

Green Lifestyles



Analysis of Animal-Human Mapping Based on GIS Systems

Project Summary

In the face of increasing urbanization and environmental challenges, understanding how human lifestyles interact with animal habitats deserves significant attention. This paper discusses green lifestyles, ecological niches, and habitats of animals compared to grey lifestyles in human-dominated environments that include cities or urban areas and their respective infrastructures. By comparing these contrasting lifestyles, one can trace the extent of human disturbance in natural ecosystems and point out areas where biodiversity thrives or suffers in Järfälla. By doing so, the study will focus on the ecological presence of mammals, particularly the top five species found in Järfälla: Roe deer, Hare, Red fox, Beaver, and Mouse. Using geospatial data from Artdatabanken and GBIF, a mapping of distribution and hotspots of species is performed to visually represent their living space. These green lifestyle maps symbolize the ecological footprints of Järfälla's fauna and present locations where these animals keep their presence despite human encroachment.

This research explores the interaction between human (grey) and animal (green) lifestyles in Järfälla, Sweden, focusing on how urban development impacts wildlife habitats. The study employs a more-than-human perspective to analyze the spatial relationships between urban infrastructure and animal ecosystems. By mapping animal sightings of five key mammal species (beaver, hare, red fox, roe deer, and moose) and examining urban development patterns, the research reveals the critical ways human activities encroach upon and fragment natural habitats.

The project utilized GIS and data from sources like GBIF and Artdatabanken to create maps detailing green areas, animal sighting distributions, noise pollution, traffic infrastructure, and human intervention in ecological spaces. Key findings revealed a reduction in green spaces, disruptive effects of noise pollution on animal habitats, and the need for integrated urban planning considering non-human species' ecological needs.

Keywords: Urban ecology, Green and Grey Lifestyles, Sensitivity Zones, Human-Animal Interaction

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1. Background of Järfälla

Järfälla, a municipality in Stockholm County, Sweden, has experienced significant growth and development in recent years. As of 2024, the municipality faces the challenge of balancing urban expansion with the preservation of its rich natural environment and biodiversity. Järfälla's comprehensive development plan aims to "grow with quality" by harmonizing urbanization with ecological preservation. The municipality has been proactive in implementing policies to maintain its natural green spaces alongside urban transformations.

Key strategies include:

- Expanding protected areas
- Maintaining ecological corridors
- Minimizing anthropogenic pressures on nature reserves

Two major nature reserves play a crucial role in Järfälla's ecological landscape:

- Görvälns naturreservat in the west
- Järvakilen in the east

These areas serve as vital habitats for diverse flora and fauna, including mammals such as roe deer, hare, red fox, beaver, moose, and many others. Despite these conservation efforts, Järfälla faces challenges related to habitat fragmentation and biodiversity loss. The municipality's growth has increased human activity in natural spaces, potentially disrupting ecosystems and threatening local wildlife.

To address these issues, Järfälla has implemented several key policies:

- Integration of ecological values into urban planning
- Creation of urban green corridors
- Establishment of buffer zones to mitigate habitat fragmentation
- Stricter regulations on pollution to alleviate pressures on sensitive species

These measures aim to align Järfälla's development goals with ecological sustainability, ensuring that future growth supports both human needs and biodiversity conservation. As Järfälla continues to develop, the municipality faces the ongoing challenge of balancing urban growth with the preservation of its natural heritage. This delicate balance requires continuous assessment and adaptation of policies to ensure the long-term coexistence of human activities and thriving ecosystems. Järfälla's development plan emphasizes the importance of preserving biodiversity through strategies like expanding protected areas, maintaining ecological corridors, and minimizing

anthropogenic pressures on nature reserves such as Görväln and Järvakilen. However, understanding the efficacy of these strategies requires a data-driven approach. Platforms like Artdatabanken and GBIF.org provide valuable geo-referenced data on wildlife sightings, enabling the mapping of habitats and identifying biodiversity hotspots. These green lifestyle maps can highlight areas where species thrive and areas under ecological stress (Järfälla Kommun, 2014).

2. Problems of Järfälla

Urbanization, as noted in Järfälla's growth plan, poses significant challenges to maintaining biodiversity. Noise and pollution from increased transportation and industrialization disrupt wildlife, while habitat fragmentation reduces ecological connectivity. However, the municipality's proactive measures, such as integrating ecological values into urban planning, provide a framework for addressing these issues. By understanding the spatial distribution of both human activities and animal habitats, Järfälla can align its development goals with ecological sustainability, ensuring that future growth supports both people and biodiversity (Järfälla Kommun, 2014). Balancing urban growth and biodiversity conservation is a critical challenge for municipalities like Järfälla, which is experiencing rapid population (Figure 1) and infrastructure expansion. As outlined in its comprehensive development plan, Järfälla aims to "grow with quality" by harmonizing urbanization with ecological preservation, maintaining its natural green spaces alongside significant urban transformations. However, the interaction between human activities (*grey lifestyles*) and wildlife habitats (*green lifestyles*) must be thoroughly studied to ensure sustainable development that accommodates both biodiversity and urban needs (Järfälla Kommun, 2014).

The built environment in the Järfälla area has had a significant impact on local biodiversity over the past few decades, as indicated by the changes between 1984, 2004, and 2024 (green represents green spaces, blue represents water bodies, and the central cross hatched areas represent built-up zones) (Figure 1). With the acceleration of urbanisation, particularly the expansion of built-up areas, natural habitats have become increasingly encroached upon, and surface conditions have changed. The fragmentation of green space edges, as well as the encroachment of buildings and impermeable surfaces, have reduced the continuous areas and migration corridors upon which many species rely for survival. This has also increased the contact area between human zones and animal habitats, affecting animal reproduction and survival and increasing the risk of biodiversity loss (Järfälla Kommun, 2014). Urban expansion has also introduced pollution (physical or noise pollution), altered the flow of nearby water bodies, and changed soil composition, all of which have had an impact on local ecosystems and plant and animal habitats. From the maps, it is evident that although the encroachment on the two nature reserves Görvälns naturreservat in the west and Järvafältet in the east has been controlled, the built-up areas in Järfälla have significantly expanded, particularly in the central and

southern regions. Even the lake Säbysjön, located within Järvafältet, is at risk of being encroached upon by built-up areas. The increase in impermeable surfaces has led to increased surface runoff and reduced soil water retention capacity.

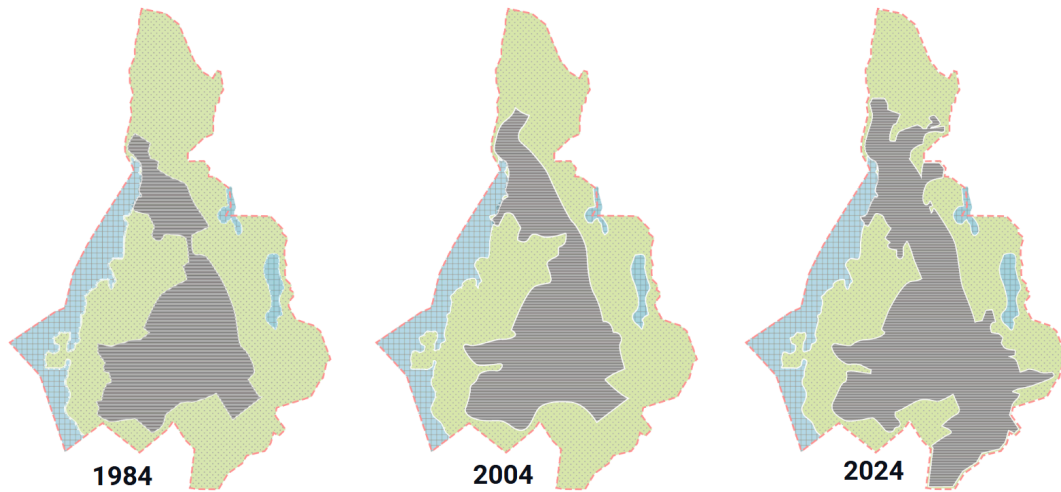


Figure 1. Timeline history maps showing how the green areas decreased by 21.33% since 1984 (Authors, 2024).

“Less green means less space for animals to live. We might be getting better at including the human green lifestyle, but what about animal lifestyles?”

Aim

This study aims to utilise a non-human perspective, identifying vulnerable regions for different animals in the green areas and analysing human activity around it, to understand the confluence in the current development.

3. Study Phases

The project aims to analyse and address the interaction between different lifestyles in Järfälla through five key phases: foundational studies, data collection, mapping processes, and a comprehensive analysis of outcomes (Figure 2). The first phase introduces the theoretical background of our study, covering the definitions of green and grey lifestyles and the more-than-human perspective. It also includes observations from the site visit, with preliminary findings on biodiversity challenges in Järfälla. The second phase identifies five key mammal species based on their frequent sightings and ecological importance. The third phase involves data collection using scientific data from GBIF and public contributions from Artdatabanken, compiling a comprehensive dataset of around 300 geo-locations for the selected species. The fourth phase uses Geographic Information Systems (GIS)

as a key tool for mapping and data visualisation, creating maps to represent green lifestyles, including the built environment, human encroachment into green areas, and traffic noise pollution. The final fifth phase includes a final overlay map that combines green and grey lifestyle data to visualise how urban development influences biodiversity, supporting the identification of critical areas for conservation and informed strategies for sustainable urban planning from a more-than-human perspective. The project concludes with a detailed discussion on buffers created in the region, areas concentrated with animal location, and potential solutions.

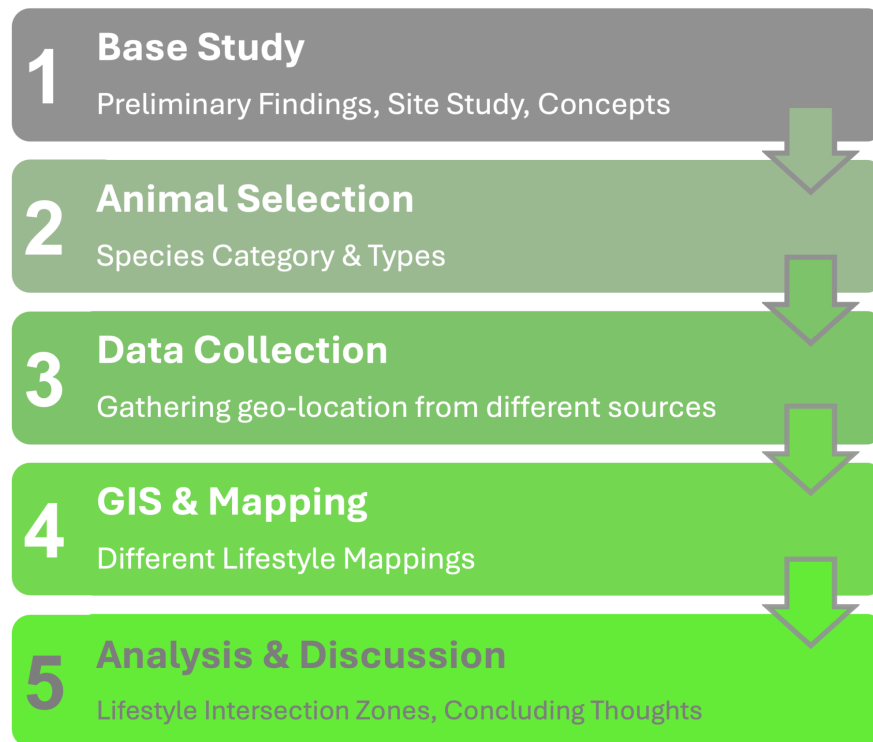


Figure 2. Illustration of the order in which we conducted five study phases (Authors, 2024).

3.1 Limitations of Study

While the project provides valuable insights into the interaction between green and grey lifestyles, it is important to acknowledge its limitations:

- 1. Limited time & Data Availability** - Due to the constraints of the project timeline, certain areas of analysis could not be explored in greater depth, such as **animal migration and movement patterns** as well as long-term ecological trends. Additionally, the reliance on secondary data from GBIF and Artdatabanken meant we were limited by the completeness and accuracy of available datasets.
- 2. Scientific Accuracy of Noise and Buffer Zones** - The absence of specialised equipment to measure traffic noise scientifically and accurately limited our ability to comprehensively

assess its impact. Similarly, buffer zones were generated based on clustering techniques rather than precise field data, which may introduce a level of estimation.

These limitations highlight areas for further research and improvement in future studies, particularly regarding the need for more precise data collection and extended timelines for comprehensive analysis.

4. Base Study

This section provides the foundational context and practical groundwork for our study, which aims to utilise a non-human perspective to identify vulnerable regions for animals in Järfälla's green areas and analyse the impact of human activity around these spaces. By redefining green lifestyles to represent the natural behaviours and habitats of non-human species and grey lifestyles as the ecological footprint of human-built environments, we explore how urban development influences the coexistence of humans and animals.

To complement the theoretical framework, we visited Järfälla to gain first-hand insights into the on-ground conditions of green and grey spaces. The visit focused on observing current conditions and assessing traffic-related noise pollution in and around key green areas, such as Görvälns naturreservat and Västra Järvafältet. Observations included measuring noise levels (particularly in Västra Järvafältet) and documenting human access to ecologically preserved areas. These observations were recorded using tools such as a sound level meter app (dB Meter) and photo mapping in Google Maps to establish spatial relationships between noise sources and green spaces.

This section establishes a comprehensive basis for analysing the confluence of human and non-human activities in urban Järfälla by integrating theoretical perspectives with practical observations. Together, these components provide the foundation for understanding the challenges faced by vulnerable species and proposing recommendations for sustainable coexistence (relates to policy recommendations).

4.1 Theoretical Background

As highlighted in the introduction of this report, urban development in Järfälla has led to habitat fragmentation, biodiversity loss, and increased human activity in natural spaces. These changes reflect broader global trends where urbanisation often prioritises human needs at the expense of non-human species and ecosystems. In this context, understanding how urban spaces are shared or contested between humans and other species becomes crucial to fostering ecological resilience.

To explore this, our study adopts a more-than-human perspective and redefines key concepts to shift the focus from anthropocentric views to a more inclusive understanding of urban ecosystems. Specifically, we repurpose the terms green and grey lifestyles to emphasise how urban development encroaches upon animal spaces. This approach challenges conventional urban planning frameworks, emphasising the interconnectedness of human and non-human actors within urban spaces and highlighting the presence of nonhuman Others.

The following sections outline the theoretical foundations of this study, beginning with the redefinition of green lifestyles to represent the behaviours, habitats, and interactions of non-human species, followed by an exploration of grey lifestyles as a representation of human ecological footprints. Finally, the adoption of a more-than-human perspective provides a guiding framework for understanding and addressing the dynamics of urban development and its impact on non-human species in Järfälla.

4.1.1 Definitions of Green and Grey Lifestyles

The term *lifestyle* is inherently human-centric, often referring to human behaviour and activity patterns. In this project, we intentionally repurpose this term to represent non-human species' behaviours, habitats, and interactions, aligning with our more-than-human perspective. This redefinition emphasises the interconnectedness of humans and other species within urban environments, challenging the traditional anthropocentric lens in urban planning. The ongoing urban development has led to habitat fragmentation, deforestation, and human encroachment into eco-sensitive areas, constraining these species' natural spaces. Habitat shrinkage, coupled with rising human activity in green spaces for recreational purposes, further disrupts ecosystems and threatens biodiversity (Di Marco et al., 2018; Marques et al., 2019; Newbold et al., 2015). By redefining lifestyles in this context, we highlight the need to integrate non-human perspectives into urban planning to ensure ecological resilience and sustainable coexistence.

4.1.2 Green Lifestyles

The term *green lifestyle* is commonly associated with sustainable practices and environmentally conscious behaviours adopted by humans. According to many available definitions, green living is a lifestyle focused on maintaining harmony by preserving and protecting Earth's natural resources, habitats, human societies, and biodiversity (Zheng et al., 2023; Safdie, 2023). It involves cultivating sustainable habits in daily life, ensuring that routine activities align with and support natural resources rather than depleting them or causing lasting harm to the environment and ecosystems.

Evidently, this interpretation primarily reflects a human-centric perspective on living in harmony with nature, failing to account for nature's intrinsic agency and its autonomous processes in maintaining

ecological balance. Therefore, in this study, we have intentionally repurposed the term green lifestyles to focus exclusively on the natural ways of living exhibited by non-human species. This redefinition refers to their behaviours, habitats, and interactions that exemplify coexistence within ecosystems. By excluding humans from this definition, we aim to shine a light on animals that truly embody the essence of 'green' living species whose lifestyles, behaviours, and interactions with the urban environment are often overlooked (Arcari et al., 2021; Van Patter, 2023), as is evident in Järfälla.

By reframing green lifestyles to move beyond human-centric interpretations, we emphasise the importance of recognising the contributions of non-human Others to urban biodiversity and ecological balance outside of human-defined frameworks. This redefinition aligns with the broader aim of adopting a more-than-human perspective, where urban planning and development are informed by the needs and behaviours of all species, not just humans.

4.1.3 Grey Lifestyles

Grey lifestyles refer to the ways humans live and interact within their built environments, including their movements, activities and the infrastructures that support them. These lifestyles are characterised by the human presence in urbanised spaces and the ecological impacts of such activities. Understanding this is essential to explore how human-centric environments and behaviours influence surrounding ecosystems and non-human species.

In the context of Järfälla, we aim to investigate specific aspects of grey lifestyles that intersect with ecological and biodiversity concerns:

- **Extent of Developed Areas:**

One key focus is to assess the proportion of developed areas within Järfälla. This includes residential, commercial, and industrial zones, as well as the infrastructure that supports human activity. Understanding the spatial footprint of these built environments will help quantify their impact on natural habitats and biodiversity.

- **Noise and Its Impact on Animals:**

Human movement and activities, particularly traffic, generate significant noise that can disturb and displace animals in urban areas. Noise pollution from traffic is a critical factor in understanding grey lifestyles, as it directly affects the behaviour, health, and survival of non-human species. Research by Kok et al. (2023) highlights that chronic traffic noise masks critical environmental sounds, such as predator cues and conspecific communication, causing animals to experience heightened stress and altered behaviours. For example, traffic noise has

been shown to increase vigilance and reduce foraging efficiency in many species, as they struggle to detect threats or interact within their communities. Moreover, traffic noise disrupts spatial and temporal use of habitats by wildlife, forcing them to avoid noisy areas that may otherwise be critical for feeding, breeding, or shelter (Kok et al., 2023). Our study will analyse the spatial distribution of traffic noise in Järfälla, identifying areas where noise overlaps with habitats of vulnerable species and showing how human development encroaches upon animal spaces.

- Access to Ecologically Preserved Areas:

Despite being designated as "ecologically preserved," many areas, such as Görvälns naturreservat and Västra Järvafältet, are accessible to humans, potentially reducing their effectiveness as refuges for wildlife. We aim to examine the extent to which these areas in Järfälla are accessed by humans, for example, by identifying man-made walking paths within them. By analysing this overlap, we can better understand the balance—or imbalance—between conservation efforts and human interaction with these spaces.

By investigating the above-mentioned factors, we seek to highlight the often-overlooked dynamics of grey lifestyles and their implications for other-than-human actors. This analysis will provide a clearer picture of how human activities and built environments intersect with the natural world, emphasising the need for integrated approaches to urban planning in Järfälla that consider both grey and green lifestyles.

4.1.4 More-than-human Perspectives and Rights to the City

There is a growing focus on urban nature and biodiversity preservation, aimed at creating more socially and environmentally sustainable cities. Despite this, the visibility of animals in urban planning and academic practices remains highly selective, with the majority being overlooked (Arcari et al., 2021). This stems from an anthropocentric view of cities and nature, where non-human species are valued primarily for their profitability or the ecosystem services they provide, reducing them to mere commodities (Arcari et al., 2021; Collard & Dempsey, 2013, as cited in Van Patter, 2023).

In contrast, there is increasing recognition of the role of other-than-human actors as central to shaping, operating, and experiencing urban spaces. More-than-human rights to the city can be understood as redefining nonhuman others as fellow urban residents to humans, instead of viewing them as ‘pests’ or ‘invaders’ (Shinghe, 2022). Urban settings typically associated with human-centric activities are, in reality, spaces of cohabitation with other species (Van Patter, 2023). To address this imbalance, it is crucial to adopt a *more-than-human perspective* and recognise the multispecies right to the city. This

approach makes visible the spaces, knowledge, and ways of living of other-than-human actors, fostering a more inclusive understanding of urban environments (Van Patter, 2023).

The research conducted by Van Patter (2023) on eastern coyotes is a strong example of successfully integrating a more-than-human perspective, reframing these animals as legitimate urban residents. The study employed a hybrid methodology, integrating spatial, ecological, and ethnographic tools, such as GPS tracking, trail cameras, and interviews, to explore coyote lifeworlds and their interactions with humans. It shifted the focus from spectacular or conflict-driven events to the everyday practices of multispecies coexistence, such as how coyotes navigate human-dominated spaces and adapt their rhythms to urban life. Insights from the study have been applied to practical measures, such as updating Toronto's coyote signage to promote education and coexistence. The researcher also included a supplementary ethics protocol, demonstrating a commitment to respecting and protecting non-human participants.

While this research exemplifies a robust approach with significant resources dedicated to making coyotes visible in everyday urban life, our approach in this study will necessarily differ due to the time and data limitations previously discussed. However, we share a similar goal of emphasising unseen aspects of urban development, particularly animal (green) lifestyles. By utilising a more-than-human perspective and acknowledging multispecies rights to the city, we hope to challenge the status quo of urban development and grey lifestyles in Järfälla, where human-centric approaches dominate decision-making and often neglect the needs of species unable to voice their presence.

4.2 Site Visit

To gain a thorough understanding of Järfälla's on-ground conditions, we conducted a site visit to assess noise pollution in and around key green areas. This visit provided critical insights into how traffic-related noise impacts biodiversity and the interaction between green and grey lifestyles.

During the visit, we:

- (a) Walked through the main green areas, including Görvälns naturreservat and Västra Järvafältet, to observe the current conditions of these eco-sensitive zones and human intervention within (Figure 3).



Figure 3. Some of the observed human interventions, including observation decks along the water body, playgrounds and man-made paths in Görvälns naturreservat (Authors, 2024).

- (b) Assessed noise pollution from roads that run along or near these green areas, focusing on the effects of traffic noise on biodiversity and human intervention (Figure 4).



Figure 4. Road infrastructure between Görvälns naturreservat and Västra Järvafältet (Authors, 2024).

- (c) Specifically, evaluated the patch of green land between road intersections on the way from Görvälns naturreservat to Västra Järvafältet to measure the influence of oncoming traffic on these areas.
- (d) Used a sound level meter app (dB Meter) to measure noise levels in different locations, mainly in Västra Järvafältet (Figure 5).



Figure 5. Locations and recordings of the sound levels within Västra Järvafältet (Authors, 2024).

(e) Recorded observations through the Google photo map, documenting the general situation within the green areas, human intervention in the green areas, and spatial relationships between noise sources and the surrounding green areas (Figure 6).

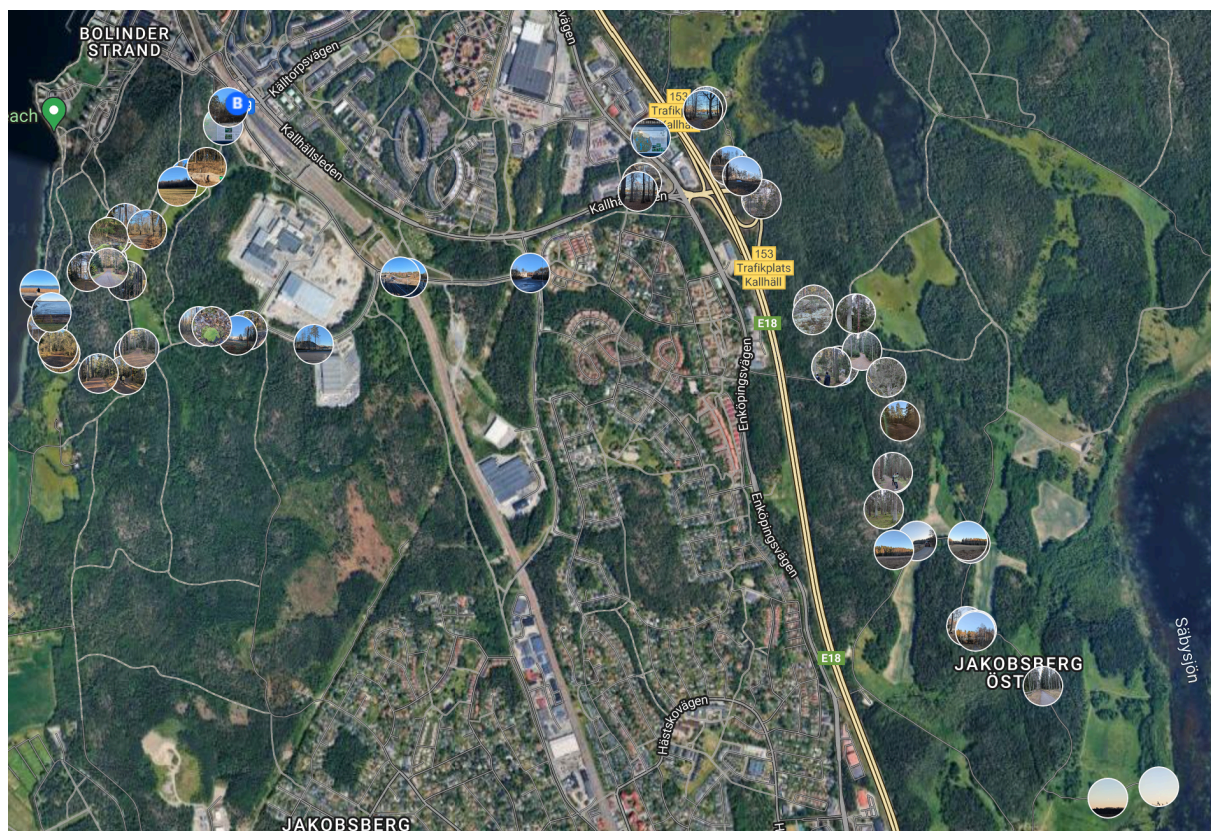


Figure 6. Photo map that documents our observations (Authors, 2024; Google Maps, 2024).

The site visit provided a snapshot of the on-ground conditions in Järfälla, offering insights into the interaction between green and grey lifestyles, including traffic-related noise pollution, human interventions like paths and playgrounds, and the overall state of eco-sensitive areas. During the visit, we did not observe any wild animals within the green areas, except for horses led by humans and deer spotted near a parking lot on our way out of Västra Järvafältet.

In addition, we noticed open spaces where trees had been cut down in both Görvålns naturreservat and Västra Järvafältet. Particularly in Västra Järvafältet, these areas without tree cover allowed traffic noise to be clearly heard, even though they were relatively deep within the green area. The noise levels closer to the roads created a sound environment that felt very uncomfortable even for us, leading us to consider that high noise levels might be a contributing factor to the absence of animals in these areas.

Overall, the visit allowed us to understand the ongoing situation in Järfälla, how grey lifestyles intersect with green lifestyles, and the extent of human intervention within these green spaces.

5. Animal Selection

Based on the information available online and from the municipality's website, a diverse range of species was identified to showcase Järfälla's ecological balance and biodiversity. The selection included 26 species across categories such as mammals, birds, insects, plants, trees, fungi, and reptiles, with 16 classified as endangered or vulnerable. These species were chosen for their ecological significance and roles in maintaining key ecosystem services. By focusing on both common and endangered species, it seemed like a plausible method to arrive at the conclusions required.

Among these species, the effects of grey lifestyles on green areas have already been studied extensively, particularly in terms of land-use changes driven by urbanization. The effects of urban expansion and grey lifestyles on green spaces have been widely studied, revealing significant habitat loss and ecosystem disruptions, with direct consequences for plant biodiversity and indirect impacts on fauna (Alberti, 2005; Seto et al., 2012). Grey lifestyles, which prioritize urban infrastructure, require space that is often created by clearing green areas, causing a direct and visible effect. Although the specifics of grey lifestyles' impact on plant species are harder to conclude, while the direct effects are well-documented. However, when it comes to animal species, the effects of grey lifestyles seem to be less studied due to the lack of visibility of these consequences. Hence, we decided to make the list more specific to birds, mammals, and insects.

Initially, the aim was to outline planning methods that considered the perspective of non-human species using the diverse animal life in the municipality. However, the green and protected areas around Järfälla are home to many non-human species, making the scope too broad and unfocused. To address this, we shortlisted specific animals to allow for a more detailed approach. By doing so, we reduced the focus to individual species, enabling us to analyze the extent of grey lifestyles' effects on green areas through these specific animals.

Further shortlisting was guided by expert advice from a researcher at KTH who specializes in protected green areas in Järfälla and he emphasized the importance of mammals. Based on his guidance, we could find the availability of data for GIS mapping like their frequent sightings in Järfälla. We then identified five key mammal species: beaver, hare, red fox, roe deer, and moose. Frequent observations suggest that these species are ecologically significant and serve as indicators of habitat quality and resource availability in the region (Magle et al., 2012; Magle et al., 2019). These species were chosen not only for their prevalence but also for their adaptability to urban environments and their ecological importance in maintaining biodiversity.

These mammals rely heavily on cohesive green networks for movement, resource access, and survival. Habitat fragmentation, caused by urban barriers such as roads and infrastructure, disrupts their natural behaviors and poses significant challenges to their long-term viability. The selection of these species allows us to focus our analysis on representative mammals that reflect the broader impacts of urbanization on biodiversity in Järfälla.

6. Data Collection

We collected data on the selected five key mammal species from two main data sources, which also served as the foundation for creating our maps:

- Scientific Data (GBIF)

The Global Biodiversity Information Facility (GBIF) is an international open-access data network that provides comprehensive information on biodiversity. Its platform compiles data from various sources, including research institutions, museums, conservation organizations, and citizen science initiatives. GBIF's interactive map allows users to visualize occurrences of species in specific geographical areas with various filters. The database supports biodiversity research, conservation efforts, and policy-making by offering high-quality, standardized biodiversity data. We utilized GBIF's map to visualize occurrences of specific non-human characters in Järfälla, Sweden. This helped us analyze species distribution and ecological patterns in the area. Verified observations from the Global Biodiversity Information System provided high-accuracy data points for our maps.

- Public Contributions (Artdatabanken)

The Swedish Species Information Centre (Artdatabanken), hosted by the Swedish University of Agricultural Sciences (SLU), is a national center for biodiversity and species data in Sweden. It collects, analyzes, and distributes information about the country's plants, animals, and fungi to support conservation efforts, research, and environmental management. A unique feature of Artdatabanken is its public contribution system, where citizens can report observations of species via platforms like Artportalen. This platform plays a crucial role in Sweden's efforts to protect its natural heritage and support global biodiversity goals. Data from Artdatabanken not only helped build our analyses but also contributed insights into the effects of human activities—referred to as the "grey lifestyle"—on green spaces and wildlife.

- Data Source for Our Maps

Data submitted by the public expanded the dataset, offering over 600 geo locations for the selected species. This combination of sources ensured that the dataset was comprehensive and accurate, allowing for a detailed analysis of species distribution and activity patterns. Our maps were developed using data derived from these two sources: GBIF and Artdatabanken. By combining GBIF's standardized biodiversity data with citizen-reported observations from Artdatabanken, we created detailed visualizations of species occurrences and ecological patterns in Järfälla, Sweden.

7. GIS & Mapping

GIS and visualisation techniques allow revelation of urban dynamics in real time, thus democratising access to helpful urban information that offers people more control over their environment (Nabian et al., 2013). To analyse the interplay between green and grey lifestyles in Järfälla, we utilised Geographic Information Systems (GIS) specifically the software QGIS for mapping and Adobe Illustrator for data visualisation and illustrations. The main purpose of QGIS was to conduct various analyses which can be extracted by layers and compiled in illustrator. The mapping process is divided into several components, which include *green lifestyle*, *grey lifestyle* and *overlay maps*. For the project aim to look through animal perspective, we started with green lifestyle:

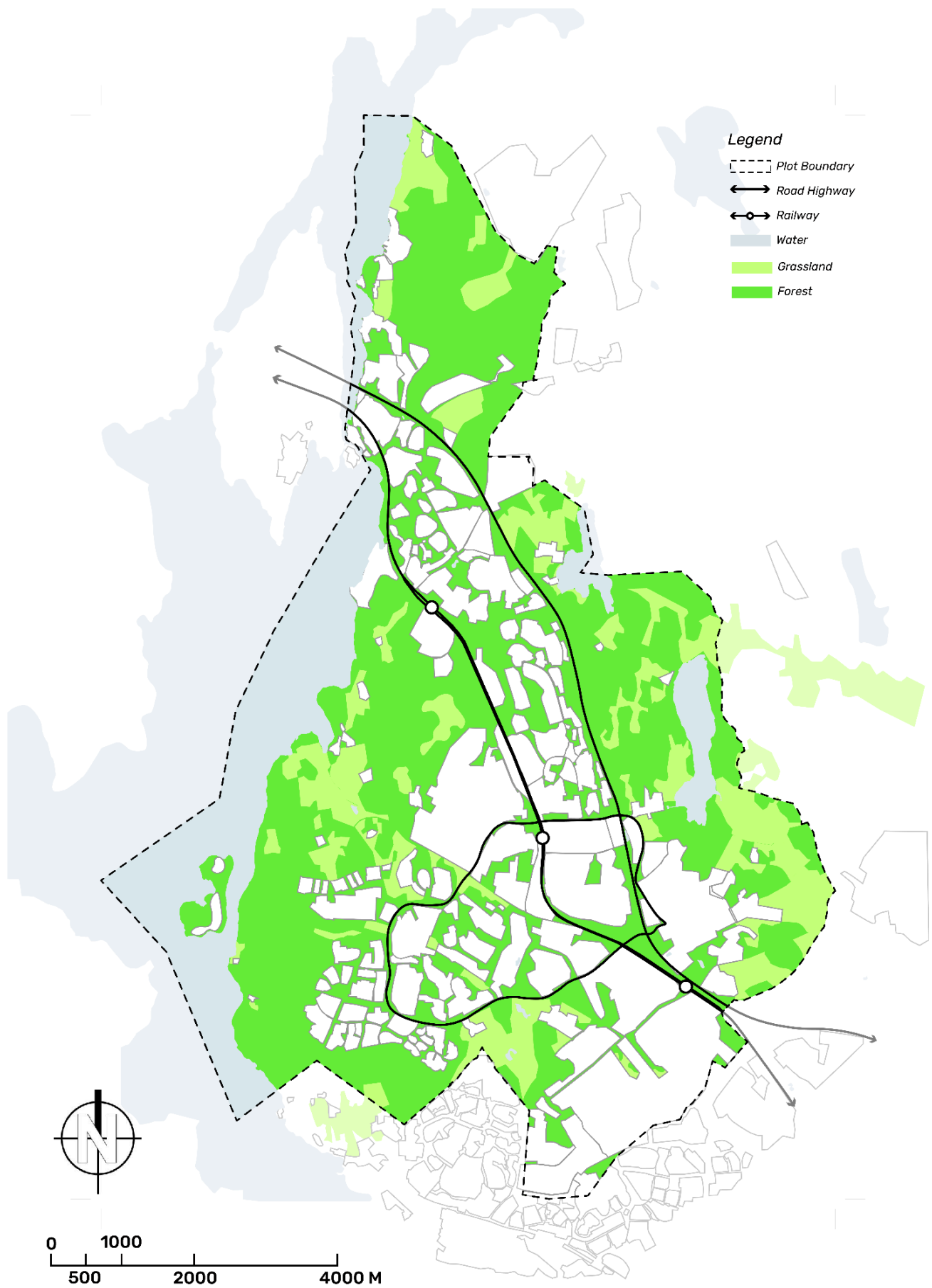


Figure 7. Green Areas (Authors, 2024).

7.1 Green Lifestyle Maps

The *Green Lifestyles* highlight the key components of how animals are living.

7.1.1 Green Areas

We start by taking the basic biodiversity region of Järfälla highlighting the potential zones of where an animal can thrive. This includes the firstly the ecological preserved areas, the forest areas, green parks and agricultural lands inside the forest. The ecological preserved areas, forest and agriculture in Järfälla's perspective are taken into nature reserve. A nature reserve often consists of natural environments and features which are connected, and may include, natural forests, watercourses and mires. In Sweden nature reserves are established by county administrative boards and municipalities, supported by the Environmental Code. The land may be privately or publicly owned (Naturvardsverket, 2024).

The Figure 7 highlights the detailed areas consisting of dense forest in darker shade and which highlights a denser zone with more trees and less open space. These can be areas where trees grow very close together and humans have not significantly altered the environment. It also highlights areas with the greatest diversity of vegetation growing on their own. The other region is the grasslands, which, unlike the sense forest, have open fields and a higher concentration of humans. The green areas also include agricultural zones where seasonal agricultural practices and animal grazing occur.

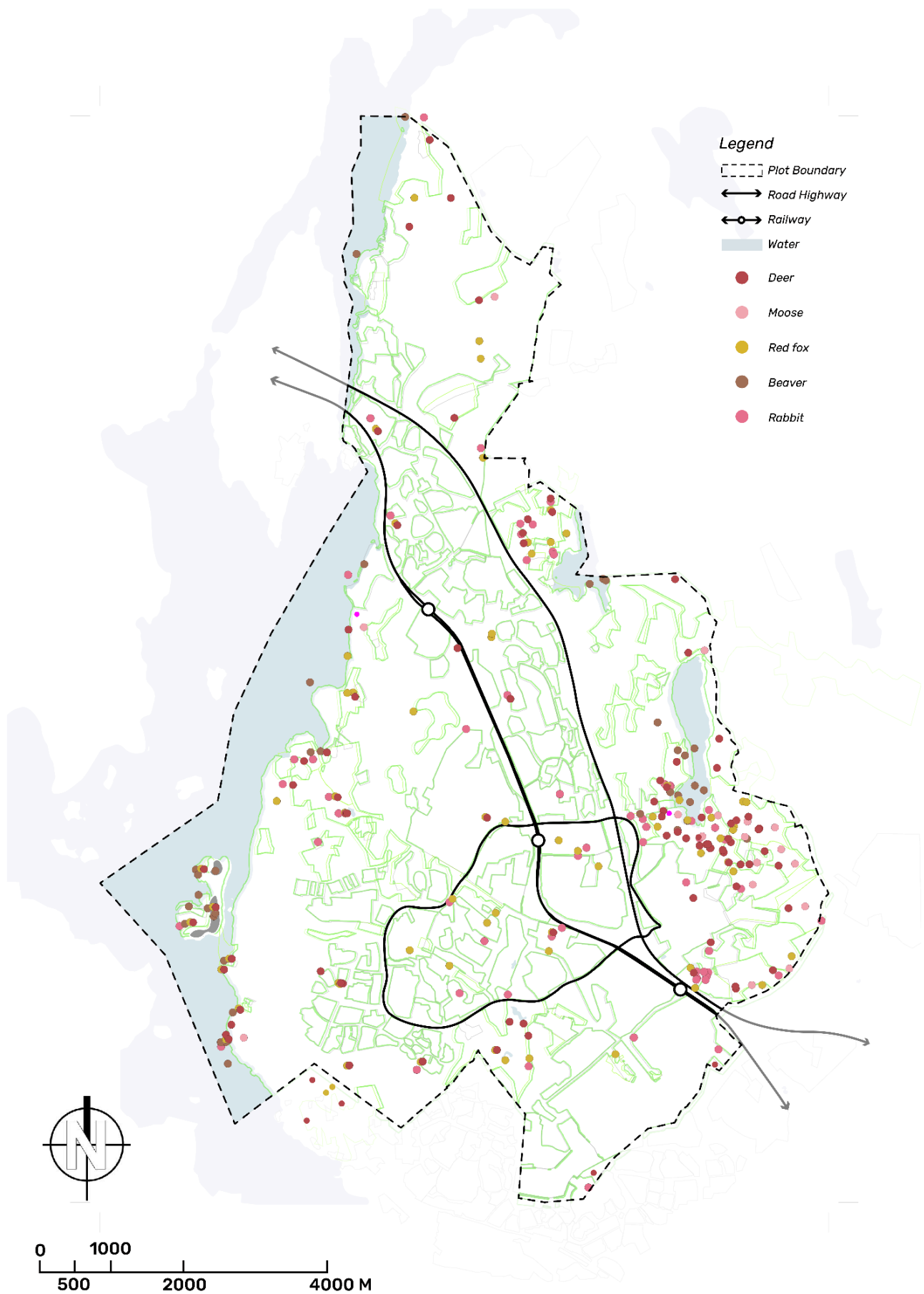


Figure 8. Animal Sightings (Authors, 2024).

7.1.2 Animal Sightings

The second map in Figure 8 illustrates the spatial distribution of animal sightings across Järfälla, based on data collected for the five selected mammal species: roe deer, moose, red fox, beaver, and hare. This visualization is the result of a comprehensive data collection process that combined scientific observations from the Global Biodiversity Information Facility (GBIF) and citizen science contributions from Artdatabanken.

The dataset, spanning from 2000 to 2024, comprises over 600 georeferenced sighting locations. These data points were processed using Geographic Information Systems (GIS) software, with each species assigned a distinct color to facilitate easy identification. The resulting layer was then integrated into the base map using Adobe Illustrator, providing a clear visual representation of species distribution patterns throughout Järfälla.

This approach allows for a detailed understanding of habitat utilization and movement patterns of the selected mammals, offering valuable insights into the interactions between wildlife and urban environments. The map serves as a crucial tool for identifying potential ecological hotspots and areas where animal activity intersects with human development, thus informing conservation strategies and urban planning decisions.

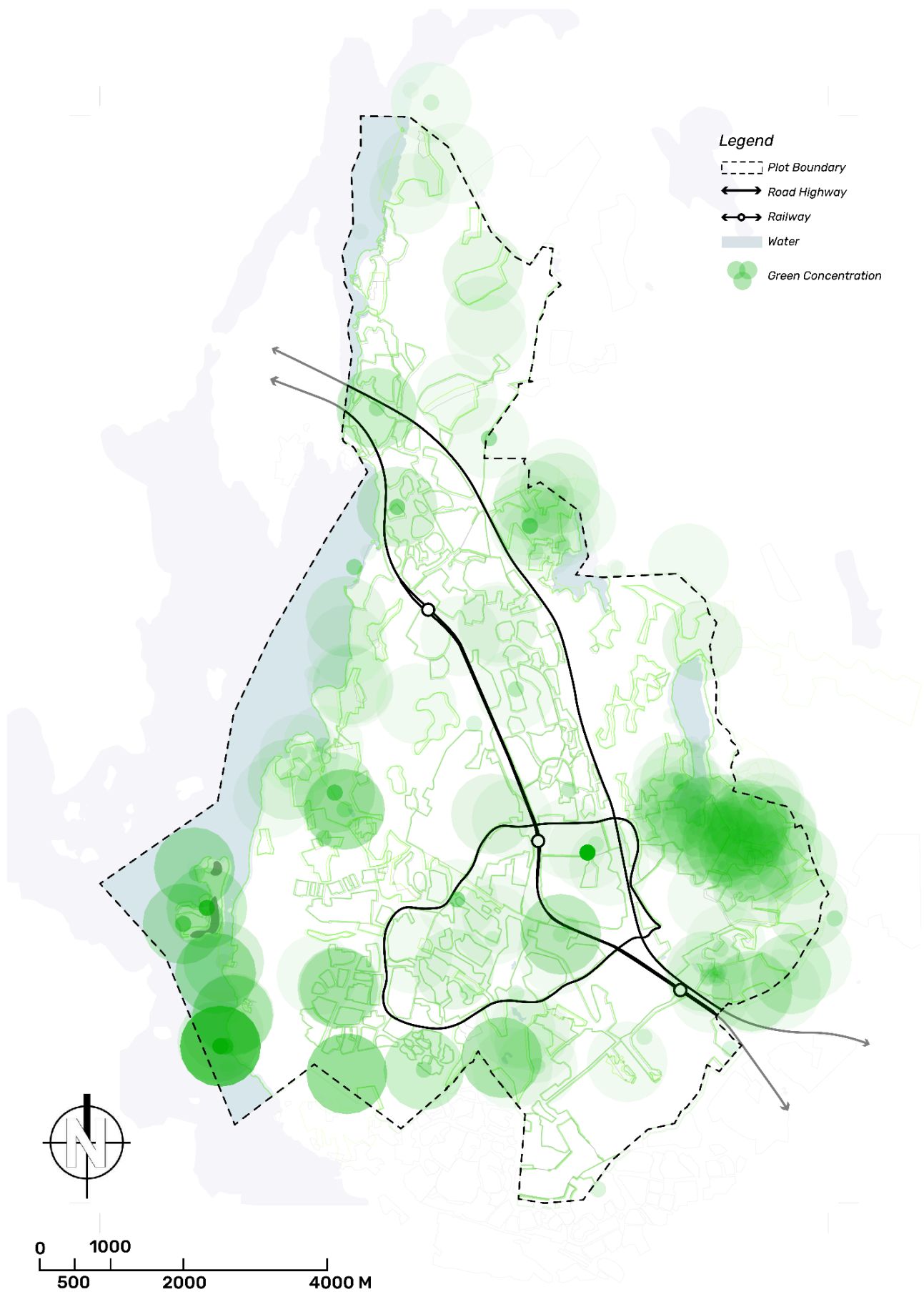


Figure 9. Sighting Buffers (Authors, 2024).

7.1.3 Sighting Buffers

The final green lifestyle map is one of the most important map of the project which shows the sensitivity of the selected 5 animals all over Järfälla. After adding the sighting locations on GIS the map in Figure 9 was created with the following steps:

1. Adding Buffers:

All animals have different ranges of senses where there is trouble around. Mostly when its a large animal, they can see and hear farther than a smaller animal. With The suggestion of a few experts, we decided on a different range of sensitivity for different animals.

Animal	Distance of Sensitivity (Metres)
Moose	500
Deer	500
Red Fox	200
Beaver	100
Rabbit	100

With the distances above, we generated buffers in GIS for each animal respectively and moved on to the next step.

2. Reducing Transperency:

To understand which areas have more prone, making the layers transparent and looking at the overlapped layers can be good solution to see the sensitivity. The priority of data was given more to GBIF data as that is the data which gives the sightings based on scientific study. With this we thought of giving the GBIF data 15% transparent and the Artdatabanken reduced to only 5%. This makes the layers very transparent but the more layers intersect with each other, the more the darkers the area gets. Thus, the more sensitivity are in this darker regions.

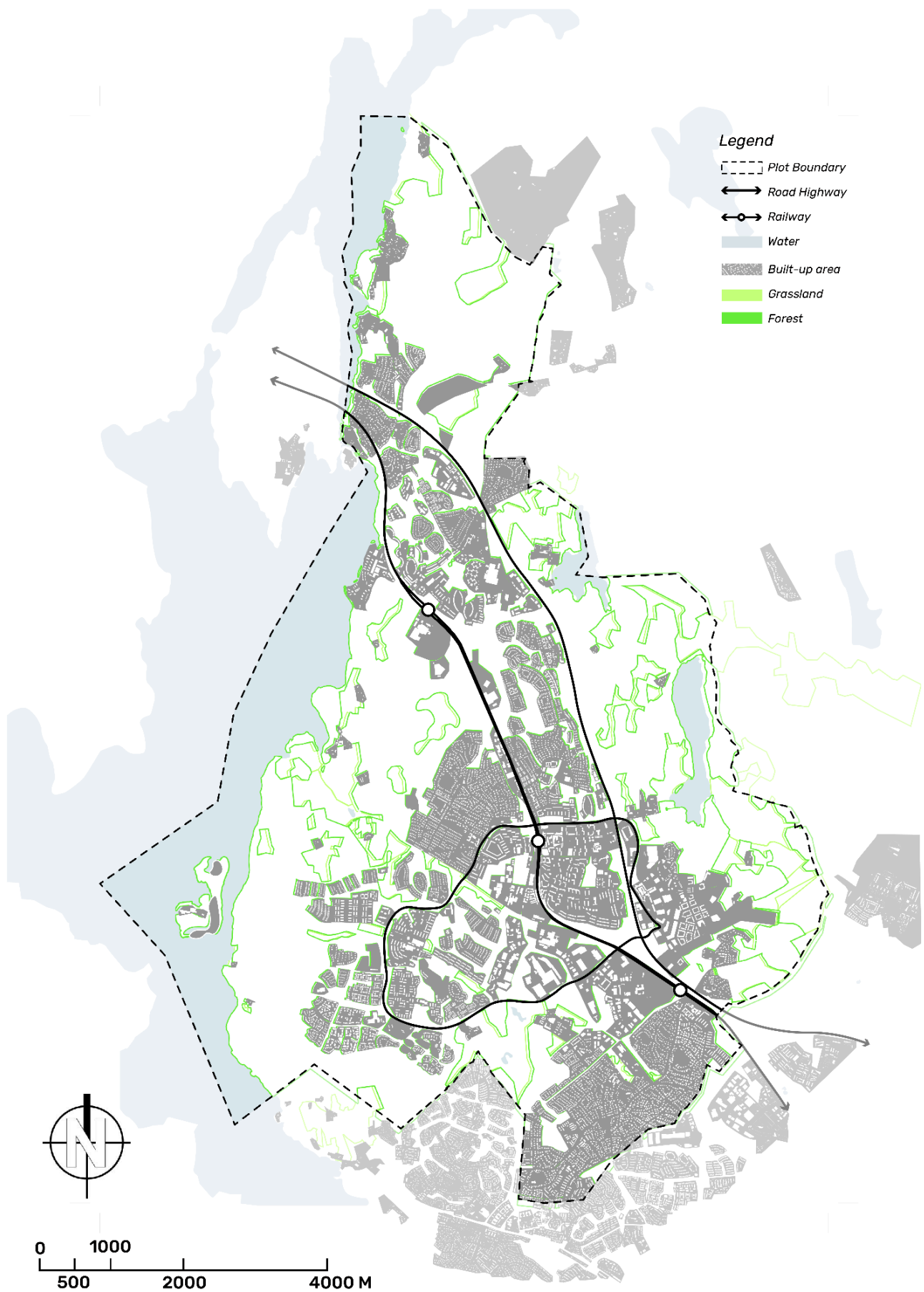


Figure 10. Grey Areas (Authors, 2024).

7.2 Grey Lifestyle Maps

Grey lifestyle maps include the built environment (e.g., buildings and traffic infrastructure), human encroachment into green areas (such as man-made paths in forests), and traffic noise pollution. Noise pollution maps used OpenStreetMap data, assigning weights on a scale of 1–10 to various road types and railway tracks, with railway and primary roads rated as the loudest and residential roads as quieter. These maps revealed the extent of human interventions in Järfälla's natural spaces.

7.2.1 Grey Areas

Figure 11 shows the distribution range of gray space in the Järfälla area, reflecting the spatial relationship between gray and green. The gray space in the figure represents the built-up area of the city, including buildings, roads and hardened paving, which is the core area of human activities in the Järfälla area except for grazing grassland. The green space is presented in the form of boundaries, consisting of forests and grasslands, and includes nature reserves such as Görvålns naturreservat.

From the mapping results, it can be observed that the trend of urban construction presents a typical "tentacle-like" expansion pattern, that is, while expanding to the periphery along the transportation network, it is constrained and squeezed by the space of nature reserves and planned green corridors. For example, the boundary between Görvålns naturreservat in the west of the region and its surrounding gray space is clear and neat, and presents different spatial characteristics from the expansion boundary of the Barkarby area in the east. According to the Järfälla 2030 planning document, nature reserves and green space networks are clearly listed as important factors restricting the development of gray space, and urban expansion will be concentrated in areas with convenient transportation but low ecological sensitivity (Järfälla Kommun, 2014). This layout plays an important role in guiding the direction of gray space, inhibiting its possibility of spreading to protected green space.

It is worth noting that the boundary of gray space forms an interface similar to the ecological contact zone when approaching the natural area, which not only reflects its spatial extensibility, but also provides opportunities for environmental restoration and ecological buffering for the gray space itself (Järfälla Kommun, 2014). By implementing intervention design in these contact areas and creating natural contact points for urban residents, it may be possible to reduce the possibility of disturbing local animal habitats due to people entering the core part of the forest. The gray space shown in the figure is not only a reflection of the pressure faced by nature in the process of Järfälla's urban development, but also a core issue of the balance between gray and green space. This dynamic balance reflects the natural space constraints received in the current expansion of urban built-up areas and reflects the urban development model.

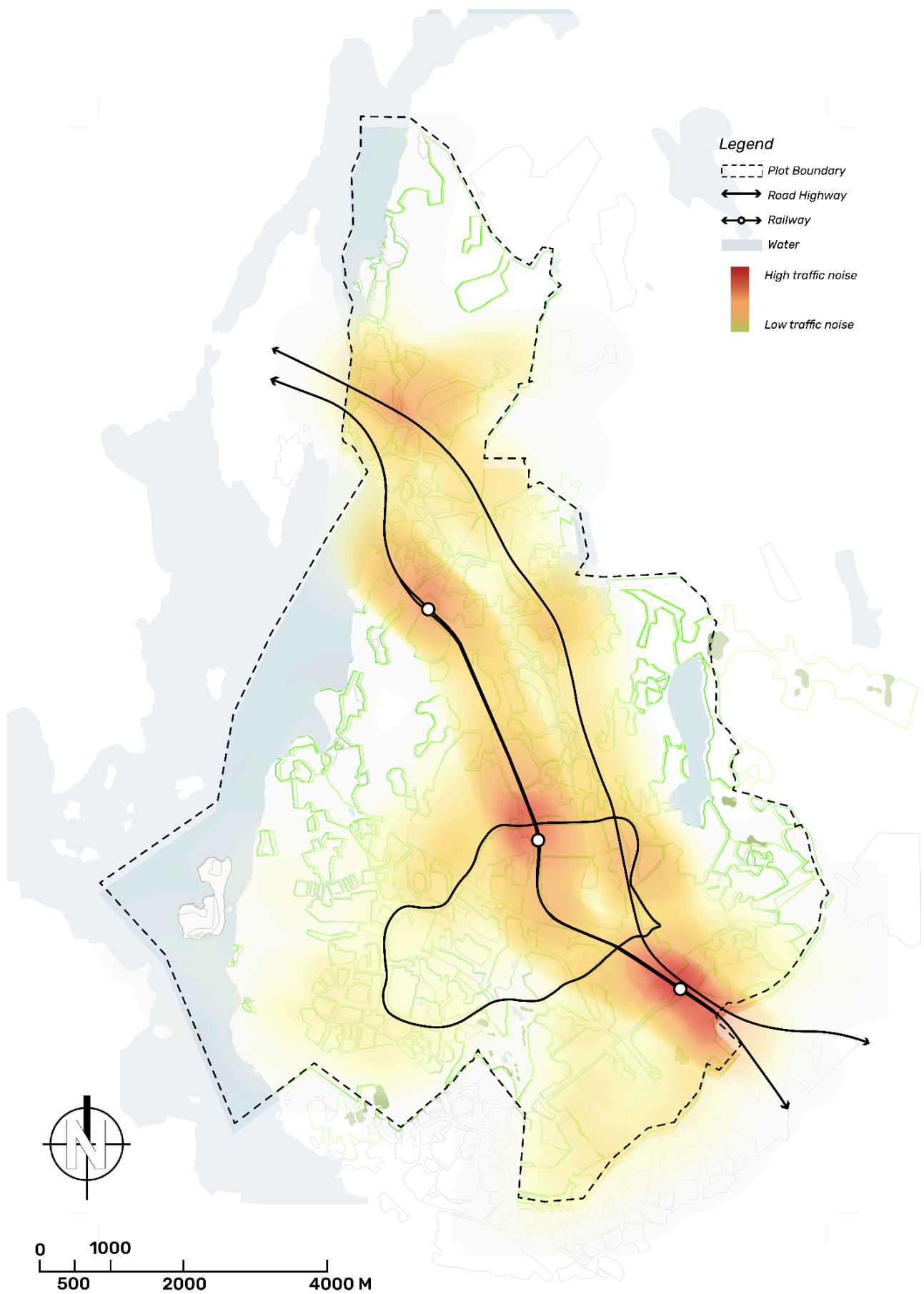


Figure 11. Noise Distribution (Authors, 2024).

7.2.2 Noise Distribution

This figure shows the distribution of noise in the Järfälla area, and the results show that the generation of this noise is strongly related to traffic activities (Figure 11). The change in color from light yellow to dark red in the figure represents the noise intensity from low to high. The main data comes from the author's field survey in Järfälla on November 8, 2024, and is collected using electronic equipment and submitted to professional software for identification and analysis to obtain decibel values to ensure accuracy.

The black lines in the figure clearly show the location of part of Stockholms Pendeltåg, part of the international highway E18, and the main commuter ring road Viksjöleden that passes through the Järfälla area, which is superimposed on the measured noise distribution pattern, indicating that traffic activities may be the main cause of noise in the area. From the distribution pattern, the high noise areas are mainly concentrated around the railway and national highway, with a clear belt distribution, especially the three traffic station areas of the railway, which are distributed radially in a small range. However, the spread of noise is mitigated and suppressed to a certain extent by the surrounding green space. For example, in the area near the western Görvälns naturreservat, the noise is significantly weakened, if it is assumed that the noise distribution of the entire loop should be uniform and radial. This reflects the importance of green space in reducing the propagation of traffic noise, but it also reminds us that the impact of noise on nearby natural areas needs to be noted, such as the obstacles to the communication of birds and other animals through sound. The strength of this buffering effect is likely to be related to the area of forest. In the smaller green space and areas close to transportation facilities, there is still a potential risk of ecological interference.

As one of the important indicators of this project, the noise distribution map intuitively shows the scope of noise impact generated by public transportation facilities in the Järfälla area and the potential interference to the surrounding environment. It can provide a scientific basis for future ecological protection planning and urban development planning, remind the authorities and relevant experts to take noise impact into consideration when constructing green space networks and transportation routes, so as to minimize interference with ecologically sensitive areas, and provide basic data support and new perspectives for exploring the balance between transportation infrastructure and ecological environment.

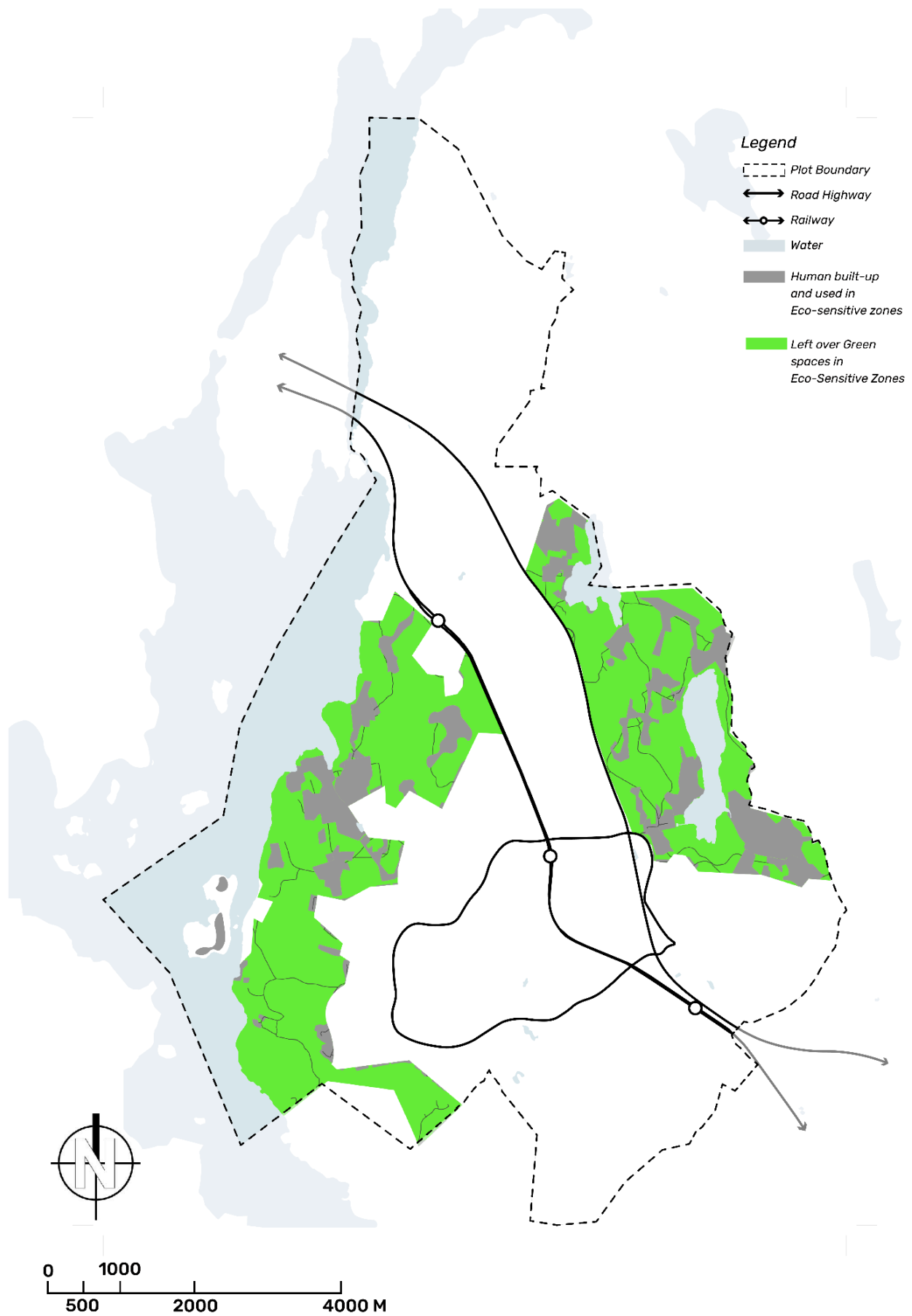


Figure 12. Human Enchroachment (Authors, 2024).

7.2.1 Human Encroachment

This map shows human intervention in the ecologically sensitive area of Järfälla (Figure 12). It summarizes and analyzes the land use pattern as an indicator, showing the distribution relationship between human construction activities and green space. The gray area in the figure represents the land used for human activities in the ecologically sensitive area, that is, artificial grassland with animal husbandry or agriculture as the main activities and some recreational activities. The green part represents the remaining green space in the ecologically sensitive area, which is mainly natural forest. The definition of the ecologically sensitive area referred to in this map is the scope of the Järfälla Nature Reserve, which is composed of Görvålns Naturreservat, Järvafältet Naturreservat and Molnsättra Naturreservat. It is the key area for identifying natural ecology and biodiversity in the region.

It can be clearly seen from the mapping results that the ecologically sensitive areas are mainly distributed in the coastal areas of Lake Mälaren in the west and the natural green areas centered on the two lakes Översjön and Säbysjön in the east. Some areas are close to the main urban transportation network. At the same time, the construction of land has caused a certain degree of segmentation of the integrity of the green space, which ultimately played a role in the identification and recognition of the ecologically sensitive areas. Ecologically sensitive areas play a key role in maintaining the diversity and richness of regional ecosystems. However, in addition to being squeezed by the external human environment, the ecologically sensitive areas of Järfälla are also disturbed by internal human farming, animal husbandry and leisure and entertainment activities, resulting in habitat fragmentation, decreased species diversity, and destruction of ecosystem structure, such as the area near Säbysjön in the east. At the same time, it must be pointed out that human hiking behavior in the sensitive area has spawned its internal road network, resulting in further segmentation of the green space. Despite this, the remaining green space represented by natural forests in the sensitive area is still closely connected in distribution, providing important habitats for animals and plants in the region, and together with the ecological corridors in the built-up area, maintaining the ecological resilience of the Järfälla region. Compared with the gray-green spatial distribution map that reflects the overall region, drawing a separate human activity and natural distribution map in the ecologically sensitive area has important significance and advantages. It can further subdivide the scope of human activities and the natural ecological core area, and more intuitively reveal the threats and pressures faced by green spaces, thereby helping the competent authorities and relevant experts to more accurately identify key ecological areas, quantify the scope of human activities invading green spaces, and thus formulate refined management strategies and related protection measures.

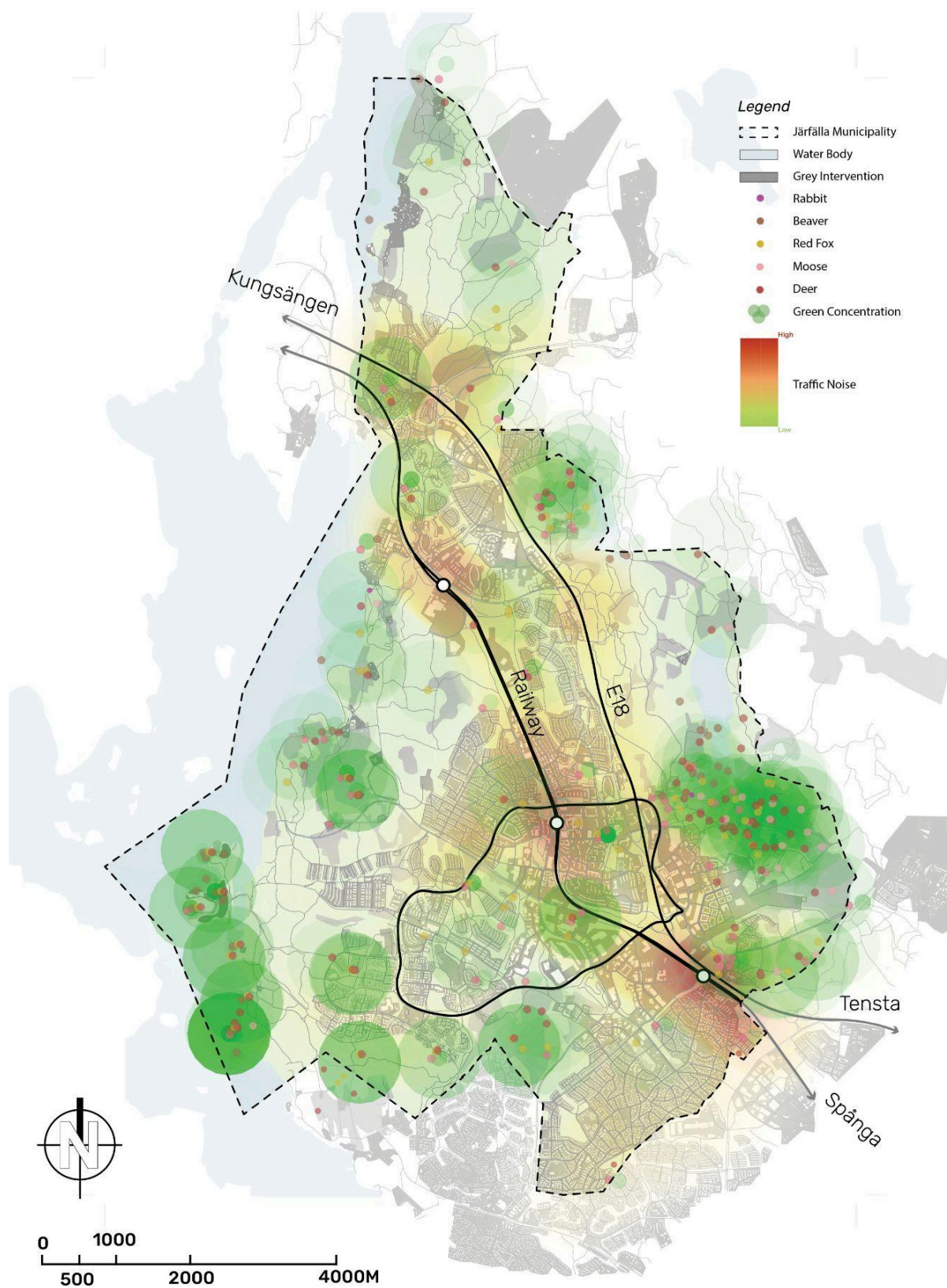


Figure 13. Overlay Map (Authors, 2024).

7.3 Overlay Map

Finally, we created an *overlay* map, synthesising green and grey lifestyle data (Figure 13). This map is a highly detailed map comprising all the characters of all previous maps. The key thing to see in this is first, where the concentrations are (darker shades of green highlighting animals sensitivity), then seeing where it overlaps the grey lifestyle areas. The sensitive areas are mostly away from built environment areas, mostly in east, west, north-east, and some in south. Within the areas, the dots of different colours will show which animals are highly sighted in that region. The intersection of these concentrations has revealed built environments encroach upon green spaces or the basic spaces of animal living.

8. Analysis & Discussion

Firstly, to talk about the data, due to the limitation factor of not getting much accurate scientific data we forfeit the maximum public data from Artdatabanken. The data had public sightings making it not a scientific strength of the study but the overall amount did give a good study. Even if the data was not scientific, getting as many animal sightings as possible makes the study more concrete. It was seen that the many points were available so to find vulnerable areas, reducing the opacity of layers of sightings on GIS can make the buffers intersect with each other. This has made the study a concrete research tool to understand with the help of common people's input.

Secondly, considering the overlay map analysis a higher number of animals are getting intersected with human interventions, the stakeholders need to see how they can make it better. For example, the east region of Järfälla where the municipality has decided to develop in increasing the population, they have planned to increase the Barkarby area more in the east, thereby increasing population. But with this animal analysis we can see that the major animal concentration is found in the region where the development is currently taking place. This comprehensive approach allows the stakeholders to identify which regions are prone to which animals are affected and by what type of development has been done. Another example is highlighting the sightings of animals within the city regions like on streets or in the parks. They seem to be coming in the grey regions many times. It is good to see the co-living but there have not been many studies published on how they must be affected or how sacred they are. An add-on for the municipality is to understand how much animal consideration has been done by them if there has been any awareness according to published reports.

Road noises mainly along the highway seem to be having a good effect on animals. Looking at the concentrations along the highways, the noises seem to be affecting animals as there are fewer concentrations along the highway. The animal sensitivity mostly starts after a certain buffer from the

roads. This indicates that the animals seemed to have been affected by the noise created by fast cars traveling on high-speed roads. After the site survey, a noise reading of an average of 62 dB/m next to the highway seems to have a higher effect on animals making them stay away from the roads. This noise stretched over the whole of Järfälla significantly reduces the area of comfortable habitat space for animals.

Policy Recommendations

Based on the six ecological identification and analysis thematic maps drawn by the GIS system in this project and the final overlay analysis map, the ecological diversity protection policy in the Järfälla area can be further optimized and formulated. First, in terms of green space distribution, relevant policies need to be introduced to strengthen the connection of ecological corridors and increase the coverage of green space to maintain a complete green ecological space network and ensure the free migration and exchange of wild animals. Fortunately, these two points are clearly pointed out in the existing Järfälla government policy (Järfälla Kommun, 2022), but there is a possibility of improvement in the precise demarcation of the core area and buffer zone within the ecologically sensitive area, considering that human activities within the current situation are relatively scattered and intensive. Secondly, the urban development boundary policy for gray space and the rewilding policy for internal white or brown land, and then actively set strict development boundaries around the urban built-up area to limit the disorderly expansion of the city, rather than simply demarcating green protection areas and passively handing over the remaining part to development behavior. The existing policy only mentions the cleaning and reuse of contaminated land, which needs to be more clearly oriented towards ecological restoration.

A case that is closely related to the urban development boundary is the UK's green belt policy, which limits the disorderly expansion of towns by demarcating strict green belt areas, and almost all forms of new development activities will be restricted, and indirectly promote the reuse of land within the urban development boundary (UK Government, 2024). The policies that can be introduced for noise distribution mainly include setting up noise barriers in key areas and restricting nighttime traffic, striving to minimize the daily impact of noise on species living in surrounding green spaces, thereby maximizing the maintenance of the original biological habits of animals. At the same time, considering the effect of green belts on reducing noise, the expansion of green space area can be taken into consideration, which will also help expand the distribution range of species habitats. A case in point is the Noise Abatement Ordinance (Lärmschutz-Verordnung, LSV) introduced by Switzerland in 1986 and updated in 2021, which clearly stipulates that noise barriers and green belts must be used to reduce the impact of traffic noise, especially in ecologically sensitive areas or areas close to nature reserves, and has legal effect (Swiss Federal Council, 1986/2021). In response to the problem of

human interference within ecologically sensitive areas, it is necessary to formulate clear development guidelines for ecologically sensitive areas, scientifically identify and divide the biological importance and species richness of ecologically sensitive areas, so as to introduce various protection measures in a targeted manner and limit the disorderly exploration of humans. Clarify the development restrictions of gray spaces in sensitive areas to prevent further land occupation, and clearly protect the natural attributes of gray spaces dominated by agricultural and pastoral grasslands in sensitive areas to ensure that these areas still perform their ecological functions normally and constitute part of the natural system, rather than being transformed into intensively used artificial land. At the same time, clear usage rules are formulated for hiking trails in sensitive areas, limiting the density and structure of roads, giving priority to the design of paths with less ecological impact, and ensuring that these roads are away from core ecological habitats.

9. Conclusion

In conclusion, the impacts of human development on wildlife habitats are significant in Järfälla by the analysis of green and grey lifestyles. For the five selected species, the built infrastructure and noise pollution heavily encroach on green areas which shows the current disruption of movement in the natural environment. Many roads, pathways, parks, and agricultural lands have been built creating a fragmented habitable space reducing ecological connectivity, and limiting movement. With the concentrations, high-density areas of animal sightings highlight critical zones that require immediate protection to maintain biodiversity.

The concentration approach, which combines animal observations with urban growth data, is an effective tool for finding ecological hotspots and places of interaction between human activity and animals. Planners and conservationists may prioritize places for protection, develop more effective wildlife corridors, and put in place targeted noise reduction methods by visualizing these crossings. Future uses of this approach could include more species, longer-term data, and seasonal fluctuations to gain a more complete knowledge of urban ecology. This would allow for the creation of adaptive management systems that balance urban growth and biodiversity protection, ensuring the long-term cohabitation of humans and wildlife in urban areas.

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