående av en egenförfattad ”Mörkerdagbok” och promenad-intervjuer med en nattfjärilexpert, en fladdermusexpert och en ljusdesigner och ljuskonstnär. Teorin all-ekologi applicerades som en ontologisk utgångspunkt och geografisk verktygslåda, samt ”non-representational theory” (NRT) som en guide i utforskandet av upplevelsen. Resultatet från mörkerdagboken gav upplevelser av att känna sig närvarande i mörkret och samtidigt känslor av något mellan stress och utmattning av överkonsumtionen av ljus. Promenad-intervjuerna visade på komplexiteten i nattfjärilarnas (nattliga *Lepidoptera*) och fladdermusen brunlångörats (*Plecotus auratus*) “behovstidtabell”, där mörkret är ett krav och det artificiella ljuset en fälla eller en blockad. I både dagboken och intervjuerna framkom skymningen som ett centralt tema.

Promenaden med ljusdesignern och ljuskonstnären underströk vikten av att erkänna utomhus som ett delat rum och att individuell medvetenhet om ljusföroreningar måste höjas och mötas av politiska och ekonomiska initiativ. Mörkerdagboken fyllde på med tankar om möjliga vägar framåt med koncepten ’lämna rum’ (uppbyggt från all-ekologins förståelse av ’äga rum’), vikten av tid, samt att vi måste omfamna mörkret för att kunna njuta av frukterna från det.

På det hela taget så framhäver den här uppsatsen vikten av *var* och *när* det är mörker och ljus. Genom att lägga till *hur*, samt genom att uppmärksamma våra (som i alla levande) cirkadiska rytmer, så pekar den här uppsatsen i riktningen att det finns ett fundamentalt behov av ett skiftbyte i tillvaroväven.

Nyckelord: Mörker, artificiellt ljus, ljusföroreningar, biodiversitet, människa-natur relationer, all-ekologi, non-representational theory.

Preface

"I will study geography in Gothenburg" was my standard answer when people asked me what I would do when I finished my work- and traveling life. I said that for some years, but now I can change the tense to "I have", and for five years in a row! Enriched with new knowledge, academic skills, abroad semesters, and friends, I'm now signing out with this master thesis, a good summary of what I find fascinating with geography: the relations between humans and non-humans, living and non-living, and how we can think about this wonderful and challenging mix.

I want to thank several people for their involvement in this thesis. First, to my informants, thank you for your time, your devotion, and for walking with me, meeting you was truly inspiring. Special thanks to Johan Eklöf for writing about darkness and light in an eye-opening way and supporting me in my engagement in the subject. Second, many thanks to my supervisor Mattias Sandberg, senior lecturer at Unit for Human Geography, Department of Economy and Society. Your support and encouragement have meant a lot to me during this thesis development; however, I will carry your curious way of looking and twisting the world with me after the final submission as well, thank you.

Then my two self-chosen "supervisors", Simon and Louise, your insights and critical eyes in combination with your humour had made this thesis so much better and the last months so much more fun than it would have been without you, you're the best! And Sara, I love that you're having my back, it's a pleasure having yours.

Last, but not least, the back office: my Joakim at the base camp who have made sure that I took well-needed breaks from the computer and given me perspectives on what's important in life, you certainly are to me. A final bunch of thanks to my parents who have hosted me during some intense weeks and given me food, love, and encouragement, as always.

Gothenburg, May 24, 2021

Maya Strömgren

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1. Introduction

1.1 Background

Although nearly outworn as a dramatic start-sentence, the fact remains: biodiversity loss is an urgent grand societal challenge, a human-caused mass extinction, and action needs to be taken (UN, 2019). Reasons for this rapid loss are multi-folded, land-use change being one of them (ibid.). However, a largely unnoticed form of human expansion is starting to be increasingly acknowledged as an alarming cause of biodiversity loss: the use of artificial light (Davies & Smyth, 2018; Eklöf, 2020). The light that is intimately intertwined with the development of our modern society, the light that still can make a significant difference for people not having access to it (UNDP, 2020). This light is, in large parts of the world, used in thoughtless manners, flowing its glow within and around the physical structures, in the air, on the streets, and in our homes. Excessive or unwanted artificial light is gathered under the term *light pollution* and according to a small, but growing body of research, this poses a substantial threat to the natural rhythm of all living species: the circadian rhythm (Eklöf, 2020, pp 18-20; Hopkins, Gaston, Visser, Elgar & Jones, 2018; Lystrup, 2017).

Light. Darkness. Light. Darkness. The circadian rhythm governs all living things to follow the phases of day and night (" Circadian rhythm", n.d.; Eklöf, 2020, p 18; Hopkins et al., 2018). Our (*our* as in all living things) metabolism, growth, and behaviour stand in direct contact with this rhythm (Hölker, Wolter, Perkin & Tockner, 2010). For humans, as a diurnal animal, it means sleep at night and be awake during the day, while for a significant part of the animals and insects, it means the opposite: rest during the day and do life-sustaining tasks during the dark hours.

Here, a space- and time conflict arises. Looking out your window when it's dark outside will probably give you a hint: it's not dark. The diurnal animal homo sapiens have extended their given part of the day to include all hours, instead of the natural light ones. Space and time have, hence, become limited for the nocturnal non-humans[1] (cf. Eklöf, 2020; Pottharst & Könecke, 2013, pp 37-38). However, as stated above, the circadian rhythm affects *all* living things, meaning that humans are also affected by the artificial extension of the light hours. Sleeping disorder is just one of the known risk of exposure to artificial light (coming from the streetlight outside your window or from the mobile phone in your hand) diabetes type 2,

[1] The term *non-humans* refers in this thesis to all living, biotic, things apart from humans (animals, insects, plants, etc.).

depression, heart diseases, impaired immune system, obesity, and cancer are others (Lunn et al., 2017; YongMin et al., 2015).

Hence, making it darker would have positive effects for both nocturnal species and diurnal, humans among them. For biodiversity loss, the darkening of an area would give direct feedback, since the nocturnal species would instantly have better opportunities to act on their normal behaviour cues (Davies & Smyth, 2018; Eklöf, 2020, p 233). For humans there are obvious gains to earn as well, concerning the different health risks that artificial light brings (cf. Lunn et al., 2017; YongMin et al., 2015). With these two aspects, pointing in the same direction, the way forward might seem simple: turn off the lights. However, looking into human relations to light and darkness, the plot thickens.

Light has a profound position as something inevitable connected to positive associations in the society, it is in our language and in our history, for example, a "bright future" or Age of Enlightenment, and a symbol of welfare and strength (Eklöf, 2020, p 165-166; Henkel, 2019). Looking at the earth from space during night, the continents are glowing; where there is light, there are humans- the ultimate proof of the species' success (Eklöf, 2020, pp 27-28). Darkness, on the other hand, has a cultural and religious position of danger and evil (Ekrich, 2005). The main character in the movies always walks alone in the dark and always gets in trouble. In real life, dark spaces outside are commonly connected to anxiety for, mostly, women (The Swedish National Council for Crime Prevention, 2020). Less light at night could, hence, restrain humans' possibilities of moving comfortably outside during the dark hours. However, the dark is a precondition for human recovery and sleep, meaning that we generally fear the dark and are at the same time entirely dependent upon it for our wellbeing (Ekrich, 2005).

There are technical ways to address the need for darkness and the need of safety, by for instance minimizing the light that goes to waste in the air, through direction or intensity adjustments (Chepesiuk, 2009; Davies & Smyth, 2018). However, as the outlining of humans' relation to light and darkness above implies, technical measures may not be enough to create sustainable progress in the matter. This is stated by Johan Eklöf (2020, p 234), writer of the newly published book "*The Manifesto of the Dark*" (*Mörkermanifestet*), where he further claims that society might have to *'reformulate its relation to the dark'*. This thesis will depart from this request[2].

[2] Eklöf's (2020) book, which is part of the foundation of this thesis, is summarized in section 2.1.

1.2 Problem statement and thesis position

The existing research on humans and biodiversity in relation to darkness and artificial light is not plentiful, but is largely unanimous; the world needs to become a darker place (see for example Davis & Smyth, 2018; Eklöf, 2020; Hölker et al., 2010). Davis and Smyth (2018) pin down this statement by claiming that the prior challenge now is to find ways forward within the complex matters of ecological and human needs. The existing research concerning darkness and artificial light is divided between these two parts; ecological (in terms of how animals, insects, and plants are affected by artificial light) and human science (foremost how humans' health and rhythm are affected and twisted by artificial light). The combination of the two parts, however, remains largely unresearched, although *the living space must be shared by both parties*. Hence, this geographical thesis will dive into this gap by exploring humans *and* biodiversity in relation to darkness and artificial light.

The exploration will be done with the theoretical help from *all-ecology*, which is the encapsulating term of the ontology of human-environment relationship formed by Torsten Hägerstrand (1916-2004). With all-ecology, Hägerstrand (2009, posthumously published) wanted to create "*…a study of the earth surface as a <u>meeting place</u> for all forms of existences*" (p 27, original emphasis). The ontology is here meant to act as the springboard for the exploration of humans, biodiversity, darkness, and artificial light.

The reason for choosing this theme derives from a normative urge: the lack of darkness is a problem. However, to be able to change something you must get to know it (Gibson-Graham & Roelvink, 2010), which reconnects to Eklöf's (2020, p 234) reasoning above; the societal need for a reformulation of the relation to the dark. In this thesis, the reformulation, or maybe the formulation, will derive from my own every day- and night experiences of living with darkness and artificial light. This way of wrestling with research is inspired by *non-representational theory* (NRT), which together with all-ecology constitute the theoretical framework of this thesis. In NRT, also called "the geography of what happens", the mundane and lived everyday experiences are embraced (Thrift, 2007, p 2). This realm of thought will guide and support me in my interpretation of the world as I experience it, in darkness and in lights. As Gibson-Graham and Roelvink (2010) express it: "*Theory has taken on a new relation to action – to understand the world is to change it"* (p 342).

Understanding and *formulation* are hence two key pillars in this thesis. The understanding particularly concerns the need for darkness for non-humans, artificial light, and my own place in this equation. The formulation builds on this understanding to find generative ways forward, exploring at a specific level to reason about the general. At the specific level

there is me, but also two chosen nocturnal species from whom I will explore darkness and artificial light, these are moths (nocturnal *Lepidoptera*, including several thousand species) and brown long-eared bat (*Plecotus auratus*). In addition to the chosen species, artificial light as such will be examined, since it is a keystone in our modern society and, at the same time, the outcome of a human-caused problem (Davies & Smyth, 2018; Pottharst & Könecke, 2013, p 37-28).

1.3 Thesis aim and research questions

The aim of this thesis is two-folded, first, it aims to explore the role of darkness and artificial light for humans and biodiversity and, second, to build upon that understanding by formulating generative ways forward in the matter. This will be done by three integrative steps; (1) exploring how darkness and artificial light are perceived in an everyday- and night setting, (2) study the chosen species in their living environment and (3) explore artificial light and combine it the two first steps. The following questions correspond to the three steps:

- How is darkness and artificial light experienced in everyday-and night life?
- What role do darkness and artificial light have for the chosen species in their living environment?
- Looking forward, what could be generative ways to co-exist?

To reach the aim, a qualitative method will be conducted, including a self-conducted diary and walking interviews with experts on the two chosen species and artificial light. The thesis will take place in the Gothenburg region, Sweden.

1.6 Clarifications

Before introducing the thesis any further, four clarifications must be done. First, concerning darkness and (artificial-) light: they are inevitably entwined in each other, impossible without the other. There are also different scales of darkness and light (for example, think of shadows or twilight) and it's hard to know if we talk about the dark or just less light. By this, I want to encourage you as a reader to keep an open mind towards the thesis's choice of words concerning these two (and maybe inspire you to start to think about it yourself, light is energy, but what is darkness?). Concerning artificial light, I want to emphasize that this is an invaluable invention and source of human life quality and that the populations that have a lack of it should have access to it, but this thesis considers the parts of the world where there is a redundancy of lights.

Second, my point of departure is biodiversity loss, however, humans have a large part in this thesis, while being the source of the problem, but also being negatively affected, and me being a human. Why the prior starting point is biodiversity is because millions of species are endangered, and extinctions are ongoing. Regarding biodiversity and humans, the term *co-existence* sometimes appears. By this term, I mean that we do already co-exist, but that there is a need to do so in a better way. Further, in many places, I use the word *humans* in a way that puts all humans under the same roof. This is because darkness and light concern everyone. By this, I'm not saying that socioeconomic questions are not important questions to ask[3], but in this thesis, all humans will be put under the same roofs occasionally, after all, humans have "being human" in common[4]. To this, the question of human safety can be added, it will surely be a theme of concern that will pop up for you as a reader, and an important one. The theme will be touched upon but is not the focus of this thesis for the same reason as just stated[5].

Third, regarding the thesis research approach, it can be seen as a combination of critical research and problem-solving research (cf. Mahmoud, Jerneck, Kronsell & Steen, 2018). Critical, since it is questioning the division of space and time between nocturnal non-human and diurnal humans, however in a non-traditional way, as critical research normally targets the socioeconomic order. Problem-solving, since it acknowledges that we have a situation that must be highlighted and discusses generative ways forward in the matter.

Fourth and last, in line with the research approach, it's in its place to share my personal motivation urges; I want action to be taken and consciousness to be spread in this subject. The deeper I dive into the theme of darkness and light, the clearer it becomes that this issue urgently needs to be acknowledged and addressed.

1.7 Disposition

This thesis will be structured by seven chapters. Hopefully, the first chapter introduced the subject and my point of entry. The second chapter gives a deeper background to the subject, outlining darkness and artificial lights effects and position for biodiversity and humans, including a closer presentation of the chosen species. The third chapter presents an overview of previous geographical research, with studies that touch common ground as this thesis. Next, in chapter four, the theory is presented, through which the empirical material will be created and analysed. The theories constitute Hägerstrand's all-ecology and non-representational theory

[3] See 8.3 for suggestions for further research
[4] To be related to Hägerstrand (2009) who often strived towards finding similarities between humans, science disciplines, and living and non-living things.
[5] See 8.3 for suggestions for further research

(NRT). Chapter five outlines the methods of the thesis; diary-writing and walking interviews, outlining what was done and how it was done. Moving on to chapter six, the empirical material from the diary and the walking interviews are presented and analysed in relation to the theory. In chapter seven conclusions are given followed by suggestions for further research. Enjoy!

2. Background

This chapter is meant to give a deeper insight into themes that are important to get a grip on in order to get a good understanding of the rest of the thesis. First a short outlining of Eklöfs (2020) "*The Manifesto of the Dark*" is given followed by study context and motive power for darkness. Further, an overview of biodiversity and artificial light is given, followed by a closer presentation of the two chosen species (moths and brown long-eared bat) and a separate section on technical aspects of artificial light. The final section of this chapter gives a general idea of humans' relation to artificial light and darkness, followed by a summary of the chapter.

2.1 Eklöf's (2020) "The Manifesto of the Dark"

"*The Manifesto of the dark- on artificial light and the threat against an ancient rhythm*[6]" is the full title of Johan Eklöfs book published in the year 2020. Eklöf is a biologist and a bat expert and has in this book captured the width of how artificial light has taken over the realm of darkness and what the consequences of this might be. A rigid base of scientific research is alternated with personal thoughts and experiences of the dark, which leads up to the "manifesto" which consists of ten points on how to deal with the dark. These could be summarized in two central themes: (1) *embrace the dark* (explore it, preserve it, maintain it, follow your inner rhythm) and (2) *spread the word* (learn more about it, talk with your close ones, and influence your municipality). As posed in the introduction, this thesis takes off from Eklöf's (2020) statement that we might have to '*reformulate the relation to the dark'* (p 234).

2.2 National context of the study

In Sweden, the national setting for this thesis, the darkness has a great presence, leaving the most northern parts without any sign of direct sunlight for months. In the southern parts, this absence is less extreme, but still, with the lack of snow making everything even darker, the darkness is present to a high extent and a given topic of conversation. Hence, the use of artificial light is crucial to get businesses going, and it is also generically considered needed in the sense

[6] In orignal: "Mörkermanifestet- om artificiellt ljus och hotet mot en uråldrig rytm."

of beautification, with mini-bulb strands decorating the trees and balconies. This cherishment of light is further shown in light festivals, arranged across the country, for example Lights in Allingsås, Lights in Biskopsgården and Höstljus (*autumn lights*) in Umeå (Lights of Allingsås, n.d.; Bostadsbolaget, 2020; Visit Umeå, n.d.). In Korpilombolo in the county of Norrbotten, on the other hand, the European Festival of the Night is held every December (Swedish Radio, 2010, 19 December). Here, the night and the darkness are celebrated as essential for restoration and creativity and words like embeddedness, peace and safeness are used to describe the dark (ibid.). The need for a darker night has globally resulted in different organisations and initiatives, like the International Dark-Sky Association (IDA). Policy initiatives have been implemented in, for example, Flagstaff Arizona, France, and the Danish Islands Mon and Nyord, where the lighting is adjusted and darkness reserves created (Eklöf, 2020, p 217-222).

2.3 Motive power for darkness

To advocate a darker night is not in any way unique for this thesis. Many actors have an interest in this question (just as many actors have an interest in the opposite). To outline different interests in the question is of importance in order to put the thesis position in a bigger context, and also to get a grip of different sources of motivation, everybody striving towards the same thing, but for different reasons (summary in figure 1 below). Above, the International Dark Sky Association (IDA) was mentioned, representing one arrow of concern: to be able to see the night sky full of stars (IDA, n.d.a.). The astrological branch is also the source of the word "light pollution", visible through, for example, skyglow (*himlaglim*) or glare (*bländning*). The word was established by concerned astrologists who notice that the access to the vision of space was gradually removed to more and more remote areas, creeping away from the city lights (Eklöf, 2020, p 12).

The use of artificial light further stands in direct relation to energy consumption, making the environmental movement another entry of concern; the less artificial light, the more energy can be saved and, hence, less carbon dioxide is let out in the atmosphere. This branch is best represented by Earth Hour, organized by World Wide Fund for Nature (WWF) every march, connecting millions of households and cities through an hour of darkness in the light of candles, manifesting the need for a global sustainability transition (WWF, 2020).

Another entry of concern, with ancient roots and modern topicality, is the embracing of the dark as something deeply aesthetic. Tanizaki (1998) with his essay "*In praise of shadows*" (*Till skuggornas lov*) is seen as the representative for this traditional eastern view of light and darkness, where beauty is found in the subtle, in the shift of shadows in the weak light of an oil

lamp. This philosophy has inspired modern architecture, for example in Roppongi Hills in Tokyo where the district lighting is planned in detail to be kind to the human eye and create beauty in dark shifts, simultaneously as a safe environment (Eklöf, 2020, pp 209-210). Further, in Sweden an architect firm has copied the title of Tanizaki's book as the company name, stating on their start page that "*In the Shadows there is time, there is the subtle, the slow, the small gestures, the private and the intimate grows*" (In Praise of Shadows Arkitektur AB, n.d.).

A somewhat related entry of concern to both the astrological and the architectural one above is the night and the darkness as cultural heritage (Pottharst & Könecke, 2013, pp 44-45). The night sky has guided sailors over the seas for centuries and the dark night holds emotional, spiritual, and aesthetic values which have been a great source of inspiration for artists, writers, and compositions (ibid.). Of course, this is still a source of inspiration, but with fewer and fewer people that can see the night sky from their homes, the connection weakens (ibid.). The lost connection is called "extinction of experience" by Miller (2005) who argues that the night sky is essential for our feeling of connection to everything that is living and existing under the starry sky.

A more recent entry of concern, which is closely related to the one of this thesis, is the concern for biodiversity loss, which, as we learned in the introduction (and will learn more about below), is threatened by the artificial light during the (supposed to be-) dark hours (Hölker et al.; Owens et al., 2020). The final entry of concern is human health, which also touches upon this thesis's entry and will be further examined below, where artificial light disturbs night sleeps all over the world and contributes to a range of serious diseases (Lunn et al., 2017; YongMin et al., 2015). The model below shows the selected kinds of motivating power for more darkness and points out the position of this thesis, departing from biodiversity loss, combining it with human wellbeing and a hint of aesthetic values (see figure 1).

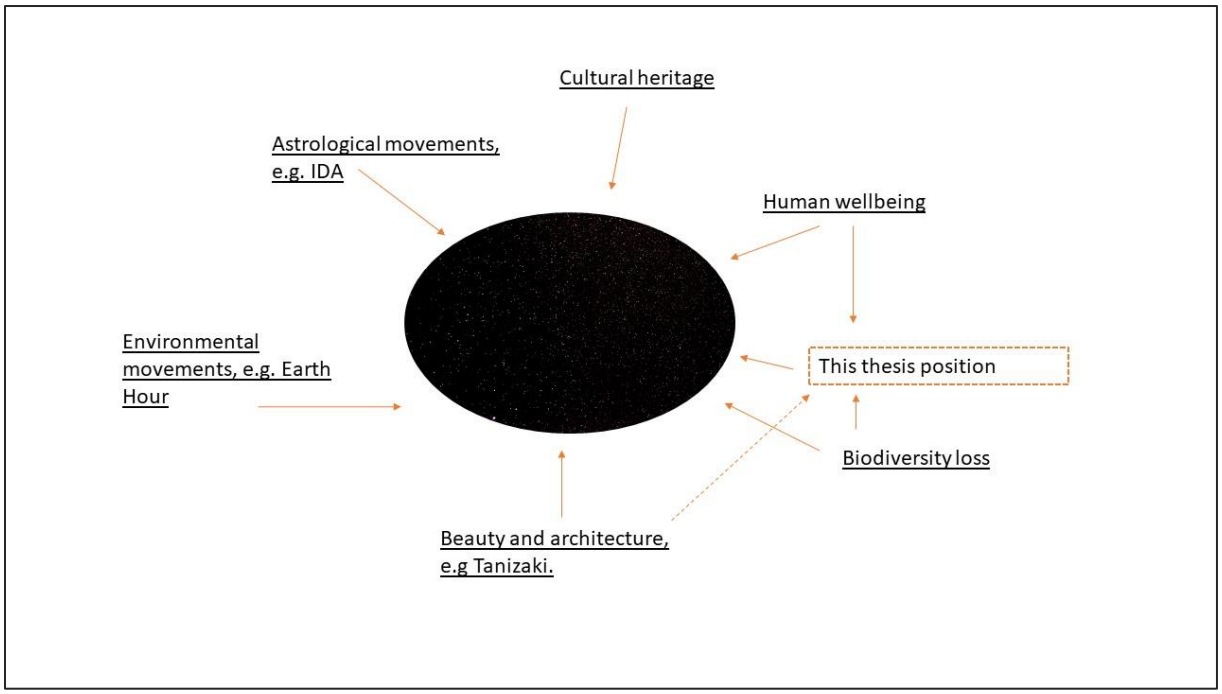

Figure 1. *A selection of motive powers for darkness, and this thesis position amongst them.*

2.4 Biodiversity and artificial light

The most famous and heart-breaking example of biodiversity and artificial light is probably the sea turtle (see for example Chepesiuk, 2009; Kamrowski, Limpus, Moloney & Hamann, 2012). The female sea turtle lays its eggs on specific beaches (always on the same beach where she was born herself) in pits of sand. When the baby sea turtles are born, they face numerous threats on their way down to the ocean, being small and fragile easy targets for predators. However, finding the way down to the ocean has earlier not been part of the problem, as the baby sea turtles simply (but still impressive) follow the reflection of the moon in the water. Now, this is certainly a part of the problem, with new-born sea turtles going in the complete opposite direction, following the brightest light, often being a mall, street lights or façade lighting, leading the turtles to death instead of a life in the sea.

Another frequently appearing example in the literature is one of migrating birds over New York (see for example Chepesiuk, 2009; Van Doren et al., 2017). Here, a huge beam of light is lightened up once a year as a memorial for the 9/11 tragedy. This beam misleads millions of birds (who use the night sky as a navigation tool) off their flight route, leaving the birds flying around the beam to exhaustion like moths around a light bulb (Eklöf, 2020, p 99). These examples in combination with the fact that one-third of all vertebrate animals, nearly two-thirds of all invertebrate animals and half of all insects are nocturnal living species, show the fatal power of artificial lights (c.f. Eklöf, 2020, pp 11, 24; Hölker et al., 2010).

However, there are always winners, even in the light-polluted world. One example is rats, but also some species of opportunistic bats who can make use of the lamplight and dive fast in and out to catch the dislocated insects (Eklöf, 2020, pp 137-138). For the city-living blackbird, the artificial light contributes to a longer mating season with more time during the day for the males to impress the females with their song. However, the long-term positive effects are a matter of doubt since the physical abilities, like the immune system, tend to be weekend with shorter periods of recovery (Eklöf, 2020, p 89).

Taken together, the effects of artificial light at night on biodiversity can be summarized in three types; direct mortality, changed reproductive behaviour and interrupted interaction between species (Lystrup, 2017). Lystrup (2017) and Eklöf (2020, pp 87-91) compare the current situation with Rachel Carson's "*Silent Spring*", stating that light pollution needs to be addressed with the same monumental action as the pesticides were in the 60^{s} and 70^{s}, if a rushing emptying of the world's inhabitants is to be stopped.

2.5 Exploring darkness: moths, bat, and artificial light

Three entries have been chosen in the exploration of darkness and artificial light, including one species group and one species: moths and brown long-eared bat, and a technological: artificial light. Moths and brown long-eared bat are chosen since they are both explicitly creatures of the night and have decreased rapidly in the last decades, a large part, due to artificial light (SLU Swedish Species Information Centre, n.d.; Verovnik, Fišer & Zakšek, 2015). The reason for focusing on artificial light beside the species is because we are dependent upon it and at the same time it is the outcome of a human-caused problem (Pottharst & Könecke, 2013, pp 37-38).

2.5.2 Moths, nocturnal *Lepidoptera*

In Swedish moths are called *nattfjärilar*, which translates to *butterflies of the night*[7], pinpointing what they all (almost all, no rule without an exception) have in common: they are dependent on a dark night to be able to maintain their life-sustaining activities (Langevelde, Grunsven, Veenendaal & Fijen, 2017). Of the world's 150 000 species of butterflies and moths, 88 percentage are moths, including, among others, noctuid (*nattflyn*), saturniids (*spinnare*) and

[7] A warning for word-confusion: In Swedish the word for butterfly (*fjäril*) includes all day living and night living butterflies, but in English butterfly only includes the day-butterflies (dagfjärilar), why the word moths is frequently used here, sometimes in combination with butterfly when both day- and night butterflies are of concern.

geometer moth (*mätare*) (SLU Swedish Species Information Centre, 2018). Only in Sweden, there are at least 2700 species in the miscellaneous group of moths (Lepidoptera, n.d.; Jan Jonasson, personal communication 2021-01-26). Moths can be sorted into categories of micro and macro, families, and species (Jan Jonasson, personal communication 2021-01-26; Lepidoptera, n.d.).

That the moth's inherited pattern is disrupted by artificial light is easy to understand, just think of a lamp attracting the insect as if it was hypnotised by the light source (cf. Van Geffen et al., 2015). Every turn around the lamp is flying time when the moth was supposed to get nectar, pollinate plants, or reproduce. The involuntary attractive light of the lamp leaves the moth with a night of no life-sustaining deeds done, or with no life at all. Why the moths are drawn to the lamp is due to their inherited navigation system, which is programmed to orientate after the moon, the brightest object in the night (Eklöf, 2020, p 11), which can be understood to be a tricky task. Consequently, in combination with other environmental degradations, the broad spectrum of moths has decreased rapidly in the last decades, as most insects have (Owens et al., 2020).

Just as the more famous bee, moths are as important pollinators (Eklöf, 2020, p 24; Hahn & Brühl, 2016), however, without campaigns fighting for their survival (for example, search on "*Rädda Bina*" or "*Save the bees*"), they are struggling in the not so dark night. Reading about moths, there is often a disclaimer that explains that moths are not ugly and boring, you have to look closer and then you will see all the beautiful patterns, which maybe gives a hint about the moths general status in the human world.

Figure 2. *Pine beauty, Panolis flammea (tallfly in Swedish), one of the 2700 species in the miscellaneous group of moths. Photo: Ingemar Larsson, http://vilkenart.se/Admin/Foto.aspx?Id=34272*.

2.5.1 Brown long-eared bat, *Plecotus auratus*

The first thing you see when looking up the brown long-eared bat on the Swedish Species Information Centre (*SLU Artdatabanken*) is “near threatened” in red letters with a graph next to it pointing straight down since 2018 (SLU Swedish Species Information Centre, n.d.). The decrease is due to degradation of quality in habitats, where artificial lighting is a significant contributing cause (ibid.). Brown long-eared bat is a creature of habit who often lives in large old buildings as churches or barns and often inhabit the same spot for generations (ibid.; Eklöf, 2020, p 140). Particulary concerning churches, the issue of artificial lighting has increased rapidly since the ongoing trend of façade-lighting in the last decades (Eklöf, 2020, pp 10, 139-140). This causes every-night challenges for the brown long-eared bat, who hunts at night, but with bright light outside they are getting trapped in their own homes waiting for the “sun” to go down (ibid.). When, or if, the night gets dark, the brown long-eared bat flies out among the vegetation, catching insects on the branches and leaves. Moths and caddie-flies are their main source of energy, which the brown long-eared bat mainly hunt by hearing, opposite to other bats who mainly hunt with echo-sounds (Fladdermus.net, 2015).

Figure 3. *Brown long-eared bat. Photo: Jens Rydell, https://sverigesradio.se/artikel/6852548*.

2.5.3 Technical aspects of artificial light

The birth of artificial light took place the year 1879 with Edison’s light bulb, since then the world has become steadily brighter, from the industrial revolution to the breakthrough of the LED lamp technique in the last centuries (Eklöf, 2020, pp 27-28; Kyba et al., 2017; Lunn et al., 2017). LED lamps could be used without being connected to the electricity grid and are energy-saving friendly, however, this has not led to energy being saved, since the convenience and cheapness of it have resulted in an increase in quantity instead (Eklöf, 2020, p 213-215). More and brighter lighting doesn’t necessarily mean that we see better, rather the opposite; bright

lights make the human eye see only what's within the scope of the lamp shine and make the surroundings non-accessible for visibility.

Different kinds of artificial light have different effects on humans, animals, and insects (Eklöf, 2020, p 105; YongMin et al., 2015; Langevelde et al., 2017). The difference foremost concerns *wavelength*, or *colour temperature*, which decides the colour of the light. Roughly speaking, blue light has short wavelengths and signals daylight and red light has long wavelengths and signals dusk or dawn (Eklöf, 2020, pp 153-155). Humans can see light between 380-800 nanometre, including all colours of the rainbow, which is nothing for a lot of animals who possess a much greater range of interpretation of wavelength, including infrared and ultraviolet (ibid.). The development of the LED-light technique has made it possible to produce a much greater variety of wavelengths, and therefore a much greater span of colours (Eklöf, 2020, p 213-215).

The blue colour (short wavelength) attracts moths, why red light (large wavelengths) could decrease the harmful flight-to-light behaviour (Verovnik, Fišer & Zakšek, 2015; Langevelde et al., 2017). Since the brown long-eared bat has moths as one of its main source of food, but won't come out in the light, light pollution measures for moths would be beneficial for the bat as well, keeping more moths alive for the bats to feed on (Voigt et al., 2018). Blue wavelength has also been proved as harmful for humans during the dark hours (Eklöf, 2020, pp 221-222; Haim & Zubidat, 2015), more on this below.

A range of general measures are promoted to decrease light pollution and harmful effects on human and wildlife when using artificial light, wavelength being one of them. IDA (n.d.b) list five artificial light-factors to concern: (1) only turned on when needed, (2) only in areas that need it, (3) no brighter than necessary, (4) minimize blue light emissions and (5) be fully shielded, meaning that light should be concentrate to the ground and not upwards or the surroundings. In terms of what kind of outdoor light, IDA (n.d.b) recommends light sources with warm light, for example, low-pressure sodium lamps, high-pressure sodium lamps and low-colour LED:s.

Solutions connected to measure number one above (only turned on when needed) is, for example, auto timer and motion sensors, limiting the light to the hours or moments when needed (Voigt et al., 2018). In addition, technical gadgets such as astronomical timer and twilight switch can steer outdoor lightning after programmed coordinates calculating the dusk and dawn (astronomical timer) or sensing when it's dark and light (twilight switch) (Clas Ohlsson, 2021a; Clas Ohlsson, 2021b).

Eklöf (2020, p 215) argues that the technical development within lighting should be used to adapt to the natural phase of day and night, stating that this will not only decrease the harmful effects on human and biodiversity but also holds the potential to establish more ecstatically pleasant lighting. Accordingly, subtle lighting can give a more visually enjoyable experience and at the same time increase visibility with less glare disturbing the eye (Eklöf, 2020, pp 213-215). Hence, the LED technique is two-folded: it is a great contributing factor to light pollution, creating a global light boom the last centuries and, on the other hand, a promising source to solutions with possibilities to variety and adaptation of light by colour, intensity and additional technical measures (ibid).

2.6 Human, darkness, and artificial light

At the time when a large part of the animals and plants wake up and get ready for hunting, mating, digestion and pollinating, the human circadian clock is set to slow down and rest (Eklöf, 2020, pp 24-25). It is time to calm down and prepare the body for the restoring capacity of the night. However, this is not how modern society is structured today. Artificial lighting gives humans the possibility to alter the rhythm and continuing activities into the dark hours, detached from the circadian clock in the light of the lamps (Falchi, Cinzano, Elvidge, Keith & Haim, 2011), as Pottharst and Könecke (2013) express it, "*Artificial lighting is both a precondition and a consequence of the 24-hour society*" (abstract), sustaining an enormous night-time economy: everything at any time (Henckel, 2009; Davies & Smyth, 2018; Pottharst & Könecke, 2013, p 41).

However, as mentioned in the introduction, humans are diurnal animals, why the 24-hour society and its lights have consequences on human health. The circadian rhythm is intimately connected with wellbeing, and for the rhythm to be able to perform its beneficial capacities, as a good night sleep, the absence of artificial light is a main component (Lunn et al., 2017, Yongmin et al., 2015). Disruption of the circadian clock due to artificial light at night, outdoor and indoors, can lead to health problems, such as sleeping disorders, diabetes type 2, depression, heart diseases, impaired immune system, obesity and cancer (Lunn et al., 2017; YongMin et al., 2015). Within this setting, the hormone *melatonin* must be mentioned since this stand in direct relation to the biological rhythm, producing a secretion at night that helps the body to restore (Chepesiuk, 2009). The levels of melatonin are lowered by exposure to artificial and natural light (ibid.), which is a contributing cause to the diseases listed above, however, foremost breast- and prostate cancer (YongMin et al., 2015).

However, this calls for a counterweight: artificial light contributes to quality and opportunity of human activities and is inevitable entwined with human development; most societies of today would not work without it (Ebbensgaard, 2019; Kyba et al., 2017; Tsao, Saunders, Creighton, Coltrin & Simmons, 2010), and it makes a great difference for areas without previous access to it (UNDP, 2020). Artificial light is further a powerful tool for beautification and for producing the "night-scape" of cities: the image of modernity and entertainment (Köhler, 2009, p 326), just imagine the night skyline of Los Angeles or New York.

Light in the dark is further an important part of city planning, creating safe environments for people to move around in (National Board of Housing, Building and Planning, 2019), for example by lighting up walking paths on the sides as well, exposing more of the surrounding areas. That brighter light equals more safety is, as touched upon above, questioned since people intend to accept and feel safe in light levels that equal about daytime light, which is commonly lower than normal urban lighting (Boyce, Eklund, Hamilton & Bruno, 2000; Eklöf, 2020, pp 213-215; Pottharst & Könecke, 2013, p 40).

One historical example of human living without light- in darkness- is the blackout (*mörkläggningen*) during the second world war (Swedish Radio, 2013, 7 September). In Sweden the blackout began partly in 1938 and lasted on different scales during the war years, obligating citizens to cover up their windows with a specific robust paper or heavy fabric to avoid being exposed by enemies. This was a collective practice where all outdoor lighting, including that on vehicles and ships, were kept at a minimum during the naturally dark hours (Swedish Radio, 2015, 1 July). Airstrikes were the main reason for this practice, keeping the targets in the safe realm of the dark (Swedish Radio, 2015, 1 July). The example illustrates that vast changes regarding lighting are possible in times of crises. To round up this section about human, darkness, and lights, we will tag along on an airplane control from 1938, where lieutenant colonel Åke Grönhagen tells about his impressions of the blackout in the Stockholm region (Swedish Radio, 2013, 7 September)[8]:

> "*We eventually passed Norrköping, which I would never have known if not the lookout-guard would have told me that the city was right beneath us. I could not see a single flash of light and that may perhaps gladden the citizens of Norrköping. That blackout was perfect.*" […]"*Stockholm should be honoured by their blackout as well. One or two lights from such a large city could, of course, not be avoided[…] the only thing that exposed the big city was the sparks from the trams, these were, however, very strong and characteristic, so only from that you could see how vast the tram network was and from that, you could more or less judge the size of the city*" […]"*As a final verdict, I would like to say that the blackout in the whole region has to be considered as much effective and well performed.*"

[8] Link to the radio broadcast https://sverigesradio.se/artikel/5630836. Writer's translation.

2.7 Background summary

A range of frictions starts to become visible from the outlining above. On the one hand, artificial light during the dark hours is essential in the night-time economy and as a tool for beautification purposes. On the other hand, it is a source of pollution, destroying connections to the cultural heritage of the dark sky and the beauty of the subtle. Still, artificial light is essential in human society and strongly connected to positive values, at the same time as a vast amount of nocturnal species (such as moths and bats) are dependent on the dark for their living. Human relations to the dark are contradictious, needed for recovery, but pushed away with the possibilities that artificial light brings, with entertainment and health problems as the result.

This chapter was meant to give a sense of the width of the subject, a brief introduction to its technical aspects and an overview of what is known within human and non-human biology about the need for darkness and the effects of artificial light. Now, over to the next chapter where a selection of research will give an overview of the topic's presence within geography.

3. Previous research in geography

As outlined above, this thesis is targeted towards darkness and artificial light in relation to both humans and non-humans, therefore studies within all these themes are of interest. In the last years, human geography has begun to fill the gap about light and darkness with studies on how it affects the spatial experience (Edensor & Hughes, 2019), studies on human-non-human relations, however, have a longer geographical tradition (Creswell, 2013, 239-259). In this chapter, a smorgasbord of studies within darkness and lights, and human-non-human relations are presented, in order to give a geographical research base for this thesis to develop from.

3.1 Darkness and artificial light

The selected articles contain both darkness and artificial light, but differences in where the emphasis lays can be found. From that emphasis, the selected articles are sorted in two separate categories. However, as Eklöf (2020) determines after wrestling with darkness and light (see 2.1) *"…without light, no darkness, without darkness, no light*" (p 206, writers' translation), as a reminder that the both contain the other.

3.1.1 Darkness

Cook and Edensor (2017) examine the experience of the landscape by night by letting a racing cyclist keep a diary about his training rides in the dark. By analysing the cyclist diary Cook and Edensor (2017) argue that the experience of moving through the landscape at night carries

profoundly different qualities than by day and that the "default" of referring to the landscape as diurnal should be questioned. This reasoning can also be found in Morris's (2011) walking study on a night-art installation on Isle of Skye. Morris (2011) concluded the contemporary understanding of landscape is biased towards the daylight setting, and that we need to acknowledge and incorporate the night landscape into our understanding. In both Cook and Edensor's (2017) and Morris's (2011) studies, as well as in Edensor's (2013), darkness is highlighted as a medium that changes the hierarchy of the senses, where a decreased vision gives space for sounds, smells, textures, and tactility, changing even the most familiar (diurnal) space into something else.

Darkness is further explored by Edensor (2013), departing from the statement that darkness is a more and more rare state and that the positive values of darkness must be studied, in contradiction to the major cultural understanding of darkness as a negative medium. Edensor (2013) explores a dark sky reserve in Scotland, and the visitor attraction Dialogue in the Dark, where the visitors got to experience a simulation of New York with all senses except vision. Edensor (2013) argues that without valuing the dark (by for example over-illumination) the human sensing of place becomes strained and non-complete. Further, Edensor (2013) concludes that darkness can foster more progressive and grounded forms of imagination, conversation, and conviviality[9]. Edensor (2013), hence, states the darkness is an important and undervalued medium in the over-illuminated parts of the world.

As a step between darkness and light, Edensor and Hughes (2019) have explored the aesthetics values of shadows and how shadows affect the choreography of movement. They argue that geographies of shade require increased awareness and recognition, while (1) shadows are a part of the ever-changing urban and non-urban spaces, (2) shadows enabled and affect movement and comfort in the public environment, and (3), shadows should be considered and taken into account in landscape architecture, architecture and design (Edensor & Hughes, 2019).

To this contribution should also Davidson's (2015) elusive exploration of the twilight be added. Here, Davidson (2015) explores the twilight through history, art, and personal experience. Davidson (2015, pp 9, 16, 21, 32) unfolds the complexity of twilight, a time marked by everything from release and pleasure to melancholia and fear, depending on place and time historically and mentally. An overarching theme is twilight as a demonstration that something ends and something new starts, where one of Davidson´s (2015) observation concerns

[9] Edensor (2013) compares "conviviality" with the Danish "hygge", in a Swedish context the word "mysigt" is a relevant translation.

returning: "*Twilight can be thought of also as the time of tranquillity and return, when all things scattered by the day are drawn back to their right places*" Davidson (2015, p 11).

3.1.2 Artificial light

Ebbensgaard (2015, 2020, 2019) is one of the front scholars representing the geographical branch that examines the creative and socially progressive potentials of artificial light. Ebbensgaard (2015) argues that artificial light, by its highlighting of different objects, is an important element of our every-night experiences. The highlighting further contributes to a discussion of the spatial meaning and invites different forms of engagement with the urban fabric, meaning that the placement of artificial light at night signals what places to be in. In his more recent work, Ebbensgaard (2019) examines the LED-light shift in London and how these changes are interpreted by citizens. Conclusions are drawn that distribution of light reveals uneven geographies and how unintentional light can contribute to appreciating spaces of safeness and comfortability. Uneven geographies of artificial light and its relation to power are further investigated, both through a historical and modern perspective, by for example Cubitt (2013), Nye (2015), and Entwistle and Slater (2019). Further, Ebbensgaard (2020) visits inhabitants of a high-rise building in London and shows how artificial light can hold intimate values of feeling at home and being a part of a world where everything is possible.

Pink and Sumartojo (2018) add automatization (e.g. motion sensors) to artificial light. The study explores how the experience of everyday movement stands in relation to automatic lighting, by following people's way home from work in Melbourne. Paths of light and people's feelings and effects for the light became visible and provided building blocks to the formation of the concept "the lit world" which the authors continued to develop in further research (see Sumartojo & Pink, 2018).

Further, Dunnett (2015) has investigated the social aspect of light pollution. Dunnett (2015) targeted two British anti-light organisations and analysed their development in relation to the broad political spectrum of modern light-concerns, such as crime, health, ecology, and aesthetics. A moral geography of light pollution was identified in which Dunnett (2015) highlights two relational discourses; (1) the astronomical values as an invaluable asset of beauty and (2) a counter-reaction against the urbanisation and light pollution as a threat against rural values, where the clear night sky is part of the identity. By placing light pollution in a landscape perspective, Dunnett (2015) means that we can create a more vital understanding of landscape, in line with the darkness studies above. However, Dunnett (2015) also emphasises how the use of light pollution in a landscape perspective can reveal human relation to the cosmos, arguing

that this can contribute to an enhanced understanding of humans own understanding of their place in the landscape and their experiences, memories, and values within it.

3.3 Human and non-human relations

"Until nonhuman agency is more directly championed, accounts of relational agency which claim to transcend human-nonhuman divides will always be magnetically attracted to the human core." (Jones & Cloke, 2002, p 66)

Since geography in its original sense is the study of the inhabited earth, there are plenty of subfields where human and non-human can be theorized together (Cresswell, 2013, pp 239-259). An overarching field for these subfields is more-than-human geographies, which in various suborders includes for example hybrid geographies, biogeography, (new-) animal geography, and actor network theory (ibid.). Below, a selection of research from more-than-human geography that addresses the co-existence of humans and non-humans, is presented.

Barua (2021) analyses the concept of infrastructure from a more-than-human standpoint, by outlining how infrastructure is more than a medium for human mobility, knowledge, or the moving of things. This is done by constructing a wider understanding of infrastructure, showing that infrastructure both reduces and produces possibilities for non-human mobilities, altering the dynamics of life. Taken together, Baura (2021) argues that infrastructure can be used as a medium for other-than-human, which, if grounded, could be a start on a society where other forms of life than humans are allowed to claim their right to movement; a more-than-human infrastructure.

Further, Hubbard and Brooks (2021) have investigated the un-justices of gentrification from an animal geography perspective. The gentrification debate, Hubbard and Brooks (2021) argue, have in large been focused on the anthropogenic effects, ignoring that non-humans are also living in the urban environment, hence, are also victims of displacement in gentrification processes. In the article, geographical studies on gentrification in relation to human and non-human are reviewed, arguing that a trans-species approach is a way of strengthening arguments for anti-gentrification, stating justice by the "right to the city". This draws on the anthropogenic "right to remain", a common argument for justices in human displacement matters, but here extended to all living things right to exist in their accustomed place.

Changing focus to a study that considers the human-non-human relation per se, Hitching and Jones (2004) have explored the boundaries between human and non-human, with emphasis on plants. The authors lift plants as a two-sided living entity, having their own agency (growing,

climbing, feeding, mating), and being an inherited part of the landscape, rooted in the earth. The human relationship to plants is explored through interviewing children in a botanical garden and private garden owners, where Hitching and Jones (2004) show how plants are lived with, cared for, bringing up memories, and stimulating senses.

3.4 Previous research wrap up

This chapter has shown that geographers are engaged in a wide range of aspects within darkness and artificial light. Further, the selected studies on human-non-human relations show that there is a widespread lack of other-than-human agency in a series of different matters. Geography is apparently well suited for scrutinizing these fields, steadily breaking new grounds. However, as earlier stated there is a lack of research where darkness and artificial light are explored in relation to the human and the non-human. Still, we inhabit the same earth, the same space, all depending on darkness and light in our circadian rhythms, rhythms that are altered and threatened with harsh consequences by the human use of artificial light during the supposed-to-be dark hours. The next chapter provides two theories that will be applied on this matter in a later stage.

4. Theory

"Theory is a way to think abstractly about the world and to speak of it in particular vocabularies" (Mahmoud et al., 2018, p 8). In addition to this description, I see theory as a certain road on the way towards increased understanding about a certain thing, where thinking and speaking are essential preconditions for this understanding. To be able to think abstractly and to speak with a particular vocabulary about darkness, artificial light, humans and non-humans, I have chosen Hägerstrand's *all-ecology* and *Non-Representational Theory* (NRT). These two theory tracks will be the filter for my empirical findings, where the all-ecology is the overarching ontological stand of the thesis and a provider of a geographical toolbox. Lining up below all-ecology, NRT is my conceptual handrail in the exploration of experience, hinting towards the method-section that will follow this part. This hierarchy is illustrated in figure 4 below.

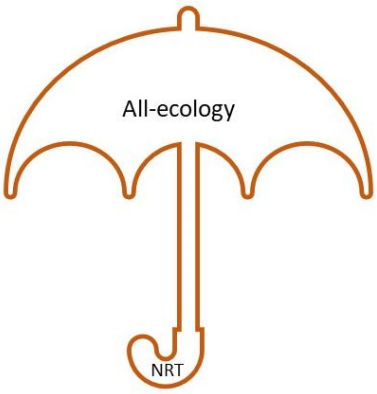

Figure 4. *Theory structure, all-ecology as an ontological umbrella and geographical toolbox and NRT as a handrail in the exploration of experience.*

Before moving on, some comfort: it is okay if you don't understand the theories on the first try, be patient and hopefully it will become clearer when it's put in relation to the empirical results. Until then, take a deep breath and enjoy the world of all-ecology and non-representational theory.

4.1 All-ecology

"Humans and their society is just a pattern in the big tapestry of Nature which history is weaving." Hägerstrand, 1976, p 332.

All-ecology is the encapsulating term of the ontology of human-environment relationship formed by Torsten Hägerstrand (1916-2004). The '*all'* points at the most critical part of the view; that everything that fills the earth, living and non-living, depend on each other (Stenseke, 2020). '*Ecology'* points at the bridging of biological ecology and human ecology, bringing the human back towards nature (ibid.). With all-ecology Hägerstrand (2009, posthumously published) wanted to create "*…a study of the earth surface as a* <u>*meeting place*</u> *for all forms of existences*" (p 27, original emphasis), which he argued was the only rational approach to establish a more sustainable being on earth. The meeting place is often labelled *all-space* (*allrummet*) in which the all-ecology takes place, governed by physical laws and a constant biological and social struggle for spaces to exist in (Hägerstrand, 2009, pp 160-161). In the all-space, time and space are two invaluable mediums in the everchanging creation of the "fabric of existence" (*tillvaroväven*) (Hägerstrand, 2009, pp 165, 225), which will be shown in the headings below.

Hägerstrand is known for his vision of the world emphasized as *one* (and for establishing time geography), arguing for the bridging of dualisms and knowledge, such as nature-culture

and different science disciplines (Ellegård & Svendin in Hägerstrand, 2009, pp 9-10, 15). Within Hägerstrand's realm of concepts and thought, the theme of understanding the human's place in nature's world and nature's place in human's world, is an overarching one, as well as the search for common features instead of differences between the entities on the earth's surface (Ellegård & Svendin in Hägerstrand, 2009, p 11; Hägerstrand, 1984). In the foreword to Hägerstrands intellectual testament (named after the time-spacious pattern presented above; "The fabric of existence"), the editors Ellegård and Svendin express that they hope that Hägerstrand's concepts and thoughts could act as a base for binding together new ways of thinking, striving towards the knowledge and action within the *whole* (Ellegård & Svendin in Hägerstrand, 2009, p 15), something that this thesis is set out to do.

Four overarching concepts from the all-ecology have been picked out as especially important for dealing with the themes of this thesis; *take space*, *in-between spaces*, *presence* and *absence*, and the *diorama*, which are presented below.

4.1.1 Take space

This might be the trickiest concept to translate from Swedish, however, it is a much relevant one, which is why I will give it a try. The concept is called "att äga rum" in Swedish which in its primary sense means that something happens; it takes place. However, literally translated it spells "to own space" or "have space", meaning that the something also takes up *space*, hence the translation to the grammatically incorrect 'take space'. Hägerstrand (2009, p 29, 84; 1996) used the term in both senses, highlighting the space and time dimension: space is occupied by different things and that this occupation is constantly changing.

The earth is a limited land, why the life of everything in it, on it and above it is in a constant struggle for space while resting and while moving. The more inherited requirements an entity has for moving, the more space it takes, if it is not restricted by another entity already taking that space (Hägerstrand, 1976). A citation by J.W. von Goethe highlights this struggle in Hägerstrand (2009); "*Everything that becomes seeks itself space and strives for continuous being, therefore presses itself into another's space and shortens the being of this*" (p 34, writer's translation).

Translated to an everyday setting; where something 'takes space', nothing else can have that space, affecting the way things move, avoiding and searching (Hägerstrand, 2009, p 84). This happens in different time scales: a tree root searches for nutritious earth to expand into, a bird navigates in between the treetops and a human walks the shortest way to the grocery store, avoiding walking into buildings on the way. This line of thought is hence based on the friction

that the limited space of earth is creating, all new things produced and born must take resources from one spot and push away something else with its existence, may it be land or air (Hägerstrand, 1996).

Seen from this position, the all-space is *crowded*, resulting in that everything that is about to happen cannot happen at the same time (Hägerstrand, 2009, p 166). A sandglass explains this the best; the grain of sand must wait due to the limited amount of space in the waist of the sandglass, time and space tightly intertwined. Hence, 'taking space' is not only about access to actual space, it's also a matter of access to time (Hägerstrand, 2009, p 165-166, 172). The process can be seen as a "*timetable of need*", meaning that all living has different needs at different times and at a different speed, which simultaneously requires enough space to move in, filled with the required entities (Hägerstrand, 2009, p 247).

4.1.2 In-between spaces

Things (including everything; the coffee mug, a human, the tree)[10] have space at different points of entry, in different positions and in different forms. This all together creates *in-between spaces* (*mellanrum*) between the things since they can't be stacked against each other due to their size, shape, and needs (Hägerstrand, 1996; Hägerstrand, 2009, p 86-90). However, in-between spaces are also filled with taken for granted phenomena like air, gravitation and radiation, although different in its qualities, as it can be pushed away and spread in another sense than physical materials (ibid.; Hägerstrand, 2009, p 86-90). Hägerstrand (1996) explains this as earth being filled with space-owning and in-between-space-owning.

All in-between (but filled) spaces together constitute the transformative *complementary space (komplementrymd*, also called free area, *friyta)* (Hägerstrand, 1996; Hägerstrand, 2009, p 87). The complementary space can be understood by imagining a warm silicone sheet laid out over the landscape, forming itself after the structures. When stiffened the form can be lifted and water can be poured in it: every space that is filled with the water together makes up the complementary space. Water in real life is also a kind of complementary space since it just like air has the floating quality of binding together the overall structure, filling the space between the harder things, like the water in Archimedes bathtub.

The complementary space is hence space for opportunity for living things to move in or the opportunity for living things to put things in, such as a house, a nest, or a vase (Hägerstrand,

[10] Here *things* refer to the physical sense: all things take up space, but Hägerstrand (2009, p 156) is also clear that living things, and there foremost humans, differ from abiotic things since they have emotions, plans and projects which the non-living do not have (se also Pred, 1981, p. 30).

1996; Hägerstrand, 2009, p 87). Since movement always has a duration, the silicone experiment only works on a frozen picture where time is stopped, when put on the real world the form would never stiffen due to the constant moving of entities, hence the shape of the complementary space always differ in the flow of time (Hägerstrand, 2009, p 87-88). Further, things also have an inherited duration (a mayfly usually shorter than a human), which also alters the complementary space; when a tree decomposes, air fills the space it once had (Hägerstrand, 2009, pp 94-95).

4.1.3 Presence and absence

The existence of the place-having entities (you, me, a stone) can be examined through *presence* and *absence* as two determinants allowing or constraining the still or moving entity, or as Hägerstrand (1984) expresses it; "*Every action is situated in space and time and for its immediate outcome dependent on what is present and absent as help or hindrance where the events take place"* (p 337). Hence, the presence of one thing or condition means that space is allowed for one individual (in its broadest sense) and constrained for another, resulting in the absence of this. This is a constant flow of happenings in time, appearing and disappearing often without us being conscious about it. One action is followed by a new set of presences and absences creating constraints and possibilities for the next action, and so it continues (ibid).

I like to think of it as a tidal beach, at low tide a human and its dog can walk on the beach, sandcastles can be built alongside small crabs whilst the air is stacked above the sand surface: all present. When high tide rolls in, the former mentioned must move to higher ground, or down in the sand or flow to another space. Now, the former absent creatures of the water, and the water itself, can be present.

Hence, presence and absence are part of the deciding of what can and can't be done, the space of action. Concerning presence and absence, two additional concepts are relevant: *constraints* and *encounters*. These are important while they shed light on reasons for things to be present or absent (constraints), and what happens when things do encounter one another (which we will see happens all the time). First, constraints (*restriktioner*), a famous concept from time geography. There are three kinds of constraints; *capacity*-, *steering*- and *coupling*-constraints (Ellegård, 2019, pp 44-45), where the capacity constraint refers to the bodily and mentally capability, as well as what resources are available. A bird with a broken wing has capacity constraints concerning flying and a human without a food-processor must grate the potatoes by hand. Further, steering constraints refers to power relations; laws, rules, and norms, such as stopping by the red light, paying tax or who are allowed into a specific area or building.

Last, coupling restrictions concern the opportunity and need to couple and decouple (ibid.); to arrive at work in time, talk with your grandmother when she is awake, or, in the bird case, to catch insects while they are out and to find a mate when its mating season. All three constraints are connected, without the ability to bike (capacity) you might have to catch the bus (coupling), in order to get in time to work according to the work schedule (steering) (ibid.)

The second additional concept, encounters (*påträffande*), are governed by the time-space distributions of things (Hägerstrand, 2009, p 86). Encounters give effects; water that reputedly hitting (encounter) a stone will in the long rung shape the stone, a single wave might encounter a crab on that stone, resulting in the crab being carried away to a new place (cf. Hägerstrand, 2009, p 70). Notable is that encounter here refer to both space and time, as an encounter takes place in a space and has a duration (Hägerstrand, 2009, pp 78, 96). Some encounters are searched for, some avoided and some spontaneous (Hägerstrand, 2009, p 97). Humans and animals (and plants, however in a less observing phase) actively search for the wished (a partner, the right food, a place to rest) and actively avoid the not wished (a predator, the wrong food, spaces that feels unsafe), resulting in complex navigation through the fabric of existence (Hägerstrand, 2009, p 72). However, encounters happen everywhere; being in the word means being touched by it (Hägerstrand, 2009, pp 82-83). Even if you were naked and took a big jump, the air would still encounter your skin. Being back on the ground, the ground encounters your feet.

4.1.4 In the diorama

A way of observing and analysing the all-ecology and all that comes with it is through the concept of the *diorama*. This word Hägerstrand (1984) borrowed from the museums where the dioramas demonstrate life in three-dimensional glass boxes, for example, “farmers life”, where the fields, the cattle, the farmer family, and the tools are presented in a small-scale artificial life. Translated to a real-world setting, the diorama is a way of looking that helps to view *the whole* (ibid.). The diorama perspective puts bits of the world under a magnifying glass where phenomena and entities are present together, striving for unification, avoidance or forcing away each other into absence or non-existing. This is a way of acknowledging that everything is building parts of the whole, from the air molecule and gravel to the trees and thoughts (ibid.).

In other words, in the diorama everything *meets*, consciously or unconsciously, as in any scene in real-world (ibid.); the mind and its thoughts, body and body, the grass and the soil, the rain moistening the soil and humidify the skin of some, fur and wings of others. This is important for two major reasons: (1) by admitting everything in one scene, even (or especially)

the mundane and taken-for-granted phenomena, more real-world knowledge can be created, and (2) departing from that knowledge, recognising the interrelations; trends and consequences can be better foreseen, which is crucial for sustainable development (ibid.)

To consider everything is, of course, an impossible task, if not carried out at a very small scale, but the departure from the diorama perspective can still be a handrail towards the realistic world (ibid.). For example, by acknowledging that the pieces studied are pieces from a large puzzle and that the pieces not laid out must be kept in mind, or imagined, in order to sense the final result. What's absent affects the present and vice versa.

4.1.5 All-ecology wrap up

The above outlined part of Hägerstrand's worldview is less known internationally than his earlier work on time geography (Stenseke, 2020). The reason for this could be that time geography overshadowed the rest or because his later works were never translated to English (including his intellectual testament, *The fabric of existence*) (ibid.). Therefore, the critique pointed against Hägerstrand's realm of thought is partly incoherent. However, two main concerns can be pointed out: the lack of liveliness and the lack of attention to power and institutions (Latham, 2020). Concerning the lack of liveliness, this, in my meaning, rather applies to time geography. I personally interpret the all-ecology as a very lively concept, which may be expressed in somewhat strict terms, but still, in order to make sense of the lively world. Concerning power and institutions, I (of course) see this as highly important, however, in this case, a rather new subject is explored, in a way perhaps never done before. I therefore argue that it is important to give space for first creating a better understanding of the lived practices, and then, more than welcome, examine the power structures connected to the subject.

Taken together, reasons to take on all-ecology are multi-folded. It offers thoughts on existence and how it plays out in the world, including the non-touchable, which makes it a suitable theory for this thesis. However, and this is maybe the biggest reason for applying all-ecology, Hägerstrand did not develop any thoughts explicitly on darkness and light. The harmful effects of artificial light were barely known when he wrote his last piece, leaving a possible gap for contribution to the further development of the fabric of existence. Another reason to take on all-ecology as an ontological stand and geographical toolbox is to pass on a bit of the worldview from an explicit Swedish public to an international scene (although in the modest form of a master thesis).

Finally, one overall critique, including all-ecology, Hägerstrand never really outlined any tools for how to translate all his thoughts into practice (Qviström & Wästfelt, 2020;

Stenseke, 2020). This is where the non-representational theory comes into this thesis, providing me with guidance in the experience of empirical research.

4.2 Non-representational theory

When Nigel Thrift (1996, 1997, 1999) started to develop the non-representational theory (NRT) it was also labelled "the theory of practices" and later on described as "the geography of what happens" (Thrift, 2007, p 2), which may give a better hint to the central themes of the theory; the mundane lived everyday experience. The non in *non*-representational refers to the theory's urge to not put labels and meanings on phenomena, rather lift up a part of the world and say, "look at this" (Thrift, 1997, pp 126-127).

This can be explained with the example of laundry, where a shirt gets to represent the world and its events: NRT wants to show the shirt (the world) with its wrinkles and wet parts, just as it looks when you take it up from the laundry basket see figure 5a). In comparison, realist research wants to show many ironed shirts in a rational setting to be able to generalize (see figure 5b) and thereby excludes elements of the living world (Vivianni, 2015). NRT, hence, turns against the representation of social existence through a rational lens (ibid.). With this said, I want to make clear that I view NRT as a *complement* to realist representational research, as Thrift (2007) expresses it in his later work *"…a supplement to the ordinary, a sacrament for the everyday, a hymn to the superfluous*" (p2).

Figure 5. a) *Example of how NRT wants to present the world (the shirt), straight from the vivid environment. Source: https://www.pinterest.se/legoupillot/washing-lines/.*

5. b) *Example of realist research in comparison to NRT, with generalisation as the goal. Source: https://www.pinterest.se/search/pins/?q=ironed%20shirt&rs=typed&term_meta[]=ironed%7Ctyped&term_meta[]=shirt%7Ctyped.*

This part of the theoretical framework is best read as a bridge towards the method since NRT carries a strong call for a methodology that is experienced and lived within the micro geographies (Nash, 2000). Within the realm of NRT thinking and practises, I have chosen three concepts as a guide for how I want to approach and mediate my thesis subject: *vitality*, *corporeality*, and *experimental*.

4.2.1 Vitality-embracing life

To take on vitality as a watchword is wanting to acknowledge *life* and in this highlight the *process* of life; that all is in the becoming, not only being (Fraser, Kember & Lury, 2005). With the all-inclusive processual life as a foundation, it naturally follows that entities are shaped by the relations to one another and that space and time are internal within these relations. The processual and relational conviction is further a way of recognizing the researcher's role as intervening in the world (ibid.). The researcher is, just as every other part, in the becoming, affecting, and being affected by, the research field. Richardson-Ngwenya (2014) states that *cultivation of a vitalist mindset* is essential here, keeping open to the liveliness of the field and the importance of the relations.

A background approach that will help the vitalist cultivation is the acknowledgement of non-human, biotic and abiotic, as dynamic stakeholders of change (Richardson-Ngwenya, 2014) (a conviction that I hope the all-ecology above transmitted successfully). To vitalize non-human agencies is a way of avoiding forgetting, or overseeing, everything besides humans (Bingham, 2006). This could be related to the writings of Rachel Carson (1907-1964), where she quite contrary to traditional scientific tradition gave the animals in her writings a soul and personality[11]. Even if we cannot know how it is to be an animal[12], the vitalization takes us one step further towards understanding and caring for other creatures, which was exactly what Rachel Carson's writings caused for a broader public (Svensson, 2019, pp 55-60). This is a matter of *affect*, where NRT strives towards not only researching affects but also being affective (Vannini, 2015), creating traces of emotions.

Further, the acknowledgement of all thing's dynamism and spatial temporalities is a way of recognizing that we cannot capture the world, everything is in a constant change with interrelations that we can never fully understand (Bergson, 2002, p 190). Hence, NRT research is about realising the failure of knowledge (Dewsbury, 2010), we take up an (incomplete) piece of the happenings in the world knowing that it is only temporary and that the next grasp could yield something else. However, this is still a matter of making the world more understandable, or, making the *lively* world more understandable (Thrift, 2008, p 8).

4.2.2 Corporeality-acknowledging the body

Our presence in this lively world is *embodied*, therefore NRT researchers use their given bodies as a key instrument in knowledge creation (Vannini, 2015). This plays out by giving importance and value to senses, feelings, and thoughts, like Vannini (2015) expresses it, concerning NRT within ethnographical research; "*From fatigue to enthusiasm, melancholia to keenness, pain to enchantment, non-representational ethnographic research is affected by bodies' capacity to affect the world and their capacity to be affected by it."* (p 321). Concerning the senses, these are allowed through the embodiment and in return helps the body make sense of the world around it; "*I only see from this visible body*" (Wylie, 2002, p 452).

Having first-hand embodied experience, individuals are highlighted as experts in their own lifeworld's, in line with the NRT overall embrace of the naïve and the mundane (Thrift, 1997, p126). Further, in NRT research about dancing, riding, running, or any other activity of movement, the corporality is clearly present since rhythm, coordination and other skills are put

[11] For example, *Under the Sea-Wind* from 194.
[12] See for example *Whats it like to be a bat* by Thomas Nagel (1974).

into a mixed motion (Thrift, 1997, p 125; Vannini, 2015). However, as this section started to outline, our very presence is embodied, why the use of corporality is convenient in every NRT research, or as Merleau-Ponty (1962) describes it; "*…the body is the vehicle of being-in-the-world...it is enacted at every instant in the movement of existence"* (p 89). Thrift (2007, p 239) underlines that corporality stands in invaluable relation to *things*, meaning that the vulnerability and the possibility of movement and comfort of the body are depending on the presence and use of material entities, such as clothes, bikes and beds.

4.2.3 Experimental- dare to see what happens

"No battle has ever been won without resorting to new combinations and surprising events." (Latour 2005, p 252).

It is not the ground-breaking methods that are primarily concerned when speaking of the experimental embracement in NRT, rather it is the approach to the happenings playing out in front of you and with you; "*To see what will happen. To let the event sing you."* (Thrift, 2007, p 12). New methods are, however, highlighted by NRT as possible means to see what is happening (Vannini, 2015); new kinds of methods might show new kinds of happenings (Bissell, 2010). For example, different kinds of performance art are emphasized as methods, or events, that could help to capture the richness of the world (Thrift, 2007, p 12).

The impossibility of empirical research, to try to capture something that can't be captured, is brought forward by NRT researchers as a source of creativity instead of a constraining demand (Laurier & Philo, 2006; Vannini, 2015), embracing experimentalism. Thrift (2007, p 12) extends this thought by emphasising that the world is filled with entities, a lot of them unknown by humans, therefore unconventional means are necessary for the exploration of the filling.

Examples of this kind of research is for instance April and Philips Vannini's (2017) texts about walking in Scotland with a hiking expert, both paying attention to the feelings and rhythm of the experience, but in two different ways (with a video camera, and with focus on presence and mind-mapping). Further, Morris (2011) applied a NRT framework when she conducted her study on walking through a night-art installation. Building on the legacy that NRT has established concerning the researchers' embodied and sensuous participation and effect on the field, Morris (2011) own experience and feelings during the walking contribute a large part to the empirical material, the analysis of it and the way she chose to present it. Laurier and Philo (2006) café-study is another example of NRT research where they explore everyday

encounters by sitting in cafés, observing, and participating. Hence, by implementing an experimental method, or mindset, bits of the lively world could be embraced that would have been set aside in traditional social research and at the same time "*inject a note of wonder back into a social science"* (Thrift, 2007, p 12).

4.2.4 Non-representational theory wrap up

NRT is a fluffy realm of thought and practices, sometimes even pointed out as annoying (Vannini, 2015). Understandable, multi-folded critique has been raced against NRT, mainly concerning the lack of acknowledgement and involvement of gender, power, injustice, and politics (Vannini, 2015; Nash, 2000). These concerns derive from the body centred experience that NRT embraces, where critics pose that this fails to acknowledge the bigger structures that affect the bodies (Nash, 2000). I agree with this critique, however, as stated in the NRT introduction, I see NRT as a valuable *complement* to traditional systematic research: we need both un-ironed carelessly hanged shirts (a bit of the lively life) and mass-produced perfectly folded shirts (to generalize knowledge).

I make no claims to have fully grasped all that NRT holds, rather, what I take with me is what has outlined above: vitality, corporeality and experimental. By taking with me, I mean two things: (1) these words are meant to help me interpret the world as I experience it, in my everyday- and night life, living with darkness, artificial light and thoughts on co-existence, and (2) the words will be guiding stars in the method when trying to mediate the material from being experienced to being written, and then read (by you).

4.3 Short bridge towards the method

What was just outlined in the last sentences above (referring to what I take with me from NRT) is important, while NRT is here used as the extension of all-ecology down to practical means. From the all-ecology ontology, the concepts of 'take space', in-between spaces, present and absences and the diorama were chosen as geographical tools for examining darkness, light in relation to humans and non-humans. However, as outlined in 4.1.5 (the all-ecology wrap up), Hägerstrand was criticized for providing insufficient guidelines for how to implement his thoughts and concepts. On that basis, NRT here informs me of how to think and deal with the living world where the chosen concepts play out. How this thinking and dealing is performed in a practical sense is outlined in the following method section.

5. Method

The method consisted of two qualitative parts combined: (1) diary-writing and (2) walking interviews. The diary was conducted by me as an extended research diary, being a supportive function for the thesis process *and* a tool for reflecting on darkness and artificial light in my everyday-and night life. The walking interviews were conducted with three interviewees, a moth-expert and a bat-expert in the area of Jonsered, and with a light designer and light artist in the park Slottsskogen. Both methods will be presented in detail below and be followed by a method reflection and thoughts on how to transfer the empirical material into a result. Before the outlining of the methods, their connection to the theories will be shortly presented, followed by a short background about the researcher (me).

5.1 Methods place in theory

Both all-ecology and NRT could be related to the methods of diary and walking interviews. Hägerstand together with Buttimer (1980, pp 24-25) were clear about the value of first-hand experienced knowledge, why diary-writing is a suitable match (see also Hägerstrand, 1976). The methodology of walking interviews fits well with NRT since it argues for a more sensuous kind of research (cf. Vannini, Waskul & Gottschalk, 2012), which walking methods are, exposing the two participants (the interviewer and the respondent) for visual impressions, smells, sounds and textures that would not have occurred to the same extent in a more isolated context (Tilley, 2015, pp 17-18). However, the theories are not separately used in the two methods, rather they inform each other and are at play when writing and thinking as well as walking.

Using a diary in combination with other qualitative methods, like walking, is a common design (Hyers, 2018, p 59), embracing the standpoint that the researcher's experience should not be limited, rather a prior resource (Engin, 2011). This standpoint goes well with both all-ecology and NRT. A fly in the mess, rather than on the wall.

5.2 About the researcher- positionality

Since the thesis empirical material is filtered through me as a researcher, it is of importance to outline how I am. This is of even greater importance since I'm in this thesis not only filtering the empirical material, I'm also creating it by writing the diary and taking part in the walking interviews. This reasoning follows the thoughts of Anne Buttimer (see Mels, 2010, p 94) and Donna Haraway (1988), where Buttimer argued for the importance of the *milieu* of the scholar,

and Haraway for situated and embodied knowledge. To give a short summary about oneself is not an easy task. To make it easier I will do the outlining departing from earlier experiences connected to the subjects of the thesis. First, however, the "hard facts": I am a 29-year-old woman, living in a relationship in Gothenburg. Now, the rest:

I grew up in Luleå in northern Sweden where it was dark when I went to school and dark when I went home from school for a large part of the year. In contrast, during the summer, the day almost never ended. Thinking about my own relation to the dark, it is a mix of being used to it, liking it, being scared of it, being told by society to stay out of it to avoid dangers, and now trying to embrace it. Artificial light was a great enabler for activities during the winter when I grew up, and in my apartment-life now it's a constant fight with my partner about having "cosy lighting" or bright lights (I'm on the cosy lighting team).

Thinking of human-non-human relations, I can see that it is a common theme throughout my life so far. My grandparents and parents have taught me a lot about plants and animals and taken me out to those environments, but also encouraged me to cherish the most mundane encounters; observing how the seeds grow or feeding a hedgehog. During my five years of geography studies, biodiversity, or the loss of it, has become a more and more common departure point for my writings, simultaneously as the attention about the crisis has increased in the media.

5.3 Diary

"*It is, by the way, frequently a good idea to think about one's own experience before one is making general statements about the world*." (Hägerstrand, 1976, p 334)

Using diary as a method provides the possibility to grasp and reflect upon experiences and observation over a long time span (Mügge, 2013, p 193; Bartlett & Milligan, 2015, p 8, 15-16), or as Hyers (2018), expresses it *"the diary harnesses the power of immediate personal witness."* (p 27). In this thesis, this personal witness is my own, which distinguish from solicited diaries where respondents are asked to fill in a diary that the researcher later will analyse, or unsolicited where the researcher analyse already written diaries (such as historical accounts) (cf. Bartlett & Milligan, 2015, pp 2-3).

In a scholar context, the own-writing diary is often called a research diary, which is used as a medium for reflexivity and critique, creating a self-aware relation to the research (Tricoglus, 2001). Further, the research diary is a tool for mediating and constructing research knowledge that helps the researcher develop as a researcher, which in turn can lead to changes

in beliefs and practices (Engin, 2011; Hyers, 2018, p 48). Hence, the research diary can be seen as an account for inner dialogue, a dialogue that is part of the data collection, and a tool for interpretation of research findings (Engin, 2011). In contrast to other qualitative methods, such as traditional interviews, the diary has the potential harness to encapsulate time and context-specific phenomena (Hyers, 2018, p 1), which suits this thesis well.

Thus, as Mügge (2013, p 193) and Engin (2011) highlight, the research diary can be more than just a record of actions, it can have supportive, explorative and knowledge constructive qualities as well. The diary can therefore be a tool for both research and intervention into one's own life, contributing to awareness and change at the same time as informing the theory (Hyers, 2018, p 48). This starts to touch upon how the diary is used in this thesis, but first, a short outlining of how diaries have been and are used by others.

5.3.1 Other people's diaries

The most famous unsolicited diary is probably "Diary of Anne Frank", however, the diary is used as a tool for capturing and process extraordinary times or everyday life in contemporary settings as well, for example in the newly published "the Quarantine Diary" (Karantändagboken) by Elin Lucassi (2021). Such accounts can be analysed by the afterworld, and give valuable clues to the past, hence mostly used in historical research (Bartlett & Milligan, 2015, pp 2-3).

Solicited diaries are, on the other hand, used as a method in a wide range of research fields: health science, medicine, sport science, transport planning, psychology, and gerontology (the study of aging) (Bartlett & Milligan, 2015, p 5). Within human geography, foremost the branch of time geography has established the use of "time diaries" as a part of their standard research kit, where the possibilities and constraints of everyday life are analysed (Ellegård, 2019).

The researcher diary, which the researchers keep themselves for logging decisions and stay reflective, is commonly used in, for example, ethnographic research or anthropology (Mügge, 2013), or within educational research as a tool for learning a language or for teachers to learn about their own teaching (Engin, 2011). This is the type of diary that is the most like the one I'm keeping in relation to this thesis. Within the educational field, Engin (2011) has explored the use of diary as a way to learn more about researching, by keeping a diary during a set time in her doctoral studies. She found that the diary included several entwined themes; questions to self, reference to 'expert other', and noticing differences and justification for decisions and activities. She concludes that keeping a diary is a beneficial way for researchers

to learn about their knowledge development; "*The researcher diary can be seen as an integral part of the development of the researcher and the construction of research knowledge."* (Engin, 2011, p 303). Mügge (2013) is another researcher that has outlined her experiences of keeping a diary in the ethnographic field. During her field studies, the research diary developed to be a tool for preparing and handling the challenges that the field posed. Mügge (2013) concludes that apart from important support, the research diary also posed new questions for further research.

Taken together, diaries written by the researcher themself have mainly been used as a support for the ongoing research, like a silent but listening friend. In my case, the diary is used as such support, but also as a way of exploring and reflecting over darkness and lights. In this sense, relevant previous research has been conducted by some very old geographers: the explorers. Nordenskjöld, Amundsen, Isabella Bird, and the Andreé expedition (for example) all used diaries as a way of preserving and observing the unknown land they encountered by the poles and in the world (Gothenburg University Library, 2017; The Fram Museum, 2019; National Geographic, n.d; Uusma, 2014). Now, I don't want to compare my adventure of exploring the darkness and artificial light in my everyday- and night life with the great travels of these legendary explorers. However, we do have one thing in common, and that is exactly the exploration of the unknown, observed through personal accounts in a diary. Even though this diary hasn't travelled to any more existing places than to my parents in Värmland, still, darkness and light are largely unknown "land", not observed by anyone in this way to my knowledge.

5.3.2 My diary

In this thesis, I call the diary the Darkness Diary. The first thing that must be clarified about the Darkness Diary is that it consisted of two parts: (1) reflections about my everyday- and night encounters and thoughts about darkness and artificial light and (2) notes about the ongoing research, choices, and feelings for the process of writing a thesis. Hence, it has an explorative function and a supportive function. The writing was done in Swedish and took place in a word-document where the two parts were separated by using black text for the reflective part and grey text for the research diary part, see example in figure 6 below. By writing down things to do, or specific research thoughts, I could feel relaxed with spending time on more loose thoughts about darkness and lights, or rather, by knowing that I *would* write down what to do made me feel calm with being reflective since the black reflective entries almost always were written before the grey supportive entries.

Thursday 4/2 07.15
Woke up 05.45 and thought it was morning, new crazy-wake up-thing. It's only 45 minutes before normal time, but it's not like I'm usually jumping out of bed at that time. Will see if it will get easier to get up later on, when it's brighter in the mornings. I don't think cross country skiing in Landvetter counts as a darkness activity, it's so much light on the illuminated ski tracks. Never thought of that before exactly now, but the lightened tracks must generally constitute huge obstacles for the animals and mess things up for the plants, like a winding wall/trap through the woods.
Today I think I will continue with writing references and such, have made a substantial amount of text and it will be unsustainable to go back and correct all that afterwards (it takes so much time). I will write about lamps as well when I get in the mood.

Figure 6. *Example from the Darkness Diary, black text for the reflective part and grey for the research diary.*

The diary was organized after date and time, with no set direction of when or how much to write. However, the amount and the frequency of writing was greater in the beginning of the diary-writing period since a lot of the thoughts and reflections that I had been carried around when thinking of the subject desperately needed to be put on paper (cf. Mügge, 2013, p 194). The official start for the darkness diary was 2021-01-25 but as implied, the reflective process started before that.

A classical diary day started with thoughts and reflections from the evening before, followed by a few sentences on what to do during the day. Some thoughts or reflections usually dropped in during the day when writing, reading, and discussing with classmates, and the day normally ended with thoughts on how the day went and what to do tomorrow. However, some days nothing was written, and some days several hours were put into writing diary, usually Mondays since I then held a lot of reflections from the weekend. Altogether, diary writing didn't only happen *when* writing, it changed my mindset since I was more aware and open to impressions that I *would* write in the diary later.

5.4 Walking interviews

"*All truly great thoughts are conceived by walking*" Nietzsche, 1889, Aphorism 34

Walk-and talk, talking whilst walking, walking interviews: there are plenty of different names and variations of this type of qualitative mobile methodology (for example see Anderson, 2004; Bates & Rhys-Taylor, 2017; Evans & Jones, 2011), but basically the essential is, as it sounds, to walk and talk together with a respondent. While walking always takes *place* somewhere (as traditional interviews do as well, however, while walking, in a much more lived way) spaces

through which the walks proceed are of great relevance, as it allows and open up for question to be asked that would not occur in an office (Bates & Rhys-Taylor, 2017, p 4; Hein, Evans & Jones, 2008).

However, to clarify, it is not the fact that the walks are conducted in Jonsered and Slottsskogen that is important, rather that they are conducted in *an* environment, where the scenes experienced interact with the talking. This per se opens up for more sensuous ways, as Hitching and Jones (2004) expresses it "…*walking offers a more sensitive approach to the interplay of thoughts and surroundings*." (p 8), which Hitching and Jones (2004) further state contributes to making it easier to talk about themes that are normally don't talked about, like taken for granted phenomena.

Walking methods are socio-spatial methods that are specifically focused on the dynamics between humans and places (Anderson, 2004). This socio-spatial dynamic is where walking interviews distinguish from traditional interviews, where the settings role in influencing the produced knowledge is often ignored (ibid.). This standpoint also highlights *time*, as it acknowledges the geographical context, and hence also the passage of time, as built-in to the human existence (ibid.). Being and moving outside can also be a way for the respondents to relax, bringing the benefit that the urge to provide the researcher with the "right" answers can decrease and a more honest and direct conversation can take place (Hitching and Jones, 2004).

5.4.1 Walking with experts, being situated

When conducting the walking interviews for this thesis, the places passed and stayed in were interpreted departing from the informant's expert knowledge, but also from their personal reflections about the impressions. Walking with experts, Bates and Rhys-Taylor (2017) explain, *opens up a <u>space of translation</u> between the expert and the researcher…*" (p 6, own emphasis). Although everyone is an expert in their own life-worlds, walking with the experts opened up spaces for me that I would not have been aware of if walking without the specific person with its specific knowledge.

The space of translation, and the act of walking itself, further serves to relocate the authority from the researcher towards the expert or balance the authority between them both (Bates & Rhys-Taylor, 2017, pp 6-7). However, the amount of authority that I as researcher held in relation to the experts was estimated to be at a minimum, concerning my limited research experience and age. Still, the contingent knowledge distance between us was made smaller by

the motion of walking and by the informants telling me about what they interpret from the surroundings.

A strong reason for choosing walking interviews in this thesis is the *situatedness*, which goes well in hand with Hägerstrand (1982) who have called his understanding of geography for 'situational ecology'. With this, I mean that by actually going to the habitats of the moths and the browned long-eared bat, and considering the lights in a specific space, we were *there* in a whole other sense than we would have been if the interviews took place in an office. The situatedness helped the understanding. I wanted to move in the same environments as the moths, the bats and the artificial lights, together with persons who can help me understand (cf. Back, 2017, p 21-37). However, as Back (2017, p 35) underlines, "being there" doesn't automatically equal understanding, like everything is beautiful when you're in love but when the rush is over the place suddenly looks mediocre. Here, Back (2017, p 35) stresses the *value of returning*, which was embraced in this thesis by visiting the area of Jonsered alone before conducting the interviews (see 5.4.2) and mentally returning to the situations and themes experienced by carrying them with me and keep on reflecting in the diary after the conducted interview walks. I was already familiar with Slottsskogen park, why I didn't visit it before the interview, but it could have affected the interview if I had visited it while thinking of the thesis themes.

5.4.2 The collaborative quality

Another reason for choosing walking interviews as a method is the possibilities it holds for *collaborative knowledge*. Anderson (2004) argues that "*conversations held whilst walking through a place have the potential to generate a collage of collaborative knowledge[….] 'talking whilst walking' can harness place as an active trigger to prompt knowledge recollection and production*" (p. 254). Note that Anderson (2004) uses the word 'conversation' instead of 'interview', a description that fits better as a label of the talking that was made between me and the informants, however since it was me collecting the information from the conversation, it will still be called interview. However, in line with spaces of translation and collaborative knowledge, no interview guide was used. Rather, a combination of a prepared and spontaneous approach was applied; prepared, by carrying my experiences, wonderings, and thinking with me, and spontaneous through our encounters with the environment and the respondent's interpretations.

Collaborative knowledge was, hence, an important part of the method since I held knowledge (from theory and literature) and experience (captured in the diary) and the informants held knowledge in their specific fields. This meant that our collective impressions

and discussions were crucial for creating new understandings, or as Anderson (2004) expresses it "*a conversational, geographical and informational pathway creation*" (p 260).

The collaborative interaction between me, the informant, and the environment is further a way of identifying places or situations of *need* (cf. Hall and Smith, 2017, pp 49-50). This, Hall and Smith argue (2017, p 49), cannot be made visual in a systematic or distanced way, favouring walking as an embodied and situational method. Further, Holgersson (2017 p 82) highlights walking interviews as a way of exploring spaces of conflicts in urban planning. My hope was that my entrenchment in the thesis subject and the informants' expertise would be combined to see 'spaces of need and conflict' for the species and put those in relation to human requirements.

5.4.3 Sample strategy and informant presentation

The informants were found through *purposive sampling*, meaning that I knew what I wanted to find (a moth expert, a bat expert, and a light designer) but that these persons were not found directly, rather through different paths of recommendations from people that I contacted (cf. Bryman, 2016, p 408)

The interviewees are here called informants due to their expertise (cf. Esaiasson, Oscarsson, Gilljam & Wängnerud, 2012, s. 227), but as outlined above, their personal reflections and experiences about the environment along the walk, were also of certain interest. What is most important about the informants, however, is that they were chosen in order to give voice and interpretations of forms of non-human life (moth, brown long-eared bat, and artificial light) that most of us only have vague ideas about. Three interview walks were conducted in Jonsered and Slottsskogen with Jan Jonasson, Johan Eklöf and Sara Ki Plans (see table 1 below). Jan Jonasson is a moth-expert with a lifetime of experience and periodically professional engagements in butterflies and moths. Now, he is retired and his main interest lies in the micro-moths, which is the group that is least known (personal communication 2021-04-19). Since Jan is engaged in moths, he has great experience from many evenings and nights of moth inventory. Although not actively involved in the light pollution debate, Jan is fully aware of artificial light's effect on moths. I got to follow Jan on a nightly inventory, where we used a bedsheet and a UV lamp to catch the moths.

Johan Eklöf is a biologist and a bat expert but also one of the few persons that are deeply informed in the matter of darkness and artificial light[13]. Sara Ki Plans is a light designer and a

[13] See 2.1 for a short presentation of Johan Eklöfs book "Manifesto of the dark" which this thesis partly departures from.

light artist. She works at a consulting company and in her own company where she produces light-art installations. Sara Ki is further engaged in the IDA (international dark sky association) and deeply informed about the harmful effects of the overuse of artificial light. Sara Ki originate from Spain and the interview was held in English.

Table 1. *Interviewee presentation*.

Informants	Short description	Locations	Date and duration
Jan Jonasson	Moth-expert	Jonsered	2021-04-19 20.30-23.10
Johan Eklöf	Biologist, bat expert and writer of the book "Manifesto of the Dark" (2020)	Jonsered	2021-03-02 18.00-19.20
Sara Ki Plans	Light designer and light artist	Slottsskogen	2021-04-14 17.05-18.35

Anonymity was not applied since the informants are not judged to be in a sensitive ethical position and the transferability of the study increases with the right names and working titles (cf. Swedish Research Council, 2017). Further, by presenting the full names, chances of getting a ripple effect of the thesis are greater than without, hopefully leading to new contacts being made and, hence, also action. After the result drafts were done, the informants got the possibility to comment on their parts, which felt important in the spirit of the collaborative quality (cf. Anderson, 2004).

5.4.4 Locations presentation

The interviews took place within the conurbation of Jonsered, located in Partille municipality, and the park Slottsskogen in central Gothenburg. Jonsered is an old mill town with stereotype brick buildings with ancestry from the year 1830, surrounded by deciduous forest, pierced by the river Säveån and adjacent to the lake Aspen (Wikipedia, 2020). The location was chosen foremost due to the presence of brown long-eared bats around Jonsered mansion, in combination with suitable habitats for moths. As a first step, Johan Eklöf suggested the spot (personal communication, 2021-01-25) and then in a second stage, I went there to consider if the spot were suitable. I figured that the combination of forest, living quarters, and industrial areas were an interesting mix, however, the dark is present (and threatened) almost everywhere, which made the setting of the location secondary after the presence of the species.

However, what really made Jonsered feel like the right spot was when I was standing in the darkness next to Jonsered mansion, looking at lake Aspen, the moon the was mirrored in the water and I suddenly remembered that I did darkness-walks in the forest on my own when I was a kid. I actively wanted to feel calm in the dark, not being limited. The same feelings as I had on those walks struck me when I stood there, and maybe that was just as much a confirmation of the possibilities of walking interviews (cf. Bates & Rhys-Taylor, 2017, p 4*)*, as a confirmation of the location.

Slottsskogen is a large and popular park in the centre of Gothenburg, founded in 1874 (Gothenburg City, n.d.). The park holds wide grass spaces for picnic and play, a zoo, and walking and running paths (ibid.). The location was suggested by Sara Ki Plans for convenience reasons, but also because she was familiar with the park and knew it had some good examples of problematic lighting.

5.4.5 Elements of effect and implementation

Two factors that strongly influence interview walks are the walking stretch and the weather (Evan & Jones, 2011; P. Vannini, 2017, p 185). Concerning the walking stretch, it is important to consider if the route is to be decided by the interviewer or the interviewee (Evan & Jones, 2011). If the researcher decides, the route could be designed to places that are of high relevance for the study, on the other hand, this requires that the respondent to move outside his or her normal routine and the empowering quality of showing and choosing an own route can get lost (ibid.). In the three walks conducted there was a mix of both parts, which will be outlined below after some thoughts on weather.

The weather should not be seen as a limitation, rather a diverse resource (cf. P. Vannini, 2017, p 185), however, I wanted me and the respondents to feel comfortable and calm during the walk, hence, decent weather was a prerequisite for the interviews. The interviews were therefore agreed to be moved if it would be rainy or too windy, not only due to the level of comfort but also considering the chances of seeing moths and bats, which was relevant in the case of Jan and Johan.

Concerning the walking stretch with bat expert Johan, I suggested a stretch, and he accepted. The question of empowerment and the valuable informality that can come if the interviewee chooses their own path was not considered to be a problem in this case since Johan was familiar with the surroundings (see 2.1). When visiting Jonsered on my recognition-tour, I tried the stretch and checked the distance on google maps, thinking rather short than long to allow for a slow walking pace (cf. Hall & Smith, 2017, p 51; Gallagher & Prior, 2017, p 171).

In the case of moths-expert Jan Jonasson, Jonsered was suggested by me, and Jan found it an interesting location with a variety of nature types, which is preferable when inventorying moths and, hence, accepted it. The weather was of extra importance in this case since the evenings must be warm (minimum over 10 C), no rain, and only very light wind for moths inventory. The more exact spot for the inventory was chosen by Jan after he had reconnoitred the area right before the interview took place. As indicated, this walking interview was less mobile than the two others. We walked a short stretch together towards the inventory spot and back from it, but the majority of the interview was stationary since moth inventory take place by putting up a white sheet with a bright lamp and then wait for the moths to arrive. However, the interview had a lot of common features with the more mobile walking interviews, being situated in the environment, feeling the cold air, seeing the moon, and having time to talk and space for silence.

The walk with Sara Ki Plans took place in Slottsskogen. The walking stretch through the park was unplanned, we just started to walk, and the stretch happened spontaneously and naturally. During all three interviews I had my mobile phone easily accessible to be able to take pictures of moments, places, or things that we talked about and I wanted to remember (cf. A. Vannini, 2017, p 191). Photography can act as an extension of oneself (P. Vannini, 2017, p 183), however, using a camera can at the same time make you feel absent from the very moment (cf. A. Vannini, 2017, p 192). This I tried to avoid by only taking snapshots, however, as the interviewees spoke of the things that I took photos at, the situations evolved to something more like mutual natural breaks, rather than unwanted interruptions. Some of the taken photographs were used to create a more vivid presentation of the result (see 5.7 and chapter 6 below). The interviews were recorded, after the permission of the informants, by putting the mobile phone in the chest pocket and using the standard mobile Dictaphone. The recordings were transcribed in near time to the interviews.

5.5 Analysis method

The foundation of the analysis is built up by the sum of what I have read, thought, and written. From this process, my areas of interest have been formed, and that have steered what I found interesting when digging into the empirical material. NRT was a key-shovel in creating and presenting the result from the diary and the walking interviews, through the embracement of the vital and embodied everyday experience. Further, all-ecology was a key-shovel in establishing an analysis framework, through, for example, the concepts of ‘take space’, in-between spaces, and presence and absence. As indicated, the analysis was not a separate

happening detached from the other parts, rather, as Altrichter, Posch, and Somekh (1993, p 12) argue for, the empirical creation (diary writing) and collection (walking interview) fed into the processes of reflecting and analysing.

Thus, the first steps in analysing the diary started when I wrote it (as for Mügge, 2013, p 199). In the next step, I printed a copy of the diary and read it, and reread it, to familiarize myself with the text, looking for loosely overarching themes. Going on, I identified diary entries that corresponded with the overarching themes, one theme at the time. For every new theme, I reread the text, looking for corresponding diary entries, which all in all gave good knowledge about the material and my last months of living with darkness and artificial light. When starting writing, the final selection and formation of the themes were shaped.

The analysis of the walking interviews started when transcribing, an essential step in getting to know the material (Braun & Clarke, 2006, p 88). In the next step, after a break from the original transcription, I read the transcriptions to refresh the memory and further acquaint myself with the material, and then reread it, making notes on specifically interesting episodes. In the next step, I started to write the stories of our walks, one at the time, making stops at the selection of the interesting episodes, chosen as described above; from the total sum of my reading, thinking, and writing. The write-down was an important part of the analysis because as Rapley (2007, p 25) says: writing is thinking.

5.6 Method reflection

Before outlining reflections of the two methods separately, an overall critique must first be addressed. This concerns both methods and the application of NRT. As it has been outlined above, I generally view NRT as a complement to systematic research, however, the fact still stands that in this thesis my thoughts constitute a big part of the material. Merriman (2014) addresses this problem within mobile methods (such as walking) in combination with NRT research; "*…experimental and improvisational 'mobile methods' provide the means to enable the research to get 'close-to', 'grasp' or witness the here-ness, now-ness and live-ness of particular practices and events – providing some 'God-like' position from which the researcher can gain a more accurate or authentic knowledge of a situation.*" (pp 182-183). I don't want to put myself in a god-like position. I tried to avoid this by (1) using two methods, including other voices than my own, (2) outlining advantages and disadvantages of the methods, and (3) overall holding a critical relationship to the thesis, more on this below.

5.6.1 Diary

An overall critique against diary as a method is the vagueness of it (Mügge, 2013, p 194), meaning that the findings can never be part of a testable hypothesis or re-done in the same way to prove its conclusions: the lack of systematic. Drawing on NRT thinking, there are two ways of looking at this (cf. Thrift, 2007, p 165): (1) methods and practices such as the one conducted in this thesis is a catastrophic step away from rationalism and systematic knowledge, or (2) it adds a layer of vitality and fills events with another kind of information and stories, connecting happenings and spatial phenomena to another extent. In this thesis, I (maybe not so surprising) embrace option number two.

A personal reflection concerning the writing of the diary is that it can be exhaustive. Like being on duty constantly for half a year, always thinking of things not to forget. Mügge (2013) reflects on her research diary in a similar way, adding the critique of time consumption: "*The diary writing was time-consuming and simply draining after a day of trying to get access to respondents, participating in political events and interviewing"* (p 195). The diary is, hence, not only a supportive tool and silent and listening friend as stated above, it also demands your thoughts and your time. Weighting the two sides against each other, I can personally say that the advantage outweighs the disadvantage, like having to call an old friend could be a nagging thought and just something that must be done, and then when you finally do the call you feel happy to hear the voice of your friend and relief of talking and sharing life and thoughts with another.

Another personal reflection concerns the question of biases: since I´m doing the diary myself, can I be biased by shaping my notes from what I would like to hear instead of what I experience? This is hard, if not impossible, to answer but as a guideline, I follow the reasoning of, once again, Hägerstrand (1982); "*There are of course ambiguities of many sorts in memories, as there are in documentary sources. The remedy is to treat both residues as honestly as one possibly can*" (p 16). Memory as a source of data is further discussed by Buttimer and Hägerstrand (1980, pp 24-25), where they state that the memory is unreliable, but that it would be a waste not to put a great value in the knowledge that has been lived and embodied in a person; "*Now, first of all, only the person who had an experience can tell about its nature. No outside observation can reveal it. So, we must either believe that the person tells the truth about his experiences or give up insights into the internal world altogether*" (p 25).

5.6.2 Walking interviews

A. Vannini (2017) poses an overall critique against using walking as a *method*, meaning that walking should "*not be considered as a method of gathering data but rather something that unfolds as a sensorial event*" (p 192). The sensory potential of walking, A. Vannini (2017, p192) means, is limited if the purely qualitative is taken away by instrumental and systematic inquiries, which framing it as a method could. In my case, I translate this critique to a reminder of being in the moment, being open to my senses, and try not to get carried away by worrying if enough data is collected. However, I still call and use it as a method, since walking in this case was more of a tool for collective experience of place and phenomena, than an experience of a walk. After having conducted the walking interviews I can conclude that the act of walking, and to a large part, I think, the personal chemistry between me and the interviewees kept the "collecting-data-haste" at a minimum. This was further a result of that we were talking about themes that engaged both parties and were integrating with the environment, hence, it was generally easy to be in the moment.

Another overall critique against walking as a method is posed by Macpherson (2016) who highlights that walking does not only open up new spaces (such as space of translation, see 5.4) but also closes them down. By this Macpherson (2016) means that waking is not a neutral approach, since it carries demands of capabilities and norms with it: if the participant *can* walk, if the participant can handle the chosen *rhythm, stretch, or terrain* or if the participant *would like* to walk. This points in the direction that walking is a non-neutral practice that closes the door for some, rather than open it up for all (ibid.). In this thesis, these questions have been handled by letting the informants have a great part in deciding where and when the walks should be conducted (see 5.4.4 and 5.4.5). When walking, I tried holding a suitable "talking pace" that seemed to match the informant, something that happened quite naturally.

Another point of concern when conducting a walking method in combination with NRT is the thought on how we are affected by other humans. By embracing vitality and corporality, you're not only letting yourself be affected by the surroundings, but you are also open to influences from other people (Morris, 2011). The same walking stretches but with different company could easily alter the topics and feelings about different experiences. Of course, this could be the case in this thesis as well, walking with different people makes you feel different degrees of comfortability, which maybe could have effects on which kind of topics I took up for discussion or similar. However, I figure that this variable could be overseen in this case since the conversation could be hanged upon an outsider (moths, bats, and artificial light), meaning that our personal chemistry didn't have to be sparkling and still bring out an interesting

material (however the chemistry was good in all three cases, which was nice, but therefore, I can't say for sure that it would have been a good material without the good vibes).

A surprising situation concerning the collaborative quality appeared when I sent out the result drafts to the interviewees. One of the experts suggested major changes in the citations, saying the same things but in a carefully prepared written language instead of a spontaneous spoken, which would have made the mediation of the situatedness disappeared. Here the collaboration came in contradiction with what I wanted, and a moral dilemma of being true to the citations and listening to the informant. This was particularly tricky when the informants weren't anonymous. The solution was a compromise, where I changed parts of the citations to make the sayings clearer but still keep the liveliness.

5.6.3 The rigour

Qualitative research counterpart to objectivity can be captured in the word *rigour* (Tricoglus, 2001). Here an important question must be mentioned; do I want to strive towards rigour? Are words like validity, credibility, transferability, dependability, and confirmability only ways of leading the method reflection away from this thesis's strengths? The thought, the reflective, the lived. Here, I choose to follow Phillips (1989, p 71) who highlights that the importance lies in if the research has been carried out in a "critical spirit". I further think that the words listed above can be a help for considering the critical spirit, however with caution since I do not want to decrease the value of the sensuous qualitative (cf. Vannini, Waskul & Gottschalk, 2012).

Tricoglus (2001) states that the critical process is an internal and an external matter, where the internal refers to the researcher's self-awareness and reflexivity, and the external to how well the internal process and the research as a whole is made accessible for critical examination. The diary is in its purest sense a tool for self-awareness and reflexivity, I therefore consider the internal critical process as highly present throughout the thesis development. Considering the external critical process, the goal in this thesis was to mediate a feeling of direct experience of my experiences, through vivid descriptions and extract from the diary and the interviews, this will be shown in chapter 6 below. The (hopefully) detailed method chapter above was of further importance in addressing the external critical process, by having described what was done and how it was done, the thesis lies open for scrutiny.

Conducting a method is to engage with the world, however, as Back (2007) expresses it, engaging with the world is "*not an automatic faculty but a skill that needs to be trained*" (p

7). This argues for the combination of diary and walking interviews in combination[14], since the diary helped me prepare for the interviews as well as the interviews helped me engage in new ways with the world. Looking before this thesis, I have experience in diary-writing when growing up and my academic education in geography could additionally be seen as skill-training for engaging with the world.

Taken together, with this reasoning I claim that a departure point of a solitary story could be a collective concern like Gunnar Eklöf said (1941) "*the foundation in you is the foundation in others*"[15] (p 181, writers translation), but at the same time staying aware of the power of my position (see Merriman's critique above in 5.6). Gunnar Eklöfs reasoning goes well in hand with Hägerstrand's search for the common features instead of differences and arguing for first-person experience (Ellergård & Svendin In Hägerstrand, 2009, p 12; Hägerstrand, 1976). However, I believe that in order to acknowledge the foundational circadian rhythms of darkness and light, the differences and frictions must be acknowledged as well, which is hopefully visible in the thesis (or about to be). Before moving on to chapter 6, the result, some thoughts on how to present follows.

5.7 About presenting a result

Diary and walking interviews hold the possibility to give a rich material in a true sense (Hein, Evan & Jones, 2008), the question is how to mediate this. A challenging task, Bates and Rhys-Taylor (2017, p 5) explain, and suggest a more creative and artful way of presenting the material than is commonly used. Bates and Rhys-Taylor (2017, p 6) argue that a lyric form of writing does not stand in opposition to traditional ways of presenting material, rather it is meant to build upon it, deepen the understanding of the material and stimulate the imagination.

Similarly, Holgersson (2017, p 83) argues that writing about a walk provides the possibility to bring both the arguments of the writer and the interviewees into a vivid form, flirting with the art of storytelling. In line with this reasoning, selected photos are shown in the result below, not only to show how it looked at the location that we were at, but also enhance or mediate a feeling, a thought, or a theme that the scene on the picture gave (cf. A, Vannini, 2017, p 191).

If the presentation succeeds in mediating the empirical material in a creative, artful, and inspiring way, I leave it to the reader to decide in the following section.

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[14] Arguments for the combination of methods, triangulation, are many. For example, see Bartlett and Milligan (2015); *Using a combination of data collection methods adds rigour, breadth, complexity, richness, depth and creativity to the research…"*(p 6) or Baxter and Eyles (1997), Engin (2011) or Mahmoud et al. (2018).

[15] In original: "*Det som är botten i dig är botten också i andra"* from Gunnars Eklöf's book "Färjesång" 1941.

6. Results

Thinking, living, writing, walking, talking, and listening about darkness and artificial light, humans, and non-human: here is the result. The material will be lifted up and looked at from an all-ecology perspective (see chapter 4). The chapter consists of five parts first, where the first two parts have *understanding* in focus, here the Darkness Diary and the walking interviews with the moth and bat experts are presented. In the third part, the focus shifts slightly towards *formulation* of generative ways, closing in on our (as in everyone's) need of darkness and the effects of artificial light. Here, the last walking interview, with the lighting designer and artist paved the way for thoughts from the diary considering how to think and act in the matter.

6.1 Darkness Diary

As described in chapter 5, the Darkness Diary consisted of two parts; a classical research diary for supporting purposes, and a part where I reflected about darkness and artificial light in my everyday-and night life in relation to the thesis development. This result is based on the latter one, including experiences from different places and different activities, from being at home and walking to driving and workouts. The experiences are presented and discussed below in three themes: *darkness moments*, *living with lights* and *light to darkness-the shift*.

6.1.1 Darkness moments

The first word that comes to me when reading in the diary about my moments of darkness during the last months is *presence*, or to be present. In this realization, I immediately feel the language barriers smashing down on me. In all-ecology, as we learned above, presence of something means absence of something else (Hägerstrand, 1984) [16]. This is true to this situation as well, but what I want to express here is a profound form of presence (*närvarande* in Swedish), meaning being in a place with all your attention, not just physically. To draw on all-ecology, the absence of light makes me more present in the moment (cf. Hägerstrand, 1984). However, there is often some kind of light involved in the moments, enabling the activity, hence, perhaps a more correct description would be that the absence of *much* light makes me more present. In

[16] Hägerstrand also struggled with the language barriers, also concerning presence, however, his explanation regards another aspect of the word, which I also find relevant, but not for these experiences. "*I am not sure that the English word presence entirely covers what I have in mind. The Swedish word is 'närvaro' or literally translated 'being near', a concept which does not suggest that the participants have to be directly aware of each other*." Hägerstrand, 1984 p 378

this case light refers to both daylight and artificial light, since the absence of (much) daylight was often a prerequisite for my mundane darkness moments, naturally taking place during the evenings. One recurring situation where the darkness gave me a feeling of presence in myself was during yoga sessions (Darkness Diary 25/1, 28/1, 17/2).

> 28/1 My best moment of darkness was the yoga, the last pose is called (ish) chivasana and then you are just laying down with eyes closed and observing your breath, very nice.

However, other darkness moments held a more social quality of presence, as for example by reading aloud sessions with my partner on the couch:

> 2/2 Yesterday we read out loud to each other in the evening. I reflected that you feel more together when reading out loud than when you do when watching a series or a movie.

In this example, the absence of the screen light from the computer gave a more present feeling in the sense of togetherness (cf. Hägerstrand, 1984). Your eyes are more allowed to look at the person next to you when reading than when watching a screen, and it is the voice of a person next to you that you hear and not a voice from a computer. The social aspect of darkness re-appears in both experiences, and memories of experiences, in the diary. The example below is from me being out bouldering[17] in the evening, feeling the gathering power of the dark.

> 25/1 The dark is also very present when I´m out bouldering in the evenings sometimes with my partner and friends…Everything gets really focused, it's cool, the surroundings are blurred out and the presence to the ones that are there becomes more intense, got a feeling of sitting by a campfire last time we were out.

Figure 7. *Bouldering session.*
Photo: Fabricio Gatica

[17] Bouldering is climbing on rocks using a crash pad to fall on instead of ropes. In the evenings we use construction lamps and head torches to light up the "problem" (meaning the route) that we're climbing.

Another example is from a memory, looking back on my seasonal work on a tourist destination in northern Sweden, where I begin to touch upon the social pulling effect of the light, being pushed by the dark.

> 2/2 The collective where I lived sort of got more gathered when it became darker, during the winter seasons, for example, you always knew where you had each other and that gave a sense of safety in a way…the dark makes us gather around the light…

Developing this line of thought with all-ecology; gathering around a light at night, being still in one place, means leaving in-between spaces and contributing to a larger complementary space of darkness for nocturnal others to move around in (cf. Hägerstrand, 1996). This is two-folded, the absence of the '*space taking*' of our moving human bodies and the absence of light that the humans need to have to see where to move (cf. Hägerstrand, 1984). However, this requires that there is no light where there are no humans, and throughout the diary it became clear that that's not the case, the in-between space owning of artificial light is extensive (cf. Hägerstrand, 1996). Indirectly this means that humans and opportunistic non-humans have taken that space, even when they are not there physically.

Another memory of darkness (or less light) came from my grandmother. I talked to her on the phone and asked about how it was during the blackout during the war times. Her answer made the increase of lights apparent.

> 17/4 Speaking of turning the lights off, I spoke with grandmother about the blackout last Tuesday. It was ongoing between 1940-45 in Jämtland. Of course, it was easier to accomplish a blackout then, because there were so much fewer lights. […]. In the family where my grandmother lived, they had ONE lamp in the house and one outside on the staircase, but that one was not used unnecessarily. So, the only thing that was done was simply put up the blackout curtain before lighting the lamp.

6.1.2 Living with lights

Gathering knowledge about artificial light and its effect on humans and non-humans made my experiences of the darkness increase in complexity. Take the bouldering example above (see figure 7), a situation filled with the joy of being and moving with friends, but there is more to the picture. For me and my friends to be able to see the boulder and the lines we are climbing we use construction lamps to light up the rock. Knowing that the light from the construction lamp adds to the infinite pattern of artificial lights and that it is shining in an environment where animals and insects live made me feel guilty, at the same time as the positive feelings connected to the activity (25/1, 25/2).

> 25/2 Yesterday me and my partner were out bouldering in the evening, it was a while ago now since I was out during the evening. It was almost tiresome because I get so many impressions, and the damn light pollution is so obvious and present when it's dark. If I would have been a small moth or bat, or a tree, I would have been so confused, it's easy to imagine. Sooo, it was a combo of really nice to be outside, nice warm air and we heard a little waterfall, but we also heard the highway a lot and the combination with all lights and the orange sky made it feel somewhat like doomsday. Got bad consciousness from using a head torch and the construction lamp when climbing.

Applying all-ecology, as our activity of bouldering took place, our bodies, and our light 'took space' from others, affecting their paths and behaviour in the fabric of existence (cf. Hägerstrand, 2009, p 84). Looking at the bouldering picture in figure 7 above, the light is shining even in spaces where the humans are not, such as the tree branches. When it's dark, you see all the lights. This created waves of emotions over and over again for me during the months of diary writing, especially when driving through town in the evening (Darkness Diary 3/2, 25/2, 15/3, 7/4).

> 17/3 On the way back home in the car I got exhausted from thinking of all the lights, a feeling of hopelessness instead of being thrilled about what a great change there could be. It just feels inhuman in some way. It is not the humans who are visible, it is the lights.

Driving the car gave a further reflection of space taking. When driving you are the light, you are not only taking up the air of the complementary space with your vehicle, rather this area is multiple times larger and ever-changing, when considering the area your headlights are encountering (Darkness Diary 15/2). Where the light encounters the spaces alongside the road, these spaces are restricted for the ones who cannot sustain their activities in the light (cf. Ellegård, 2019, pp 44-45; Hägerstrand, 2009, p 70). Hence, the interruption that a road constitutes in an environment is larger than the actual asphalt, when considering the effects of the activities taking place there.

Some artificial lights got more of my attention than others, especially the streetlight outside my apartment that intruded the bedroom (Darkness Diary 25/1, 29/3). This example shows how the artificial light not only enables presence for humans (people that want to walk during the evenings), but constraints for others, whose night sleep is disturbed (cf. Ellegård, 2019, pp 44-45). The streetlight made me pull down the blinds, even if I didn't want to since it is nice to wake up to the sunrise. Hence, both capacity constraints and steering constraints are in action; a human who wants to sleep in a dark room (capacity constraint, not able to sleep

with a streetlight in the eyes), and is forced to pull down the blinds (steering constrain, the light makes the human regulate its behaviour) (cf. Ellegård, 2019, pp 44-45). Friends of mine had a similar situation where they had to refurnish their bedroom due to a huge DHL sign shining in on their bed (Darkness Diary 22/3).

A further recurring theme is the lights as a sensitive topic and a taken-for-granted phenomena, that seems to be a human decision right. Talking to people about the subject, they usually showed understanding, but when talking about garden lights in their vicinity, the answer was typical "ye, but it is sooo dark here, we need a little light".

> 8/2 I don't think they think that it concerns them out here in the countryside. Since it's so dark everywhere, you must kind of have permission to light…Is lighting like what people eat, a highly personal thing that is none of your business?
>
> 12/4 This weekend the reaction came again; "here you understand if they want to light up a little because it is sooo dark here". First, we had spoken about façade lighting and all the friends thought it was totally unnecessary, but then it turned out that the neighbour had some kind of garden lighting and that was considered to be absolutely understandable. If it's dark, you have the right to light?

The picture below shows a glimpse of artificial lights in my every night (evening)- life. The picture was meant to show the crane construction lights (in the upper middle), the façade light on our neighbours house (on the left), and the street light outside the bedroom (on the right), but what mostly came out of the picture was how bright the light was shining in our kitchen, spreading its light into the supposed-to-be free area of the complementary space outside the window (cf. Hägerstrand, 1996).

Figure 8. *Lights outside and inside our apartment from Darkness Diary 29/3.*

6.1.3 Light to darkness- the shift

Going through the Darkness Diary, many of my everyday-and night experiences of darkness and light circles around twilight. During February and March, the rhythm of the sunset was often in sync with me finishing my thesis work for the day, resulting in a kind of ritual where I could take a walk from daylight to dusk (see figure 9 below). This was a much-appreciated activity, where I felt "calibrated", done with the working part of the day, ready for rest, training, and household stuff (Darkness Diary 2/2, 26/2, 22/3, 25/3). Some days I was out climbing from full daylight until dark and these experiences was also strongly connected to a good feeling, sprinkled with enhanced senses, like sounds, smells, and unexpected beauty, like the sparkling mini-crystals in the rock in the light of the head torch (Darkness Diary 5/3, 17/3). I started to enjoy twilight so much that I almost felt deprived when I missed it (Darkness Diary 9/3).

> 8/3 Again: it is nice to be part of the shift from light to dark (felt that on Saturday as well when we took a sauna with my parents, each time I went out and took some air it had turned a little bit darker), later I felt very clear that I was only a visitor when walking in the forest when it had begun to get really dark. Maybe an unwelcome visit, since the blackbirds were very upset with me.

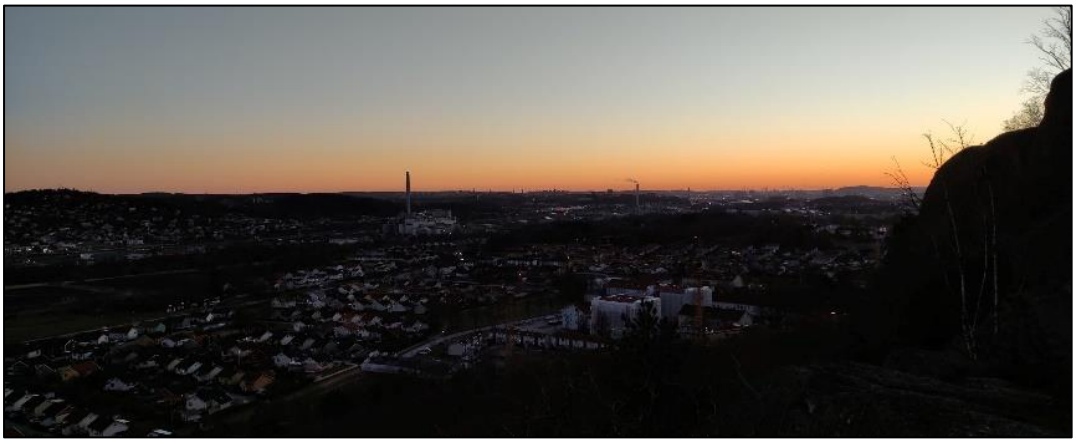

Figure 9. *Photo from twilight walk, Darkness Diary 8/3.*

The last sentences in the citation above marks a feeling that grew more and more during the thesis writing: the twilight marks a shift, a transformation, a signal (Darkness Diary 23/4). Speaking in all-ecology terms, the slowly increasing absence of daylight leaves room for an increased presence of the dark. Hägerstrand did not explicitly talk about this shift, but, as we have learned through this thesis, everyone's wellbeing is tuned in to the mechanism of light- and darkness (cf. Eklöf, 2020). Bringing artificial light into the scene changes the situation for all living things trying to find spaces for rest, hunting grounds or finding a partner in the dark part of the fabric of existence (cf. Hägerstrand, 2009, p 72).

6.1.4 Summary

Living with an enhanced awareness of darkness and artificial light gave rise to a range of experiences, stretching from increased life quality of a profound presence to anxiety and hopelessness over the overuse of artificial lights. The collected knowledge resulted in an inner battle about lights, similar to the one you can have in a grocery store if trying to weigh all the different parameters against each other in order to make a sustainable choice and at the same time buying something that tastes good. Further, through experiences between daylight and darkness, the Darkness Diary gives hints about the twilight as an essential shift.

6.2 Moths and bats in darkness and lights

In this chapter, you are welcome to accompany me on the walks in Jonsered with moth-expert Jan and bat-expert Johan. Just like in the outline of the diary above, there will be breaks in the story where different aspects are discussed with all-ecology eyes. The first part, regarding moths, contains few mobile elements for being called a walking interview, but the central meaning of being *situated* in an environment is there in its very essence (see. 5.4.1 and 5.4.6).

6.2.1 Moths inventory, visiting the night

I first found Jan in the oak meadows on the hill towards Jonsered's mansion. The time was 8.30 pm and it had slowly begun to turn to dusk. Jan was walking around with his butterfly net, that's how I knew it was him. He told me that the meadow we were standing in was a great place for the larvae of butterflies and moths since different larvae require different kinds of host species, like oak, dead trees, and bracket fungi [18]. After a short chat, we retreated down the hill towards the train station where Jan had localised a suitable location for our nightly inventory. We carried the equipment from Jan's car into the forest, following a small path, being shouted at by the upset blackbirds, who did not approved twilight visitors like us. A couple of hundred meters down the path Jan showed me the place where we would put up the bedsheet. During our installation of the equipment, Jan told me that the butterfly- and moth community have noticed a distinct decrease in insects amounts the last decades, he remembered that as a child (already engaged with butterflies) he could stand under the streetlights with a long butterfly-net and catch 50 moths at once. That's not possible anymore, Jan said and pinpointed that accordingly more and more butterfly and moth species are being classified as endangered.

[18] In Swedish: ticka.

The conversation steered towards artificial light and (repeatedly being interrupted by the loud trains that went past us a hundred meters down the forest) Jan told me about an inventory he had done for SJ (*Swedish railway company*) at Varberg station. SJ had found that there were plants around the railway yard that were worth preserving and wanted to know if the butterflies and moths that live on those specific plants were there as well, before they could do expanding measures on the yard. That was a hard place to make inventory, Jan told me, with huge light poles spreading its intense light all hours of the night. I asked him if he found anything interesting, but the result was rather poor, he told me.

> *"No, it was scarce, the micro-moths were doing alright, they are also drawn to the light, but since they're not so good flyers they stay closer to the ground and do not fly up 15 meters to the light poles. The big ones, however, there were not a lot of those […] The only species that was really interesting there was a small snailcase bagworm, a micro moth, which reproduce asexually*[19][20]*"*

Here, we make a short break in our moth inventory experience and apply an all-ecology perspective: the particular plants that particularly moths require were *present* in the railway yard in Varberg. There was *complementary space* in the form of air for the moths to move in, but the additional presence of artificial light shining through the complementary space resulted in the *absence* of these species. Some species might have been there, Jan told me but died due to the flight-to-light behaviour; an involuntary presence which resulted in a profound absence. Back to the woods, the evening was getting darker, and we were getting ready with the bedsheet set-up. We pulled it between two trees, placed a UV lamp in the middle (which often will manifold the catch of moths compared to a normal light bulb, Jan told me), and connected it to a portable generator (see figure 10a and 10b below).

[19] *Apterona helicoidella*. In Swedish: snäcksäckspinnare

[20] After the transcription, I emailed Jan and asked him why this particular species could survive and thrive in the bright environment of the railway yard. He told me that this micro moth is represented in the Nordic countries by only wingless females and being on the ground was in this case a precondition for survival.

Figure 10. a) *The inventory set up before the generator was turned on, seen from the front.*

Figure 10. b) *The inventory set up after the generator was turned on, seen from the back.*

With the generator drone as a background we talked about the overuse of lights and I seized the opportunity and asked Jan how the lights affect the moths and other insects during the winter months. Jan said that he doesn't think it's affecting them since they are well hidden under bark or in the ground. Steering the conversation to our task at hand, I asked Jan if there is special species that are only out flying in the twilight. It turned out that there are not only certain species out flying (feeding, mating, transporting) in the twilight, there are different species connected to all hours of the night. Some moths are only out during the beginning of dusk, Jan told me, some only during the darkest hours, and some in the very shift from dusk till dawn.

Looking at this example from an all-ecology perspective, and at the same time acknowledging the effects of the taken-for-granted phenomena artificial light, the all-space gets significantly more *crowded* than what Hägerstrand could have imagined when he developed the ontology. Some moths apparently have a small window of opportunity where all "sand in the sandglass" must pass, if space is crowded by artificial light at this time, the waist of the sandglass gets even tighter (cf. Hägerstrand, 2009, p 165-166, 172).

Jan continued to tell me about how butterfly and moth inventory is more complicated than bird inventory due to the different times of flight, but also due to the different seasons. In

addition, many butterflies and moths have two generations during one year, for example, some are out flying in June and then turn to larva- and pupa stage, and then back out flying in August.

Suddenly, the first moth came crashing onto the bedsheet and the excitement was great. It was drawn to the light but found a dark spot under the branch that was holding the bedsheet on the ground and stayed there. Jan could immediately tell that it was a small quaker (*Orthosia cruda*)[21] which often visits the flowers of the great sallow (*Salix caprea*) [22] in search of nectar and such trees were just blooming around us in the forest. As a larva, however, it feeds on the leaves of oak trees, a fascinating fact we ascertained, and released the moth into the night. After a short while, the first micro-moth arrived, "*finally*", Jan said. It proved to be a common flatbody (*Agonopterix heracliana*)[23] and Jan saved it in a small glass cylinder for his collection.

An engrailed moth (*Ectropis crepuscularia)*[24] arrived and after flying around the light, Jan caught it in his butterfly net. It sat still in the net and I could take a picture (see figure 11 below). I asked Jan why the first one, the small quaker, was hiding under the branch in a dark spot and this one was completely still in the bright light. He thought that it has to do with the stress that the light causes. If they are lucky, they find a dark spot to rest on, but if not, the bright light will have to do. In general, if they stay, for example, by a streetlight until the morning, the birds can easily come and catch them.

Figure 11. *Engrailed moth. The colours are twisted from what our eyes saw, due to the UV light.*

[21] In Swedish: mindre sälgfly.
[22] In Swedish: sälg.
[23] In Swedish: flockblomsterplattmal.
[24] In Swedish: dubbelvågig lavmätare.

In all-ecology terms, the involuntary presence that artificial light causes the moths results in a devastating crash of the sensitive time-space balance of the "sandglass" (cf. Hägerstrand, 2009, p 165-166, 172). The moth finds itself in the wrong place at the wrong time, encountering the birds shift, which most certain leads to death (cf. Hägerstrand, 2009, p 70). Hence, the 'space taking' of artificial light is not only a matter of excluding the moths from particular spaces, it also limits the moth's access to time for life-sustaining activities (cf. Hägerstrand, 2009, p 165-166, 172).

As the night progressed, the moths started to appear at shorter intervals; the streamer *(Anticlea derivata)*[25] (lives on roses), pine beauty *(Panolis flammea)*[26] (lives on pine), clouded drab (*Orthosia incerta*)[27] (prefer a variety of bushes and trees), hebrew character (*Orthosia gothica*)[28] (not so picky Jan determines) and common quaker (*Orthosia cerasi*)[29]. Around 10.30 pm we got to experience a small example of the tight time-shifts, as Jan described earlier in the evening. The micro-moth early flatbody (*Semioscopis avellanella*)[30] showed itself in several specimens, from nothing to several in only a few minutes and Jan told me that they are dependent especially on hazel, which we noticed had just begun to turn green around the path where we were standing.

> *M- There is one! But high up, we need a longer butterfly net, oh here is another one, this one we might be able to catch, it stayed on the tree.*
> *J- I think it is Avellanella, that light coloured one that we had before. Yes, it is that one. It lives on hazel and there is lots of hazel here.*
> *M- Ah, they are starting to wake up now*
> *J- Yes*
> *- we are seeing another one-*
> *M- Their hour obviously starts now.*
> *J- Yes, apparently, yes.*

Our inventory was slowly coming to an end, and the complexity had gotten more and more enhanced; the moths need darkness (at different times) and the right host species (e.g. pine, oak, and bracket fungi) and different species for food (e.g. hazel, great sallow), all depending on the time of the day and year, and generation. All-ecology's "timetable of need" captures this in a beneficial way, highlighting how all living things have different places they have to be at specific times, and that these spaces have to be filled with the required entities (cf. Hägerstrand,

[25] In Swedish: rosenfältmätare
[26] In Swedish: tallfly
[27] In Swedish: föränderligt större sälgfly
[28] In Swedish: gotiskt sälgfly
[29] In Swedish: oföränderligt busksälgfly
[30] In Swedish: hasselvårmal

2009, p 247). Applying this concept on moths, a timetable of need emerges with a tight driving schedule including a wide range of stops. Further, it demands stopping places filled with a broad plant variety and *non*-filled with artificial light.

The clock turned 11.00 pm, our inventory was over, and we turned off the generator. Just as when you turn off the kitchen fan, Jan and I felt an ease spreading in us and the forest. When taking the bedsheet down, we found that almost every moth we had caught during the evening was either hiding on the backside or in the hemline. Even if we had released them, they were not released by the light.

We gathered our last stuff and started to walk back to the parking lot.

> *J- Then we leave the place as we found it, right?*
> *M- Yes, now they can get back to their routine, but not sleeping, we weren't waking them up.*
> *J- No, that's true.*

6.2.2 Spaces of brown long-eared bat

Johan and I met by the church in Jonsered, just before sunset. The church was fully illuminated (see figure 12), which immediately gave rise to a conversation about the problems of lightened bat-habitats. Johan had not done any inventory in this particular church but expressed that he could understand why people find it beautiful. However, knowing the consequences, he mainly felt the harm, trapping potential bats inside, or not welcoming any new settlers. I asked Johan about the chances of seeing the brown long-eared bat this evening. Chances were unfortunately small, Johan told me since it was still cold and then they hibernate, but he had seen one the weekend before and had brought the detector[31].

Figure 12. *The illuminated church at our starting point.*

Walking down towards the river, Johan told me about how churches that are lightened up from the inside instead of façade lighted causes less harm (on nocturnal's activities and on diurnal's rest) since the light isn't "spilled" as much, pinpointing that it could still be aesthetically appealing:

[31] A handhold-gadget that scan of sounds in the environment around, picking up sounds at frequencies that human wouldn´t hear otherwise.

"I can imagine that the experience is still quite pleasant for humans, it looks inviting when you see the lighted church windows, that can provide a feeling of safety, you don't need to have that tower all lighted up."

Applying all-ecology, this example emphasises that it is essential *which* spaces that humans take and that the artificial light is a crucial extension of human 'space taking' (cf. Hägerstrand 2009, p 29, 84; 1996). By keeping the light inside the building structure, the light is kept (in a greater extent) to spaces where humans are, or at least, could be, making the outside-in-between spaces free for those who naturally move through them (cf. Hägerstrand, 1996; 2009, p 87)

We arrived at a bridge that crossed the river, standing there I asked Johan to explain to me what we saw from a bat perspective (see figure 13 and 14 below).

Figure 13. *Looking at the buildings from a bat-perspective.*

M- If you look at this building [figure 13 above], do you think you [as a bat] get scared off by those lights or can you still live there?

J- I don't think you like that sign [the Jonsereds Fabriker sign] or the lights around that sign over there [in the middle of the building], but if you look in the corner there or around the gable, where there are no lights from the outside [there it's alright]

M- So they can sense that kind of micro-areas?

J- Yes, exactly, if there had been only the Jonsereds Fabriker sign, it wouldn't have been a big deal, but now all the lights together light up the whole area.

-We turn to the other side of the bridge, see figure 14-

J- Towards this direction, it's better and it's important that it is by the water, a lot of bats hunt over water. These old brick buildings are pretty good as well since they can live in the holes between the bricks, right by the water. […]

M- Alright, so you could be thankful for the water not being lighted up here?

J- Yhe, this is a quite good example, only a few windows lighted up, that doesn't do that much harm, but you still don't have to leave them on when you're not there.

Figure 14. *Looking at the river and the old brick house from a bat-perspective.*

Looking through the eyes of a bat (as good as we can) and adding on to the all-ecology reasoning above about what spaces humans are taking, the plot thickens to more than a strict inside-outside division. Bats live *in* the built structures, demanding spaces that are, in an economic sense, owned by humans, including the light on and around the buildings. This dual struggle for spaces to exist in highlights the very core of the *all* in all-ecology: living (bat and human) and non-living (buildings and water) are all connected to each other (cf. Stenseke, 2020; Hägerstrand, 2009, pp 160-161).

The dusk was steadily getting darker and we kept on walking through the old mill district, over the railway bridge, and uphill towards the area where Johan knew that brown long-eared bat had nested earlier years. Large oak trees surrounded us in the meadows (where I first met up with Jan). On our way uphill we encountered several places with intense lighting, a railway station, a parking lot, and an entrée to a public garden (see figure 15 below), with no humans in them. Knowing that the bats live in the area, and especially the very light-sensitive brown long-eared bat, and listening to Johan's reasoning made the effects of the human 'space taking', and the unnecessariness of it all, clearly visible.

"…then off course we can turn the lights off all the time everywhere, but in this case, for example, the parking lot there, it's not a single car there and I don't think there's going to be any tonight, not here either [the garden entrée], […] so these are great opportunities to turn the lights off."

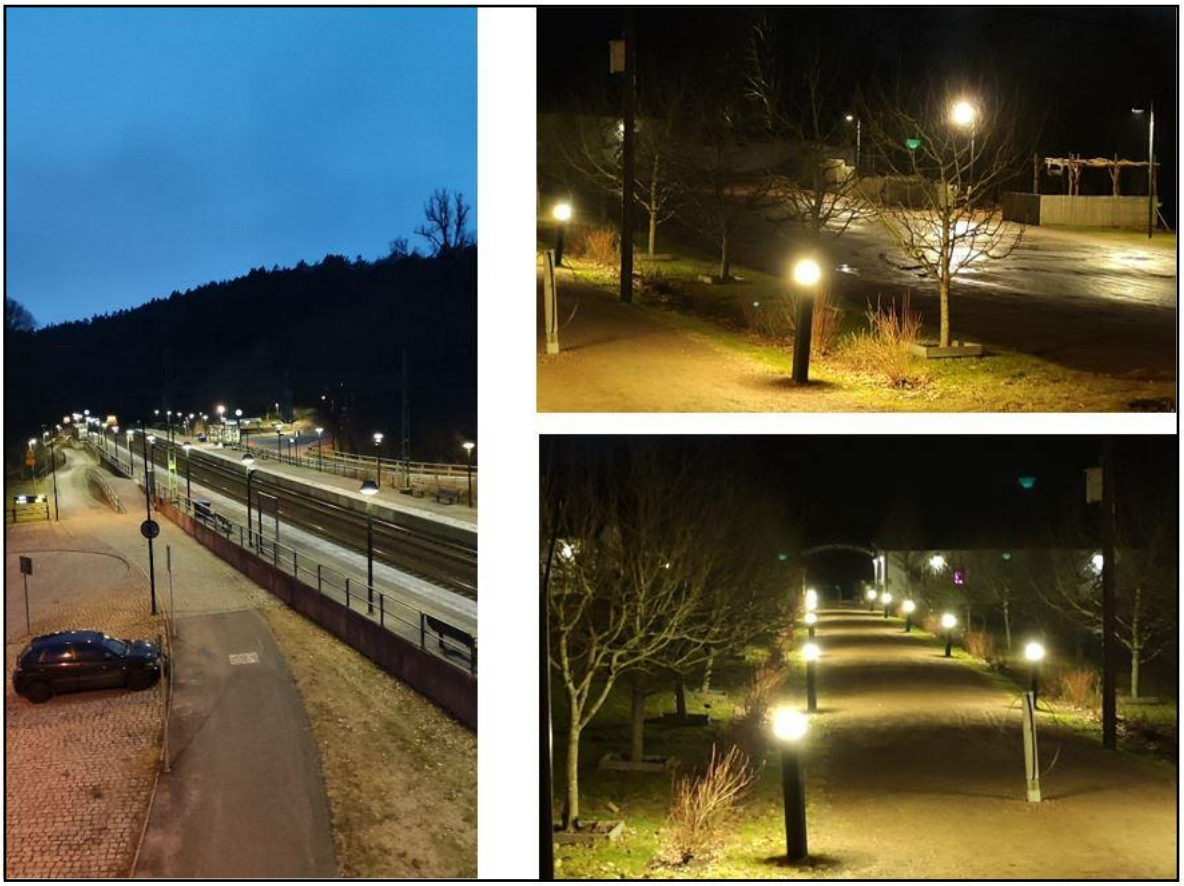

Figure 15. *Places of lights, showing the 'space taking' of human use of artificial light. Left: the train station in Jonsered. Right up: the parking lot outside the public garden. Right down: the entrée-way to the public garden.*

Figure 16. *View over Aspen, sky glow at the horizon.*

We reached the top of the hill, stood by the mansion, and admired the beautiful night view of the lake, at the same time as the skyglow from a small town in the distance reminded us of the width of the human expansion (see figure 16). We took a path down to the lake, now it was quite dark, and walking on the uneven path required some enhanced attention. Johan explained to me that the absence of artificial light and the openness of the path in combination with a variety of vegetation and the nearness to water made air over the path beneficial for bats to move and hunt in. As we turned around to make our way back to the church, I asked Johan which hours of the day that are most important to keep dark for the bats:

J- ...bats usually come about half an hour after sunset […] it differs depending on how shadowy it is, how hungry they are and what species it is, but the first ones come about that time and the last one maybe an hour after that.

M- And then they're out flying the whole night?

J- That varies, if there is a lot of food they might be out only for two hours, or maybe rest a bit and out again at dawn, or fly so far that they have to find a temporary place to stay in.

M- I´ve gotten the impression that twilight and dawn are essential for many animals

J- Yes, exactly, there are not many that are completely night living, they often use the twilight or dawn as well. If we take insects as an example, there are some that are out exactly when it's too dark for the birds to see and too early for the bats to be out. […] There's a little peak there.

The example shows that also without the add-on effect of artificial light, the "timetable of need" is a fine balance between space and time, and presence and absence of the wanted and the not-wanted (cf. Hägerstrand, 2009, p 247; 1984). Johan continued to tell me about a façade-lighted church where he had done an inventory of bats. The church lights had made the bats change their daily timetable of need after the auto timer of the façade lights. Each day, the "night" came several hours late, reducing time for movement in spaces that provided essential room for life-sustaining activities (cf, Hägerstrand, 2009, p 247), blocked at the doorstep by the presence of light.

"[…]it was by some church in the area around Ulricehamn, first I didn't think that there would be any bats there since I couldn't hear any and the church was quite heavily lighted, but then at a later occasion, we noticed that the façade lighting turned off at twelve a clock and then the bats came out at once. So, they were just waiting […] tuned in on it and came pretty much immediately. Hopefully, that night was enough for them."

Our walk was slowly coming to an end, we had made our way down the valley, crossed the river, and we were back at the church. No bats wanted to come out, but I was thankful for being shown their environment, and we both agreed that it was nice with an evening walk.

J- ...too bad that nothing was out flying today, but that's what we had expected.

M- It was nice to see the places they inhabit anyway.

6.2.3 Summary

Visiting the night of the moths with Jan and walking in the habitat of the brown long-eared bat with Johan, made two major themes emerge: complexity and time. A micro-moth depends on special host species, special flowers for feeding, at specific hours of dusk, night, and dawn. A brown long-eared bat depends on living places in (often) human-built walls and attics, water,

variation of vegetation, and open passages at different times of the dark hours. On top of all this, a major obstacle: artificial light altering the "timetable of needs" in challenging ways with species being diminished and endangered as a result. With Jan I got to experience the effect a single light can have on moths, and Johan clearly explained the situation for the bats by "translating" the environment we walked in. Keeping in mind that these are only two examples from the non-human world, the time-space (non-)balance of the fabric of existence has only been unfolded to a very small extent.

6.3 Towards generative ways

In this part, the last walking interview, with lighting designer and light artist Sara Ki is presented. Here, all-ecology theory will be put on pause due to the more concrete character of the interview, focusing on how to transform the usage of artificial light. In the next section, the Darkness Diary makes a comeback by outlining thoughts on what to do and how to think about the struggle between darkness and artificial light, with support from all-ecology. After that, in chapter 7, the results are put into "the diorama". Now, time for forward-looking.

6.3.1 Walking with a light designer

It was a beautiful spring day when I met up with Sara Ki in Slottsskogen, warm in the sun and cold in the shadow. Our walk took place before sunset since Sara Ki had to catch a boat out to the islands in the early evening. As we walked into the park Sara Ki told me about her point of view with the contemporary lighting situation.

> *"Basically, now a lot of places are over-lighted, and some of those places don't even need to be lighted overnight. We are using, first of all, super blue light, which is scientifically proven that it is worse for us and for the wildlife. I mean, we are humans, we have the capacity to adapt to darkness, even though some animals are much better, so of course, we have to lighten a little bit for the humans but we need to…respectful lightning I would say."*

She continued by explaining to me that it is important to protect areas that don't have artificial light, because once it's there, it's hard to turn them off, mentioning Dark Sky Reserves as a possible way. However, she emphasised that we (as humans) need lights and that the striving for a dark sky doesn't mean a dark ground. The light should simply be put where it's needed,

with the light directed towards the ground where the activities take place. The iconic Gothenburg bulb-lights stood along our walking path, stating a classical example of how to not concentrate the light to the ground, Sara Ki encouraged me to take a picture (see figure 17).

Figure 17. *The iconic Gothenburg bulb-lights in Slottsskogen.*

We walked further into the park, with the sun in our faces. Sara Ki told me about the difficulties in promoting respectful lighting when working as a consultant. I asked her if it has to do with the costs, the lack of knowledge, or concern for it being too dark and unsafe.

> *"It is all of them. First of all, it is the cost, second because people are not educated about it, it is not so spread out, not everyone knows that having unshielded lights outside your garden in cold colour temperatures could affect animals or insects more than if you have it in warmer colour temperatures, maybe people with some gut feeling of 'oh the warmer light is cosier', but they don't know. […] so that's the other thing[the concern that the dark is unsafe], and a big one, […] people relate, more light-more safety,[…]it has been shown that much more light does not bring more safety. […] if it's very bright, you are seen as well, so you don't feel that safe..."*

Concerning the costs, it primarily has to do with the standard colour temperature on lights (counted in Kelvin, K), Sara Ki explained to me. If we want to have respectful lighting, we should start to use warm lights outdoors, from 1800-2700 K (red light) during the dark hours, Sara Ki continues, but the standard K by the manufacturers are 3000K, 4000K, sometimes found in 2700K. If you want to have warmer lights, you must pay extra for the customized fixtures, and, Sara Ki assures me, that is often not a popular fact by the customers. On top of this, the will to pay is not there because the knowledge of *why* to consider colour temperature is not spread out. Sara Ki told me that she tries to implement respectful lighting in all her projects, but cheap solutions and short-term economic goals are often the priority for the customers. Considering the question of safeness, Sara Ki painted me a mental picture of how a respectful and safe-feeling walk could look like in Slottsskogen at night, but some more walking and talking must be done before arriving there.

Our walk went uphill, passing the seal pool. We stopped by a light pole (see figure 18 below on the left) and Sara Ki pointed out how another kind of light distribution could have concentrated the light to the ground, instead of being spilled out in the air. Just a little bit further, another light provided us with a different example of how the distribution could be changed (see figure 19 below on the right). Here, Sara Ki explained, the aesthetic reason to highlight the

tree could still be met, but it should be done from the top to the bottom instead of the other way around. She drew parallels to the lighting of churches:

Figure 18. *A light pole where the light distribution could be improved to avoid light being spilled out.*

Figure 19. *Tree lighted upwards instead of downwards.*

> *"…for example, if you want to light a church in the city. You can light it up and make it pretty, highlight its architecture, but then be aware of how you place the light, and you have the technology to time it as well, you can use it until 11 or 12, but then you can turn those lights off gradually. You can let the night be night."*

As we continued walking in the colder air of the early evening, Sara Ki told me about how technical gadgets, like tunable lighting[32] are used in indoor environments to create healthier lighting, promoted as "human-centric lighting". As a lighting designer, Sara Ki is sceptical against the labelling "human-centric lighting", since adapting the light after human needs requires more than tunable lighting, it is also a question of intensity of the light, *who* is going to use the room, and for *what* purpose[33]. In outdoor environments, she continued, it is not as common with tunable light technology, since "*it is already night, so then you don't want the day*", there the strive must be towards warmer colours. Sara Ki emphasised the differences in indoor and outdoor lighting, being very specific when talking about her projects, dividing them in interior and exterior. Concerning the outdoor lighting, she argued, regulations are required in order to reach change on a broad scale:

[32] Changes the colour temperature and the intensity with the day.
[33] Sara Ki gives the example of a hospital: here you need light that serve the staff in their work and light that is calming for the patients that are worried and in pain.

> *"Then it is when it has to be some regulation that tells you ´hey you are using light outdoors, you are affecting the wildlife, you cannot use it higher than 2500 K´, so if we can reach this, everything change, cause then manufactures are forced to provide it as a standard"*

Our conversation kept on returning to *awareness*. Even if more scientific knowledge is needed, large-scale measures could be taken based on what we know, like adjusting the light to where it's needed and using warmer colours. But, as Sara Ki expressed it, *"…we have to reach everyone, and science is extremely good in getting data and facts, but it doesn't touch people and that is because it's missing to reach the feelings of a human being."*. This gap is what Sara Ki wants to overcome with her light art.

> *"I want to use art to bring people into spaces where they feel it and they can absorb that moment, experience it, and see the effect of the topic and what it is about. If the art is good, it will create an experience that will touch you and you will act"*

Sara Ki showed me pictures and videos from her latest installation where the visitors got to enter a bioluminescent wonderworld of mushrooms (see figure 20) [34]. With the installation, Sara Ki wanted to mediate a fascination for how lights are used in nature, racing awareness to the effects of artificial lights and future possible light sources.

Figure 20. *The bioluminescent wonderworld of the mushrooms. Photo: Hans Christian Riss.*

Our walk was slowly coming to an end and I asked Sara Ki how she would have changed the iconic bulb-lights of Slottsskogen, that we took a picture at from the beginning, if she had the permission and the resources. She answered that first, she would have collaborated with architects from the city to design a new classical shape; it could still have an aspheric form, but with the light distributed

[34] The installation is called "Interconnection" and was created by Sara Ki Plans and her husband Johnatan Ki Lindhult with music by sound artist Anton Helmersson. The installation was created for the Copenhagen Light Festival. The links go to ARC magazine where more pictures can be seen and to videos of the exhibition. https://issuu.com/mondiale/docs/arc121/30, https://www.linkedin.com/feed/update/urn:li:activity:6769261190469214208/.

downwards. Then the colour temperature would have been warm and, considering humans feeling of safeness, used in combination with motion sensors in a particular way:

> *S- … you cannot have the light off and then switch it on, that doesn't work.*
>
> *M- why?*
>
> *S- Because that scares you in a way if everything is dark and then you move and it's spotting on you, it doesn't give a good feeling for humans.*
>
> *M- Even if it's like woosch [slowly increasing from dark to light]*
>
> *S- Yes, that's what you want, you want to have maybe ten percent, five percent of the output of the luminary, all the time very low output. Let's say here in the park you have a lower output and then when people come it detects you a little bit ahead, so it's not like it switches on when you are there, it starts to switch on ahead when you start to approach it. […] it has to be softer otherwise people don't feel good, […] and it has to be light, imagine you are here and everything is dark, you will not feel safe, you need to see a little bit, a little bit, but the thing is that if it is a little bit, your eyes will adapt you will see good.*

We reached our starting point at the entrance of Slotttsskogen and found another example of a spotlight lighting up the treetops and the sky instead of the ground. Sara Ki concludes that there is so much to do about the lights, and she felt exhausted by the overuse*, "…when you know about it, you see it everywhere you go."* However, she was determined to do something about it and believed in starting local in the parks:

> *"So, let's see if we can make a change in how we illuminate the parks of the cities, local to global, start small and locally in Gothenburg"*

6.3.2 How to deal with the situation: thoughts from the Darkness Diary

Living with intensified attention to darkness and artificial light, at the same time as writing about its effects on humans and biodiversity, inevitably gave rise to thoughts of generative strategies. These thoughts gathered around three overarching themes; '*leave space'*, *time*, and *embracing*. 'Leave space' could be seen as an extension of all-ecology's 'take space'; recognizing that humans and our artefacts (including the lights) take a disproportionate amount of space, the next step is to leave space for others (Darkness Diary 28/1, 10/2, 11/2, 17/2). In a note from 10/2 I reflect on this conflict in relation to reading about encounters:

> 10/2 Miller (2005) writes that places for meaningful encounters must be created […]. In my case, I feel that this might have to be taken even further- meaningful non-encounters. To know when to back off, when to leave space for someone else. Only the people who you know the best, know when to leave you alone for a while…

However, to be able to know when to back off, when to leave space, you must know the other part, and how can we know the other part if we can't meet with it? My Darkness Diary reflection continues:

> 10/2 In order to know someone, you may still have to meet?!? Or at least be informed of there being x species that are not feeling well and need peace and quiet[…] The question is if we have time to reconnect as Miller (2005) wants to[…] a lot is pointing in the direction that we don't have that. Now I got the "get out of the way"- song stuck in my brain. Relevant text in the context[35].

The song text I had stuck in my brain goes "*Get out, get out, get out, you have to get out of the way*" [36]. I was thinking that it's humans that have to get out of the way, feeling stressed from knowing that we (as in humans this time) are already taking up much space with physical structures and land use and then expanding this with artificial light. It's just too much 'space taking', that could be partly transformed to 'leaving space' by turning off lights.

'Moving on to *time*, the 'leave space' concept develops from what we have to do, to *when* we have to do this. We know that it considers the dark hours of the day, from dusk till dawn, but when during the year is it most important and *how* should this be done? Or in all-ecology terms, when is the all-space most crowded and what can we do to "widen the waist of the sandglass" (cf. Hägerstrand, 2009, p 165-166, 172)? I repeatedly come back to these questions (Darkness Diary 10/2, 17/2, 26/2, 3/3, 1/4).

> 17/2 Maybe more flexible working hours could adjust our usage of the outdoor rooms? [...] Give us the possibilities to feel better and the possibility to leave room. Time, time, time.
>
> 3/3 But is it really impossible to introduce a daily earth hour?? Or a half? Maybe that specific insect peak that Johan talked about…if we brand it in some catchy way…can't make up any good name but it can't be impossible!!
>
> 1/4 …you could maybe regulate the garden lights in the same way as summer/winter tires!

The third line of thought on possible strategies is the theme of *embracing*, more specifically embracing the dark and the rhythm, building on how to 'leave space'. A citation has followed me from the beginning of writing this thesis which pinpoints this thought:

---

[35] Song from 2012 of the Swedish artist Alina Devecerski called "Flytta på dig".
[36] The original Swedish lyrics that I had in my head goes
Flytta, flytta, flytta
Du måste flytta på dig

> 26/2 One sentence that feels super important is " …satisfied with the circumstances we were placed in…"[37] …It is something incredibly beautiful with it…if you are satisfied you could find a kind of peace in living with what you have; imagine Gothenburg, super rainy, grey, dark and cold the last months, but if you just embrace it, it is not that bad, then it's quite nice. To be in the rhythm: it is dark now, time to slow down. Just being.

To this could be added further reflections concerning the two essential drivers behind the rhythm: the sun and the moon. It is with consolation to myself that I affirm that the basic condition of the greater rhythm is still there, humans have just put on a layer of light that partly hides the dark part of the rhythm from us all (Darkness Diary 26/2, 1/3).

6.3.3 Summary

Meeting with Sara Ki was like meeting many of my own thoughts from the Darkness Diary (see 6.1 and 6.3.1 above), the burden of the knowledge, seeing bad lighting everywhere you go. However, with the difference that Sara Ki is a professional, which reveals that the will to implement respectful lighting is not enough; awareness and economic, and political reasons stand as obstacles in the way. Combining the walk with Sara Ki with the Darkness Diary thoughts on how to deal with the situation show that there are technical ways to 'leave space'. Sometimes by letting the dark spaces be dark, but often by adapting the lights for biodiversity and humans in the same space, implying the *where* and *when* as central themes. This steers towards something that has more to do with *sharing* than with *leaving*, however, with the requirement that humans have to decrease their contemporary part of the share.

7. Epilogue

7.1 Looking into the diorama

Imagine the diorama, a big glass box, maybe $3m^3$. The box is filled with these last months of thesis development; the places I've been, the people I've met, the places we walked, our conversations, the moths, and the browned long-eared bats. All this and more is in the glass box in a miniature version, like a small fairyland. This diorama has unexpected functions, humans and non-humans therein can walk and fly around, just as in the world outside the glass walls. As we stand there and watch the diorama, the scene changes, because this special diorama has captured the rhythm of the sun and the moon- day and night. It requires patience, but we have comfy chairs to sit in if our legs get tired, and slowly we begin to see the daylight fade, leaving

[37] Tanizaki, J. (1998). *Till skuggornas lov, nyutgåva*. *In praise of shadows, new edition*. Page 43. Citation translated from Swedish "…*tillfreds med omständighterna vi försatts i…"*

its way to twilight, gold and blue. Amongst the vegetation and in the walls and attics, we know that the moths and bats are getting ready in their starting holes, some are already on their way out.

Most of us are now sitting in the chairs and we witness how the natural shift is starting to get interrupted by bright spots of light from the ground, the floor of the diorama. We stand up and lean forward a bit to see the roof, we can catch sight of a couple of faint stars in the ceiling, but the vision is getting clouded by the lights from ground level, spreading lights in all directions. One of us is getting quite upset, because he sees that moths are getting trapped by the light, and from another side of the glass box another person spots a family of brown long-eared bats still being in the attic in the church, although their hour already started. You yourself spot a human in its bed, tossing and turning with lights from the streetlight creeping in between the blinds and a phone being charged with a blinking blue light next to the bed. "*Can´t we just turn the lights off, please!"*, more voices are heard around the glass box, and a small panic starts to spread in the group.

Just as a friend of yours is about to rush down the hall to get help to turn the lights off, you see something in the diorama and tell your friend to wait a bit. Down the paths of Slottsskogen you see a couple slowly walking home from the city under the classical light bulbs, it looks peaceful. The scene makes the people around you change their vision, and another person spots a woman on an evening run with headphones in the streetlights of the steep hill towards Jonsered's mansion. You peek in some houses and children are reading under the blankets, parents reading books in the light of a lamp, a guy watching a movie. In the streets of the city people are having a good time together under the lanterns at the open-air pubs.

A calm but confused silence settles over the group. We can't turn the lights off we say to each other and heavily sit down in our chairs again. After some minutes of silence looking into the puzzling world of the diorama, an idea starts to grow in your head. Imagine, you tell the group, if there were only lights where humans are, and if these lights were adapted in ways that were less harmful to our health, less attractive for the moths and less repulsive for the bat. In that moment, as by a wiggle of a wand, the diorama changes. Suddenly, large spaces of air that were earlier filled with artificial light are dark and large parts of the ground are also immersed in darkness. Doubt is spreading in the group, if this was such a good idea, but then we see another couple approaching Slottsskogen (which we almost didn't recognize because of the changed bulbs and lower output on the luminaries), but here they come and a beautiful way of light is slowly laid out before them through the park. People are still sitting in the open-air pubs, laughing together, we can even see them better now without the light-clouded air. We

hear a faint strange high frequency bib from inside the glass box and realize that the brown long-eared bat family are out hunting in the dark spaces of the night. It takes a while for our eyes to get used to the whole new setting, but looking really close we see that moths are out on their wings as well, some still recovering from the light trap, but we think they will be alright. Inside the houses, life looks pretty much the same, the lights on the screens are adapted to be better on people's eyes, but we barely notice the difference.

Something is not quite right though, it's not a euphoric feeling that has spread in the group around the diorama. *"It doesn't really look like the Gothenburg I know"*, someone says a bit quietly, *"I can't even tell that it is the road up to Jonsereds mansion"*, another person admits with a sting of disappointment in the voice. More voices are rising, talking to each other about how dark it looks now, if it can be safe really, they like their façade lights at home, scepticism deepens. You turn silent, but after a while, you realize that if you bend forward and look at the ceiling of the diorama now, you see more stars than you have seen in a long time, but you don't dare to share that discovery and you don't know why. Gazing over the altered landscape inside the glass box, listening to the bats, you meet the eyes of another person through the glass walls. You can tell that this person has discovered the same thing as you and that those eyes are sparkling from the wonder and excitement of this new world.

7.2 Conclusions

As Hägerstrand (1984) reminded, it is impossible to take everything into account in "the diorama", but it's a way of starting to take steps towards being able to say something about the real world, the world where everything *meets*. In the story above I have used the diorama-metaphor to process my impressions from this thesis development and to meet the aim and research questions. Reconnecting, the aim was to explore the role of darkness and artificial light for humans and biodiversity and formulate generative ways forward, building on the exploration. Three questions were posed; (1) how is darkness and artificial light experienced in everyday-and night life?, (2) what role do darkness and artificial light have for the chosen species in their living environment?, and (3) looking forward, what could be generative ways to co-exist?

From the Darkness Diary, I found experiences of darkness as an enabler of gathering and calming feelings of profound presence. I further found experiences of something between panic and exhaustion over the overuse of lights and what it is doing to us all. The walking interviews opened spaces of translation where the complexity and the "timetable of needs" of the moths and brown long-eared bat became visible, making the navigation through the "fabric

of existence" to an elusive every-night challenge, with darkness as a requirement and artificial light as a trap or a blockage. In addition, the twilight emerged as a central theme in both the Darkness Diary and the interviews.

Further, towards generative ways to co-exist, the walk with the lighting designer and lighting artist emphasised the importance of the difference between indoors and outdoors, acknowledging that outdoor spaces are shared and should be designed and used thereafter (which also became problematised when looking at buildings from a bat-perspective). Further, it showed that for changes to be done, the individual awareness about artificial light must increase and be met by political and economic initiatives in order to achieve large-scale changes, such as adjustments of outdoor light distribution, colour temperature, and implementation of motion sensors. Here, the Darkness Diary contributed with thoughts on '*leave space*' (as a built upon all-ecology's understanding of 'take space'), the importance of *time*, and the attitude towards darkness, claiming that we need to *embrace* it to enjoy the fruits of it.

To reconnect to the story above, the ending was not completely happy, even if a range of measures were made to keep human values of lights at night and leaving space for the nocturnal non-humans. People were out enjoying nightlife and evening walks; the moths were less trapped, and the brown long-eared bats could come out of the walls when they wanted to. Still, there was an unease in the group. As this thesis has shown, darkness and lights are sensitive subjects with deep cultural roots and the awareness about the effects of artificial light is low. However, as the eyes you met through the glass walls expressed, and as the Darkness Diary showed experiences of, there are openings for reformulation of the relation to darkness, and hence also to the lights.

That darkness and light are inevitable parts of each other became more and more obvious when writing this thesis. When trying to make themes of darkness and light, I always returned to the question if it was an experience of darkness or an experience of another kind of (or less) light. I felt the limitations of language when talking and writing about these themes, especially concerning darkness: a word is needed that covers the dusk, night, and dawn, since, as this thesis highlighted, these are all essential times of the day [38].

Turning to the theories, I can determine that applying all-ecology to darkness and light, when considering humans and non-humans, were beneficial for analysing the material. It helped

[38] The word *day* is a further source of confusion, by meaning the night as well. I hereby give the English language the permission to take on the Swedish world *dygn*, which means the 24hours, day and night and all in between.

me understand and twist and turn taken-for-granted phenomena and spaces in detail, yet with an ever-present overview, hopefully, the theorisation mediated that to you as a reader as well. All-ecology puts everyone under the same lens, and that was needed when considering a scarcely researched field about phenomena that affect us all. Regarding non-representational theory (NRT), this might not be as present in words as all-ecology, but, as outlined NRT is rooted in methodology, and so in this thesis, working in the shadows. With NRT in my back, I was encouraged to conduct this thesis in this not-so-traditional way and take my everyday- and night experiences seriously. Further, I wanted to mediate my experiences in a vivid way, if you at some point felt that you were almost there with me, I´m happy, and NRT has a large part in that. As pointed out earlier, Hägerstrand, (1976) encouraged to think about one own's experiences before drawing conclusions about the general. I (with supposed backup from NRT) can suggest an extension to that encouragement by adding *live* to the *think*, and here diary-writing and walking interviews were a beneficial way for processing and encountering the lived life, in darkness and (artificial) light.

This thesis departed from the alarming loss of biodiversity, here specifically due to artificial light at night. Throughout the thesis development, the importance of *where* and *when* there is darkness and lights got more and more profound: space and time matter. Adding on the *how*, and by acknowledging our (as in everyone) circadian rhythms, this thesis implies that there is a fundamental need for a shift change in the fabric of existence.

7.3 Suggestions of future research in fusion with the previous

Since there is no study to my knowledge that has explored human and biodiversity in relation to darkness and artificial light in a similar, "all-including" way as this thesis, it's unfruitful to compare the results in relation to the previous geographical research from chapter 3. However, the studies presented in chapter 3 provide an interesting springboard for suggestions how future research could further investigate our (as in everyone) existence in darkness and light(-s). The overall claim about future research is, hardly surprising, that more studies on darkness and artificial light in relation to human and biodiversity is needed, and the entries for this are many. I will depart from this thesis and outline the holes that I suggest should be filled.

In human studies, critical research is needed which explores the possible effects of a darker city, bringing in socio-economic aspects, such as gender and disabilities. Safety is an important theme here that needs to be considered to a much larger extent than this thesis could cover. As a suggestion, Pink and Sumartojo's (2018) work on automatization and "the lit world" could be built upon. Concerning methods, sense-walks could be an alternative, with a

combination of quantitative monitoring and qualitative walking groups targeting light pollution (see Gabrys, 2017, pp 145-161 on air pollution walks). This, in combination with more in-depth studies on human interpretation of darkness and lights could make up a good base for planning policies and design. To this, the need of understanding human and non-human movements in relation to darkness and lights could be added. Here, Edensor and Hughes's (2019) exploration of the choreographic effect of shadows and Barua's (2021) work on more-than-human infrastructure could provide start-off points. Moreover, lights' general status within the planning process would be interesting for future research to investigate since it is a platform where major changes, like the one in the diorama, must be initiated.

Regarding biodiversity, more research is needed on how different species are affected by different lights and how automatization like motion sensors affect the behaviours. Further, plants need to be more addressed in this matter, while they have the specific position of being non- (or less) mobile than other non-humans and can therefore not choose to stay away from the light of the lamps. In general, consequences of artificial light for ecological systems need to be further investigated, as well as the effects of new possible light sources, like bioluminescence. This could be related to Hubbard and Brooks´s (2021) article on animals' "right to the city", which drawn on to this thesis could be translated to the "right to the rhythm", which goes for both humans and non-human. Hence, we need to understand this rhythm and what affects it to a larger extent, to be able to meet the needs.

Further, what has started to become clear throughout this thesis development is that the *twilight* marks a fundamental shift, the time of the day when the space-time friction starts to get as most intense and, hence, there is a great need of knowing more about our co-existence, movements, needs, and feelings during these hours. In this sense, Davidson's (2015) citation; "*Twilight can be thought of also as the time of tranquillity and return, when all things scattered by the day are drawn back to their right places*" (p 11) could be extended with "…*and the things drawn back by the day are scattered out in their rightful spaces of the night*", with the notion that we currently lack knowledge about this transformation and the spaces and creatures of the night.

Finally, I want to encourage more studies where humans, animals, insects, and plants are explored together. As a suggestion, with help of all-ecology. This thesis only used a fraction of what Hägerstrand's ontology carries, but I hope that it can be an inspiring example of how to adapt the theory to the lived world. After all, we live in the same spaces, by day, by night, and all in between.

7.4 …simply geography?

In the Darkness Diary 11/2 following entry is written:

> .
> 11/2 An apparition: could darkness and light be tools for overcoming the gap within geography??
> A concept that affects everything in all places, spaces, landscapes, AND time.

The gap considers the division between human and physical geography, and the fact that even if geography should be an all-encapsulating study of everything on earth, the physical and human geography rarely share common ground, or as Creswell (2013) express it *"…human and physical geographers appear to live separate intellectual lives. They meet for coffee, chat about the weather, compare fortunes of sports teams, but geographical ideas are rarely the subject of conversation."* (p 239). This gap goes further than within geography, as Hägerstrand pinpointed (see Stenseke, 2020). This became exemplified with a conversation I had with moth-expert Jan on our inventory evening, where there was great confusion about my education in comparison to why I was in the forest looking at moths:

> *J- So then you've read botany as well?*
> *M- No…*
> *J- Only zoology?*
> *M- No…geography*
> *J- Oh, but this is more towards biology...*
> *M- Yes, in the thesis it will be a mix, humans and animals*
> *in relation to darkness and light*
> *J- Physical geography?*
> *M- No…more towards human geography.*
> *[pause]*
> *J- Well, well is good that you are including some animals.*

I think this conversation and Jan's last comment says something about the bigger picture: humans and non-humans live on the same earth, in the same spaces, hence, both must be considered together, even if the traditional disciplines are not organized that way. Perhaps this gap is the reason why an all-encapsulating phenomenon such as darkness hasn't been studied with humans and non-humans together before (as far as I know). Starting from a common reference frame, such as the rhythm of darkness and light, is one way to start doing so. Bridging human and physical geography (and beyond) are not new ideas. Massey (1999) has argued for the power of space and time as a common thread for the disciplines and animal geographers have claimed that the branch holds this bridging potential (for summary see Creswell, 2013, pp 246-250). Perhaps the difference in method and research tradition would still keep the gap solid,

even if more common questions are discussed, however, if I had to put this thesis in a disciplinary, I would say that it is a thesis in geography, simply geography.

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