The impacts of urbanization on pollinator communities in Bergen, Norway

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Front page: Bumblebee (*B. pascuorum)* feeding on a field scabious, Bergen, Norway 2022.

Photo: Ingrid Vaksvik

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ABSTRACT

This study was conducted in Bergen, Norway in 2022, whereas I investigated the underlying factors of pollinator abundance and the abundance and richness of *Bombus* (bumblebees). I explored pollinator communities across urban, suburban, and rural sites along with associated habitat characters such as plant communities. The intention was to make a reliable report about both the present and historical status of pollinators in an urban to rural environment.

To collect a variety of pollinators, I used pan traps in blue, white and yellow color and yellow vane traps with blue windows. I found that the rural region had the highest abundance of both pollinator groups and *Bombus* individuals. Syrphidae (hoverflies) was the most abundant group, while Apocrita (wasps) had the lowest abundance. The numbers were highly variable in urban and suburban areas yet showing that both pollinators in general and bumblebees followed almost the exact same pattern across sites. The rural areas were most sufficiently sampled and exhibited the highest occurrence and richness of *Bombus*. The abundance and richness of *Bombus* was highest at the beginning of my study in late June and declined throughout the season. *B. pascuorum* was the most abundant and most occurring species and showed an affinity for rural areas. The most common species in the urban sites was *B. pratorum*.

Seven sites were compared when looking at correlations between my records and historical records. I found that the correlation between my species and the sites were explained by similarities in abundance and richness of *Bombus*, while the old associations were explained by geographical location. Only five of the 44 most abundant plant species were found in all three areas sampled, showing that plant communities had great variety overall. The rural region had the highest richness, and most flowers were purple or pink, suburban areas had the highest abundance and mainly yellow or purple flowers while the urban area has most white flowers and partially yellow. The great variety of flowering plants could potentially maintain both richness and abundance amongst pollinators. My study highlights the need for in-depth research on variables that can affect local pollinator communities, as every urbanized area is unique.

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1. INTRODUCTION

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Urbanization is the general demographic processes which drives the worldwide increase of city expansion. Habitat loss and fragmentation due to urbanization are considered some of the most devastating anthropogenic impacts to the natural environment, alongside climate change and pollution (e.g. pesticides and chemical fertilizers) (Harrison & Winfree, 2015). Biodiversity is mainly negatively affected by these alterations that are made to provide humans with transportation, housing, industry, tourism, food, and other goods. Urbanization pose a major threat to biodiversity, as it replace agricultural land and force the facilitation of a few generalist species on behalf of high species diversity (Sánchez-Bayo & Wyckhuys, 2019).

Nonetheless, urbanization can be important for native, threatened plants and animals (Dylewski et al., 2019; Ives et al., 2016). In fact, Ives et al. (2016) found that compared to non-urban land, there were more threatened species in equivalent city areas. Further they emphasized that individual plant species had the greatest distribution within cities, and that distribution of animals was represented as high for a few species and very large for some. Still, fitness and stability over time is not reflected by the mere presence of a species, although over-representation in a certain area indicates the importance of urban conservation (Ives et al., 2016). Urban areas are considered heterogenous compared to rural agricultural land and may improve living conditions for species with certain requirements (Banaszak-Cibicka, Ratyńska and Dylewski, 2016). For instance, vulnerable species can greatly benefit from cities where their food supplies are kept viable throughout the year (Ives et al., 2016). High heterogeneity should improve the richness of plants and create specific value to bees that utilize the city as a refuge, as monocultures and other agriculture practices intensify. Although, it is argued that heterogeneity in both suburban and urban environments can affect pollinators differently due to unpredictable changes made by humans (Banaszak-Cibicka, Ratyńska and Dylewski, 2016; Tarigan, 2019). According to a study by Verboven et al. (2014), bees and hoverflies have higher abundance and richness in rural semi-natural areas, than rural areas with high amounts of agriculture and urban areas. For example, the abundance of pollinator species decreases when semi-natural land is transitioned into agricultural land. When semi-natural land is replaced by urban land, hoverfly abundance is reduced but some bee species may in fact do better in an urban environment than in semi-natural and rural-agricultural land (Verboven et al., 2014). Another study by Johansen et al. (Johansen et al., 2019) show that most pollinators benefit from heterogeneous, semi-natural habitats and hay-meadows in low-intensity farming systems. This information could have the potential to reduce the loss of pollinators and overall biodiversity in grasslands.

The growing alteration of natural land emphasizes the significance of pollinators (Harrison & Winfree, 2015). In addition to pollination services they play important roles in nutrient cycling, detrivory and herbivory, as well as nutrition for mammals, amphibians, birds and other animals on higher trophic levels (Hallmann et al., 2017). Pollinators face multiple challenges in urban settings, such as; pesticides in urban lawns and gardens, the introduction of non-native species, increased levels of managed bees for beekeeping, light pollution (may result in exhaustion, predation and burning), general pollution and higher levels of nitrogen in soil – drivers of urban warming (Harrison and Winfree, 2015; Camacho, Barragán and Espinosa, 2021). Also, honeybees and bumblebees display negative responses to pollutants in the flowers they feed on. The plants accumulate pollutants from the soil in nectar and pollen, and this can change pollinator behavior patterns when searching for rewards or even change their fitness by reduced longevity (Harrison & Winfree, 2015). Concerning chemical pollutants, many have already been banned both in Norway and the EU. One such chemical is the insecticides thiacloprid, which has reproductive and metabolic consequences for humans and may leave residues in rotational crops (EFSA et al., 2019).

Plant-pollinator interactions are also disrupted by warming, which can cause major shifts in potential interaction partners and species overlap (Harrison & Winfree, 2015). A phenomenon called urban warming is increasing temperatures in cities even further. This issue is influenced by industrial activity and the climate in sub-urban areas. Rising temperatures are also caused by increased solar radiation from the conversion of natural to artificial vegetation (known as soil sealing) (Venter et al., 2020). The effects of this may modify a species' physiological tolerance, and disturb plant-pollinator interactions (Harrison & Winfree, 2015). According to NSG Williams, Hahs & Vesk (2014), heating has a direct impact on native plants, causing non-thermophilic species to be filtered out and replaced with non-native plants adapted to warmer climates. Similar procedures may also affect bees. As heating speeds up their metabolism, adult spring-emerging bees experience more weight loss than bees overwintering as larva and emerging in summer. Spring-emerging bees also suffers from lack of feeding opportunities and habitat loss (Harrison & Winfree, 2015). Ultimately, climate warming has negative outcomes for both urban ecology, economy and social well-being (Venter et al., 2020).

It is undebated that habitat loss is reducing biodiversity, but there is still disparity whether fragmentation has any effect on species richness (Rybicki et al., 2020). Habitat fragmentation is a result of habitat loss and can reduce connectivity between fragments. Although extensive habitat loss has solely detrimental effects to biodiversity, fragmentation offers benefits to polylectic (generalist) and edge species whilst specialist species (monolectic and oligolectic) are likely to suffer from it. Fragmentation increase functional connectedness, a variety of habitat types, the endurance of predator-prey relationships, and less intra- and interspecific rivalry (Bogusch et al., 2020; Rybicki et al., 2020).

Urbanization and the loss of natural habitats (e.g. requirements for larvae) also affects specialist species more than generalist (Bates et al., 2011). For instance, two important factors affect bees by habitat degradation; nesting place and food availability (e.g. plant height, abundance and cover of plants pollinated by insects) (Bogusch et al., 2020; Dylewski et al., 2019). When considering the generalist/ specialist interactions of bees and plants, the pollen is gathered from various plants by polylectic bees whereas oligolectic bees mostly acquire pollen from a few related species (single genus or family). Oligolectic bees depend on both habitat and pollen source, typically using separate parts of heterogenous habitats for pollen collection and nesting. Polylectic bees prioritize the local availability of pollen and nectar, making them vulnerable to the loss of flowering plants. However, most flowering plants are generalists and do not depend on specific pollinators or they may self-pollinate (Bates et al., 2011; Bogusch et al., 2020).

The bumblebee (*Bombus*) is a key stone genus and amongst the most efficient and important pollinators. Therefore, I made *Bombus* the focus of this study. As generalists, they thrive in many different habitats (Glaum et.al, 2017). Most European bumblebees are polylectic and can exploit various foraging resources, which implies that a decline of specific flowering plants should not have a profound impact on *Bombus* populations (Bogusch, Bláhová and Horák, 2020; Glaum et.al). Nevertheless, they possess social behavior which makes them reliant on pollen and nectar-rich resources in approximate location to their nests (Bogusch, Bláhová and Horák, 2020). Their eusocial behavior means living in colonies where the members have divergent roles and possess distinct patterns of movement and behavior (Glaum et.al, 2017). For reproduction to occur, bumblebee colonies require a constant supply of pollen and nectar from early spring until late summer. Nevertheless, foraging performance can be affected by abiotic factors such as wind, ambient temperature, and humidity. Restricted access to suitable nesting sites can also affect the colony, such as absence of deserted tree stumps, tall grass, or bare ground. These restrictions are prevalent in cities, as impermeable surfaces prevent bumblebees from building ground nests (Vaidya et al., 2018).

From a 2019 study of 60 European bumblebee species and sub species, 46 % had declined in the last 136 years and 24 % of these were threatened. One of these species declined by > 80 % as a direct result of habitat fragmentation and the use of chemical fertilizers as substitution for red clover. Global warming restricts the population density and range of bumblebees, as they prefer cold habitats (Sánchez-Bayo & Wyckhuys, 2019). This could be bad news for Norwegian bumblebees. Nevertheless, several decades of *Bombus* investigation and registration in Norway may be of use in this matter. Some major pollinator mapping projects were conducted in the last decade, such as the government's national pollinator strategy (Landbruks- og matdepartementet, 2020) and through the Norwegian Biodiversity Information Centre (Artsdatabanken). For instance, the latter contains records of bumblebees dating all the way back to the year 1800, with increased recordings from 1869 onwards. The 1950's showed a positive spike in recorded bumblebees, but numbers decline from the 60's until the preparation of a Nature Index for Norway in 2009 (Totland et al., 2013; Artsdatabanken, 2021). The emphasis in the continuing surveillance of pollinators has been on bumblebees and butterflies (Åström et al., 2021). Large sampling efforts of bumblebees were performed by a scientist named Astrid Løken between the 50's and the 80's, and some of this data is used in my thesis.

Hoverflies (Syrphidae) are also important for this study. In addition to providing pollination services, they predate on phytophagus pest insects such as trips, aphids, leafhoppers, and caterpillars. Syrphids are receiving more attention now that bees are declining (both wild and domesticated), as bees are more traditionally known for crop pollination than hoverflies (Glaum, 2017; Rader et al., 2020). Another interesting group of pollinators in this study are wasps. They also pollinate crops and acts as biocontrol of crop pests if there is a match between the preferred flower phenology and the pest eggs of choice (Rader et al., 2020).

Habitat fragmentation, global warming, chemical fertilizers and so forth will also impose negative effects on the ecosystem functions that pollinators provide regarding food production (e.g. food, materials), plants (e.g. primary production, soil accumulation) and fodder for related animals (Bates et al., 2011; Silva et al., 2021; Venter et al., 2020; Wenzel et al., 2020; IPBES, 2016). Urban food production is expanding, and a substantial amount of people earn their livelihood from urban agriculture (Hallman 2017, Wenzel 2020; Sivakoff, Prajzner and Gardiner, 2018). The extent of urban agriculture is larger in developing countries, providing food security and additional nutrition for private households (Bates et al., 2011). Pollinator importance is receiving increased attention, acknowledging that about 70-75 % of global crop species and 80 % - 87% of wild plant pollination requires insect pollination (Hallmann et al., 2017; Silva et al., 2021; Wenzel et al., 2020). In fact, animal pollination is responsible for approximately 35 % of agricultural food production worldwide (Silva et al., 2021). About 90 % of all flowering plants are dependent on pollination by animals (mostly insects) to some extent. Insects are solely responsible for pollination in northern ecosystems, and approximately 80 % of Norway's wild plant species have seeds that are favored by pollinating insects (Landbruks- og matdepartementet, 2020; Artsdatabanken, 2021).

The diversity and abundance of pollinators in agroecosystems is expected to improve by creating mosaic structured landscapes that are well managed, thereby reinforcing crop production. Provision of floral resources and nesting sites are also regarded as important for local pollinator communities (Banaszak-Cibicka et al., 2016). Regardless of these insights, several studies reports that insect biodiversity is declining and important pollinators in the Hymenoptera taxa (e.g., bees and bumblebees) are most affected (Bates et al., 2011; Hallmann et al., 2017; Potts et al., 2010; Sánchez-Bayo & Wyckhuys, 2019). Between 1990 and 2011 alone, the number of European bees severely decreased, a tendency that was also observed in moths and butterflies (Hallmann et al., 2017).

Cities are important for the preservation of biodiversity, especially when considering the development and administration of urban green spaces (UGS) (M. F. J. Aronson et al., 2017). According to Kowarik (2011), the heterogeneity of UGS increases the variety of plant species, and the presence of diverse resources across different types of green spaces explains the existence of different pollinator communities. Urban agroecosystems and vacant lots (to some extent) tend to have a wider variety of floral resources than other urban green space (Sivakoff et al., 2018). Specialized pollinator species that are rare in urban environments are particularly vulnerable when introduced to a single area of green space, as they cannot exploit all habitats within this setting (Lepczyk et al., 2017). Further, Nielsen et al. (2014) claims that habitat variability in green spaces enhances the species diversity of many taxa.

To maximize ecological functioning in urban environments, we must consider how networks of various types of green space types are associated (Lepczyk et al., 2017). UGS management is subject to a complex assortment of interacting social, cultural, and economic factors, including governance, economics, social networks, multiple stakeholders, individual preferences, and social constraints. Emphasis on research and better management strategies is needed to balance human demands and perceptions while conserving biological processes and improving urban biodiversity. We need to identify major challenges in managing biodiversity of UGS and other important topics that require further investigation (Aronson et al., 2017; Venter, Krog and Barton, 2020).

In the future, more sustainable cities will likely put higher pressure on green areas as population density increases and travel distances are reduced (Russo & Cirella, 2018; Venter et al., 2020). Although preventing urban sprawl saves space for nature, countryside, husbandry, and recreation, it will also intensify urban activity. To counter this development, greenery elements such as high quality and sufficient UGS is needed (Russo & Cirella, 2018). The positive spillover effects from the conservation of green areas and pollinators have shown to improve air quality, climate regulation, hydrology, physical and mental health, creating green jobs and increasing the value of aesthetics, education and natural history (Bates et al., 2011; Dushkova et al., 2021; D. M. Hall et al., 2017). The non-material benefits are formally called cultural ecosystem services (CES), and can be used to clarify the societal value of green space (Dushkova et al., 2021).

The overall biodiversity in cities depends on green spaces that are environmentally heterogeneric. Their size, quantity and quality are important to maintain a diversity of organisms (Aronson et al., 2017; Cardoso & Gonçalves, 2018; Dylewski et al., 2019; Lepczyk et al., 2017). Urban landscapes cover a wide range of land types, from urban wasteland to industrial areas with fragmented and impervious surfaces - including buildings, car parks and roads. These landscapes also consist of green infrastructure (GI) such as street trees, peri-urban forest (forest ecotones), and alternative green space. The latter may include nature reserves, allotments, parks, private and botanical gardens, cemeteries, green roofs, roadside verges, pavements, and nonetheless; semi-natural habitats such as flower meadows and all-natural patches of native vegetation (Ahrné et al., 2009; M. F. Aronson et al., 2017; Baldock et al., 2019; Zajdel et al., 2019).

My contribution towards a more pollinator friendly city is a project that explores the effect of urban green areas on pollinator abundance and richness. To address these matters, I conducted an experiment across gradients of urban and sub-urban areas in Bergen. Several types of green space acted as main predictors, along secondary predictors such as time/ month of pollinator sampling, plant communities and potential effects of pollinator traps. Other factors of local variation were also considered, such as nest-building opportunities, sun exposure, closeness to nearby sites and possible predation pressure but also weather conditions (to some extent). Pollinator assemblages were the main response variable and plant communities the secondary response variable, as plants are affected by the same predictor variables as pollinators.

I used passive traps to collect pollinators throughout the summer season of 2022 and sorted the samples into bumblebees, honeybees, solitary bees, hoverflies, and wasps. Bumblebees (*Bombus*) and honeybees (*Apis mellifera*) were identified to other taxonomic levels and quantified, while the other taxa were counted and identified to different taxonomic levels; hoverflies to family level (Syrphidae), wasps as suborder (Apocrita) and solitary bees as clade (Antophila). Data from all samples was imported into excel and visualized in R Studio.

In this project I have three hypotheses:

1. Pollinators are less abundant in city center sites, due to less abundance and richness of plants and less green space than in suburban and rural sites.

2. The richness and abundance of *Bombus* will rise with increasing distance from the city center. Suburban and rural areas are more heterogeneous, have more green space and more resources for bumblebees than urban areas. This provides increased access to rich and abundant communities of flowering plants, nesting availabilities, and mating opportunities, not to mention less human induced disturbance and less restrictions between sites.

3. The overall richness of *Bombus* has declined since Astrid Løken's bumblebee sampling between 1950 and 1978. There has been a rapid increase of urbanization in the last 70 years, with detrimental effects to *Bombus* communities.

I will also investigate possible effects of plant-pollinator interactions. This is based upon the presumption that plant abundance and richness of blooming plants is higher in June/ July than August/ September and therefore *Bombus* richness and abundance is higher in June and July, along with abundance of other pollinators (I did not examine their richness). I believe that city center sites may have higher plant diversity (number and evenness of distribution) than other sites, thus more *Bombus* specialists. Urban green space such as parks and public gardens may contain more exotic plants than sub-urban and rural sites, simply because of aesthetic preference and limited restrictions. There may also be a higher tendency to keep exotic plants in private gardens in cities vs. rural areas. I assume that aesthetic appearance and limited green space might outweigh the need and interest of keeping edible and/ or native plants. Other aspects such as the lack of knowledge about beneficial plants to pollinators and humans may also cause city residents and city planners to use exotic plants to a higher degree than non-urban residents.

For future studies it would be interesting to look more closely at the effects of vegetation, nesting opportunities, weather, temperature, and wind speed – as well as identifying all the pollinator groups to species level. This could make more accurate estimates concerning patterns of pollinator communities at different levels of urbanization.

1. MATERIALS AND METHODS:

2.1 Study site description

Overview

I collected pollinators and plants in Bergen and surrounding areas during the summer of 2022. I also sampled pollinators in 2021, but for a shorter period and in more urban areas than 2022. In addition, I examined historical data from Astrid Løken's sampling of bumblebees in Bergen and surrounding area from 1950 to 1978.

Bergen is the second largest city in Norway and has roughly 290.000 citizens (Statistisk sentralbyrå, 2023). The city is located in a region on the west-coast of Norway that consists of islands and mountains from > 400 MASL along the coast to > 1000 MASL inland (Hjelle et al., 2015). This includes 16.065 acres of operative agricultural land (within city limits), in addition to 17.300 da. greens and parks governed by the municipality - whereas public parks cover 1.800 da. Approximately 13.000 sq. meters of rose beds and an equal amount of summer flowers are also managed by the municipality (Bergen kommune, 2022). Topography, soil, and vegetation have various effects on the natural vegetation in Bergen and near-city areas. Deciduous heat-demanding trees coexist with conifer boreal trees, while the cultural landscape is dominated by meadows, heathland, pastures and orchards (Hjelle et al., 2015). The city is situated in a valley between mountains that are 300-600 m high and stretches about 15 km from north to south.

Climate

Oceanic and temperate weather prevails, annually generating 2250 mm precipitation on an average of 235 days (one of the highest rates in Europe). The monthly mean temperature ranges from 1.5 °C in January to 14.5 in July (Parding et al., 2016). The local weather conditions are strongly affected by a variability of storm frequency, as well as surrounding mountains that form clouds and promotes precipitation (Parding et al., 2016).

Study sites and sampling periods

During summer 2022 I had six sampling periods with 12 collections, divided into three sets of collections: June/July, July/August, August/ September. A total of 15 sites were selected to fit three types of areas including urban, sub-urban and rural areas. The sites were mainly chosen on assumptions that the local abundance and richness of plants were enough to cater for a diversity of pollinator communities. One exception was Nordnesparken, chosen on the assumption that it would demonstrate low pollinator richness and abundance due to low floral resources. Nevertheless, the data collection aim was to find locations containing similar types of flowering vegetation, with a mixture of local and exotic plants. Each area included five sites, starting with the rural ones: Liland, Espegrend, Slettevollen, Rambjørga, Tennebekk. The suburban sites were Storetveit, Svartediket, Simonsviken, Hasteinarparken and Sølvberget. Finally, the sites assigned to the urban area were Christieparken, Musehagen, Nordnes, Tippetue and Mulen. The most adjacent of these sites were Mulen and Tippetue, with roughly 1 km distance in between them. Seven of my sites had the same or roughly the same location as seven of the sites sampled by Astrid Løken (Figure 1 and Table 1).

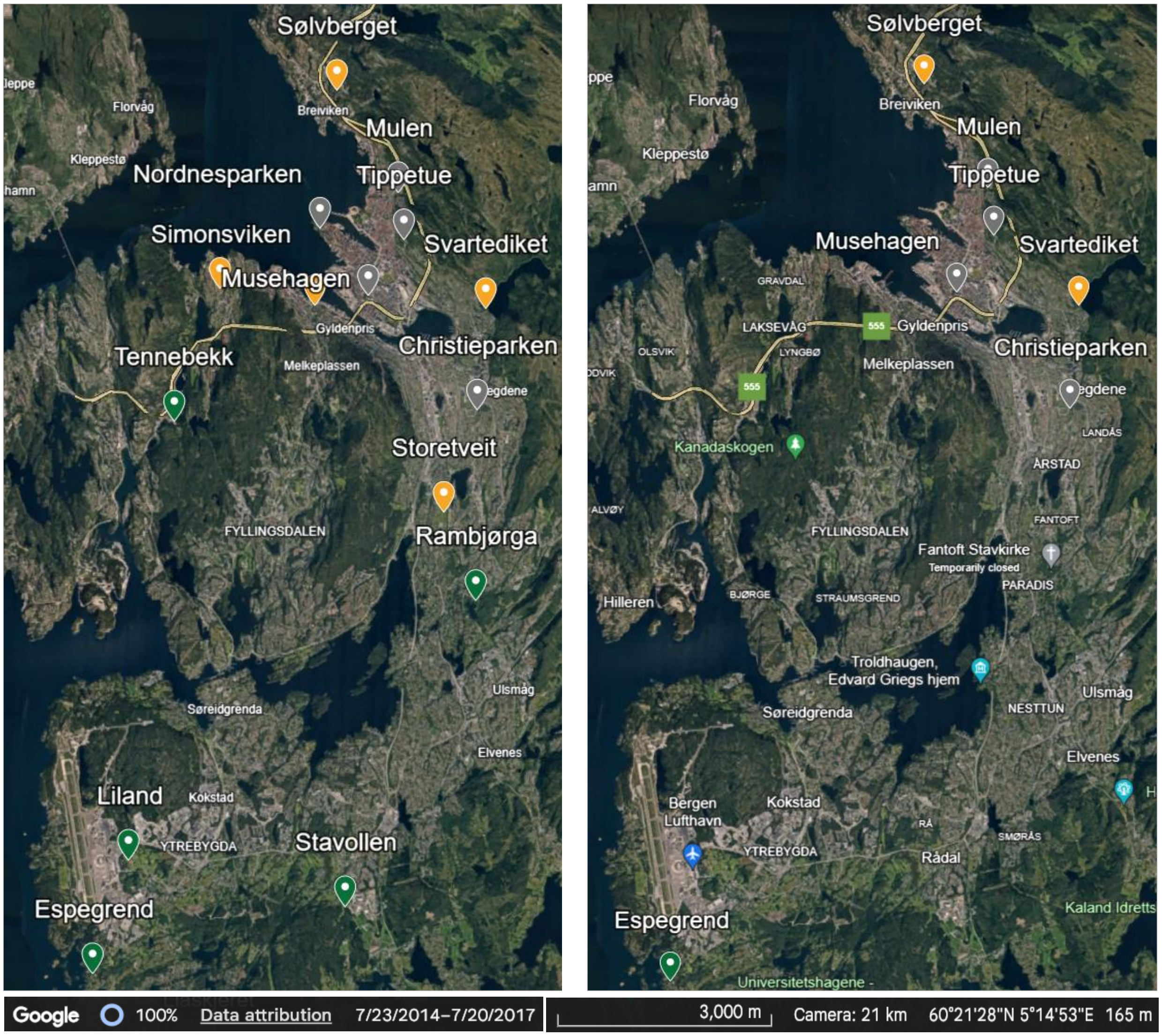

Figure 1: Pins on the left map representing my 15 sites divided into areas of urbanization in Bergen, Norway (2022). Pins on the right map representing the seven sites that have been sampled by both me and Løken, divided into urbanization areas. The sites are differentiated by color; rural in green, suburban in yellow and urban in grey (Google, 2023; Vaksvik, 2023).

I also sampled pollinators for four sampling days in primo July 2021, collecting them in seven different sites close to Bergen city center: Svartediket, Store Lungegårdsvann, Munkebotn, Langevatnet, Nygårdsparken, Krohnegården and Damsgård hovedgård (**Figure 2.** More information: Appendix C, Tab. 8 and Fig. 19).

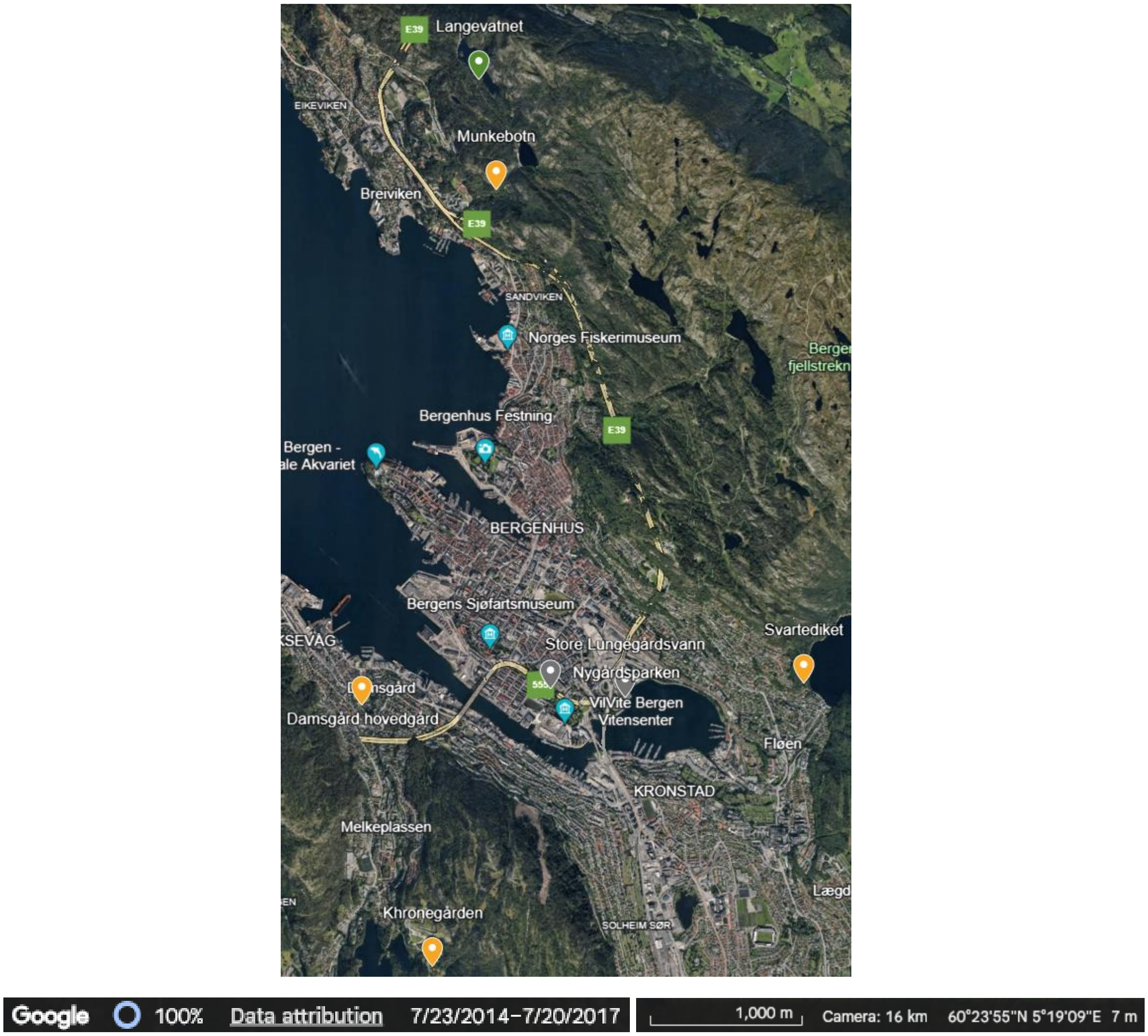

Figure 2: Pins representing the seven sites sampled in 2021, divided into areas of urbanization in Bergen, Norway. Only the blue traps are represented here, as the yellow traps did not catch more than one Bombus individual.

Table 1: Prominent features of my 15 sites in Bergen, Norway (2022). Urban sites have more defined boundaries than suburban and rural sites, and most of the latter two areas were measured to ~150 da. Ecotone refers to the area betweena a forest, mountain or hill and a residential area, parking lot and/ or road (Universitetet i Bergen, 2023; Bergen kommune, 2023a; Bergen kommune, 2023b; Bergenskart, 2023).

Site	Area	Prominent feature	Dekares	Km. to next site
Espegrend	rural	Forest and hiking area	~150	2,4
Liland	rural	Vacant agriculture land	~150	4,3
Rambjorga	rural	Protected landscape area	~150	1,8
Stavollen	rural	Vacant agriculture land	~150	4,3
Tennebekk	rural	Ecotone, no buildings	~150	2,7
Hasteinarparken	suburban	Suburban park	~30	1,1
Simonsviken	suburban	Industrial area	~30	1,9
Solvberget	suburban	Residential area	~150	2,3
Storetveit	suburban	Cultivated recreation land	150	1,8
Svartediket	suburban	Ecotone, residential area	~150	2,0
Christieparken	urban	Urban park	~60	2,0
Mulen	urban	Ecotone, residential area	~150	0,9
Musehagen	urban	Urban garden	9	1,1
Nordnesparken	urban	Urban park	32,7	1,6
Tippetue	urban	Forest and hiking area	~150	0,9

The sites that were assigned to the urban area were similar in terms of relative proximity to the city center, a mixture of native and exotic plants, high heterogeneity of habitats, vast expanse of impermeable surfaces such as pavements and buildings, few green corridors, and high levels of human related disturbance (pedestrians, vehicles, pets, housing, industry, air pollution, light pollution etc.). The suburban sites had the same characteristics as the urban ones, but they were less prominent in terms of human related disturbance, pollution, exotic plant species and impermeable surfaces. The rural sites were much less affected by all these characteristics than the other two areas.

Each of my sites were carefully examined before sampling, first using google maps to avoid less than 2 km distance between sites. These considerations should exclude any other major forces of influence between sites, apart from habitat distortion and gradient of urbanization. However, some sites could not satisfy these terms due to a lack of ideal habitats for my purpose. E.g., sites inside and near the city center were located closer than others. All sites were positioned within an 18-kilometer zone from north to south/ southwest. Finally, the sites were mapped using GPS coordinates.

Urbanization

The level of human disturbance in and around Bergen city was visualized by a GIS map showing which areas were most urbanized (**Figure 3**). A satellite image of Bergen was used as the base map, while additional layers displayed all roads, densely populated areas, buildings (schools, hospital, shopping malls e.g.) and vegetation types such as agricultural land. As this was a multiple criteria-evaluation (MCE), I used weighted overlay with a scale from 1-9. The optimal number for population density and roads were 1 (1 = 0 % = no roads within 250 meter and distance and 0 % population density), while the most desirable number for buildings were 9 (or 0 % surface covered). However, the weighing was set to 15 % for population density, 25 % for distance from roads and 60 % for buildings. The map revealed higher levels of disturbance in Bergen city centre, around large buildings, and around infrastructures in suburban and rural areas (**Figure 3**).

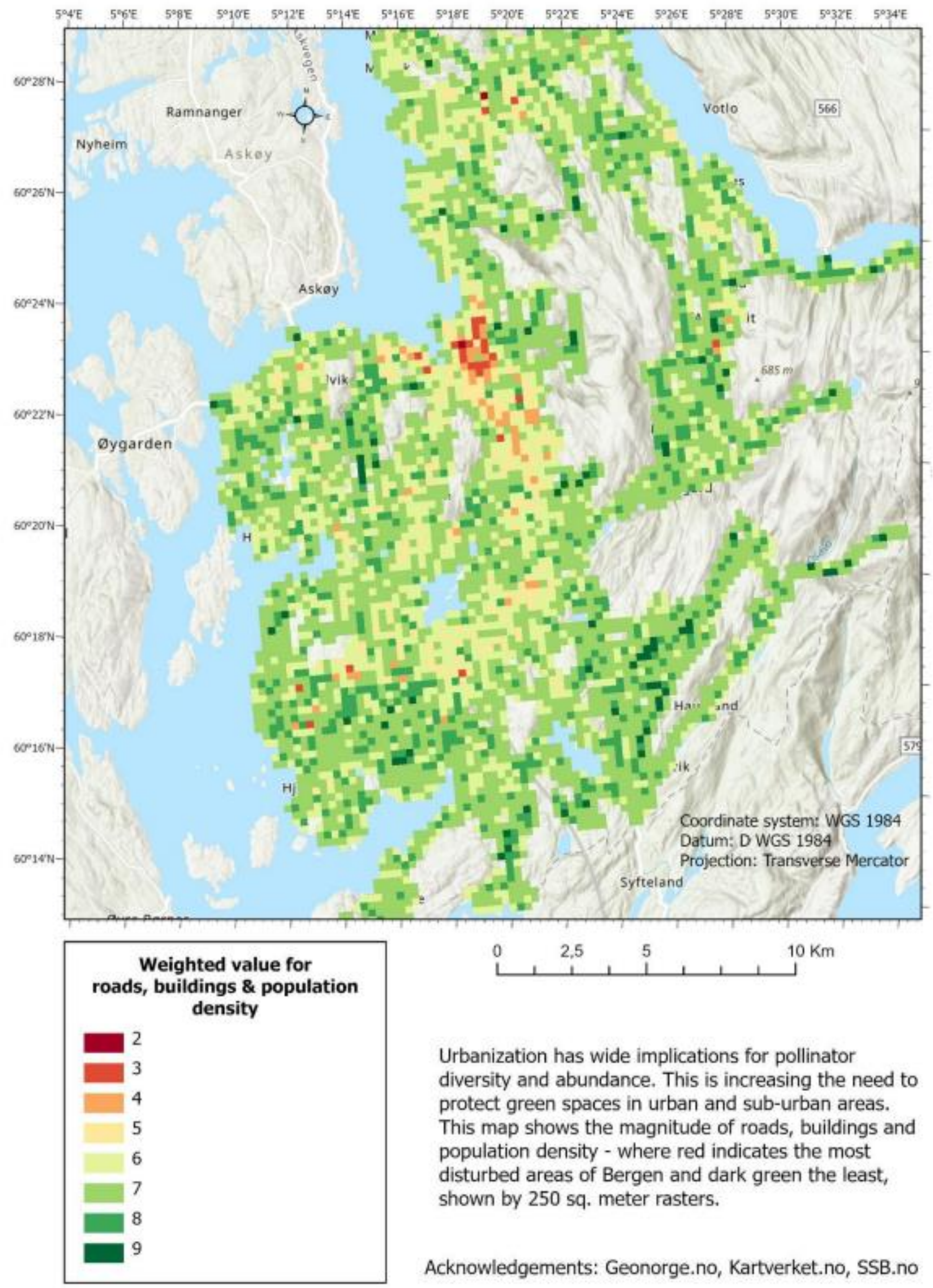

Figure 3: Map displaying human made impact on Bergen and surrounding area (2022). Red to orange- and peach-colored (2-4) squares likely indicates "large buildings" and dark green "no buildings", as "population" and "roads" were low weighted in comparison. Light yellow; and light, green-colored pixels (5-6) may imply "Bybane", highways, medium population density and surface covered/ buildings. Rural areas have lower population density, less roads, and less space demanding roads – so green (7-9) may simply imply agricultural land (buildings would be ~red) and no other human disturbance of significance (Hagen et.al, 2003; Kartkatalogen, 2022; Kartverket, 2022a; Kartverket, 2022b; Statistisk sentralbyrå, 2022; Vaksvik, 2022).

2.2. Data collection

Pollinator sampling

Most studies are using active trapping with hand netting to collect pollinators and/ or a combination of different passive traps. However, the sampling of bees across extensive geographical regions is most efficient using pan traps (Bates et al., 2011) (although not optimal for all bees or hoverflies), while vane traps are designed to mainly catch bumblebees. I mounted one vane trap per. site and three pan traps per. site, sixty traps in total. Bees and hoverflies are highly influenced by color (Bates et al., 2011) and although yellow is regarded as the best color to catch bees, there may be preference variations (Falk, 2015). To catch as many flying pollinators as possible I used traps colored white, bright blue and bright yellow (Bates et al., 2011). The pan traps were sprayed with Sparvar fluorescent colors, one color for each of the three traps. To increase access for flying pollinators and restrict interference by ground dwelling animals and vegetation, the traps were mounted approximately 50 cm above ground. Each trap was attached to the arms of a crux mounted on a pole, and the pole was positioned as close to flowering plants as possible. I also positioned them in a sunny site, expecting to maximize the catch. The vane traps had a yellow, pre-colored container with four perpendicular blue windows on top. These traps were attached to branches of trees or woody shrubs, so that the bottle had a height of roughly 1.60 meters above ground. This setup naturally kept the traps in shade or half shade.

Water was added to each trap with an unscented and colorless soap in a 1:10 dilution, to break water surface tension and efficiently euthanize specimens. Vane traps had about 250 ml of dilution and pan traps had about 80 ml dilution, equivalent to roughly ¼ the height of a vane trap (covering about 5 cm depth of the bottle) and ¼ of the pan trap (covering about 1 cm depth of the dish). More dilution was added to pan traps when the forecast predicted dry and warm periods, and the opposite action was enforced when expecting heavy precipitation. Too much rain can turn the trap over or wash out the specimens by flooding, while draught and warmth can dry out the dish and the specimens – and cease or halt the trap efficiency. Vane traps can get heavy and fall after much precipitation (Falk, 2015).

The traps were left for approximately 96 hours (four days) and sampled twice during each week of the survey, divided into six sampling periods. The pollinators were brought to the lab for rinsing, drying, sorting and identification, then kept frozen at -20˚C. All samples were stored in plastic test tubes with labels on both the tube and the lid, assuring that either ID number could identify the content.

Plant sampling and registration

I mainly registered plant abundance and diversity by observation, and collected species that I was unable to identify at site (Appendix D, Tab. 16-21). The abundance of flowering vegetation varied considerably between locations. A wide range of green spaces were represented, including natural and human induced vegetation such as residential areas, parks, hiking spots, meadows, and forest edges. Plants were collected to map any factors that could make a great impact on pollinator communities.

Plant abundance per. species was estimated using a 1 – 4 range, where 1 represents some individuals (~5 %), 2 equals a fair amount (~10 %), 3 represents plentiful (~30%) and 4 represents very abundant (~ 55 %). The range was initially changed from 1-5 to 0-4, and 0 was removed from the main tables to match the overall plant abundance score (1-4) per site. Zero was determined as "absent or insignificant" in the main tables, along with 1 and 2. However, Tab. 19-21 in Appendix D includes zero values (equals one individual), value 1 and value 2 to show the full width of my dataset. Only the values of 3 and 4 were used in the main tables.

The sampling radius was determined to 50 meters as a minimum length, to obtain the most amount of data within a reasonable timeframe. The length was measured from the center of the trap installations and outwards by counting steps. Other measurements would be strenuous or nearly impossible to conduct due to the issue of radius length combined with ground characters such as slope, vegetation and/ or private property boundaries. Plants were recorded and collected during the first week of July, August, and September (More information in Appendix D, Tab. 16-21).

Pollinator sampling 2022

The first sampling of pollinators was conducted on the 28th and 29th of June and named T1 for short. The second sampling period from 2nd to 3rd of July was named T2, then T3 for 30th -31st of July, T4 for 3rd -4th and August, T5 for 30th – 31st of august and finally T6 for 3rd-4th of September.

Weather

The survey was mostly carried out on dry and calm, temperate to warm, and overcast to sunny days, hence optimal weather conditions for winged pollinator activity (Bates et al., 2011; Verboven et al., 2014). These conditions coincided well with my fieldwork schedule, allowing almost precisely 1-month intervals between the first day of each sampling period. The weather was reasonably stable both during and between my sampling periods, minimizing the weather effect on any data deviation. Weather data was gathered from seklima.met.no by applying these search terms from the 1991-2020 normal (month): mean air temperature deviation, regional mean air temperature deviation, precipitation in percent, region precipitation in percent and a custom period from March 2022 to October 2022 (Appendix C, Fig. 24). I also included historical weather deviation in Appendix C (Fig. 25) with data from 1960 to 1990's, using the same search terms as the 2022 data except changing the year and exchanging the monthly search for a year-to-year search.

Sampling by Løken, 1950 - 1978

Astrid Løken sampled her bumblebees between 1st of April until the 29th of September, from 1950 to 1978. The sampling method she used was likely sweep netting and observations, based on assumptions of common methods around that period and a short indication in "Norsk Entomologisk Tidsskrift" by Løken (1973, pp. 1). She would get the observational benefit of active trapping, such as the nesting and foraging sites of bees and any attacks by parasites (e.g., cuckoo bees). This method is also useful in terms of replication and numerical data sampling (Cooper et al., 2012; Falk, 2015). The location of her sites has not been clearly described regarding vegetation or exact location, and the distance to my sites can differ with anything from 0 to approximately 2-3 km (**Figure 1, Table 4 and Table 5.** More information in Appendix C, Fig. 20 and Tab. 15). I was not able to find any detailed information about Astrid Løken's sampling in the Bergen area, neither in her records at The University of Bergen, her "Studies on Scandinavian Bumble Bees, 1973" or in the "Norwegian Biodiversity Information Centre and GBIF Norway web program". The latter reference contains a species map (Artskart) with the dataset I used from Astrid Løken's sampling (**Table 5.** More information in Appendix C, Fig. 20, Tab 14 and Tab. 15).

Pollinator sampling 2021

I only used vane traps for this sampling, one with a yellow window and one with a blue window. The distance between sampling sites and traps was based upon avoidance of vandalism and the presence of flowering plants. The yellow and the blue traps were mounted with a few meters distance up to 90 meters distance (**Figure 2**). I also identified solitary bees and hoverflies, but they are not included in this study due to their low numbers (More information in Appendix C, Tab. 13 and Fig. 19. Fig. 21 shows a random sampling period from 1983-2021).

2.3. Data analysis

The data was first and foremost manipulated to reveal any difference between abundance and richness of bumblebees across different sites and areas – whether it be urban, sub-urban or rural. Essential information from field and lab work were fed into Excel and visualized using R studio and ArcGIS. The packages I used for the R studio visualization were vegan (Oksanen, 2022) and ggplot2 (Wickham, 2016). Vegan was used for Principal Component Analysis (PCA), Detrended Correspondence Analysis (DCA) and Rarefaction analysis. For my ArcGIS map I used the ArcGIS Enterprise software, release 11.0 (Redlands, C. E. S. R. I., 2011). All statistical analyses were made using R Statistical Software (v4.2.2, R Core Team 2022).

Data preparations

Bumblebees (*Bombus*) and honeybees (*Apis mellifera*, females) were counted and then identified to species level and sex. The identification was done by using a stereo loupe and literature from Løken (1985) and Ødegaard, et al. (2015). Other pollinator groups were counted and identified as follows; hoverflies to family level Syrphidae, wasps as suborder Apocrita, solitary bees as clade Antophila. The *Bombus* species *B. lucorum, B. cryptarum, B.magnus* were classified as the *B. lucorum* complex, as they are hard to distinguish from one another without the use of DNA-analysis (Ødegaard et al., 2015).

Most of the plants were originally identified to species level (Appendix D, Tab. 19-21) but due to project limitation and species verification challenges, the plant identification was adjusted to genus level in the actual paper. However, high coverage of the host plant is of more importance to Apidae (bees, bumblebees, honeybees and wasps) than the specific plant species (Banaszak-Cibicka et al., 2016). Identification of plants was done using Gyldendals store nordiske flora (2012).

Statistical models and data visualizations

The richness of *Bombus* was illustrated using rarefaction curves, and a boxplot was used to illustrate *Bombus* richness in each area. Rarefaction was used to illustrate how species richness varied with the number of individuals. I mapped the *Bombus* spp. composition against sites in a PCA and the composition of my sites versus Astrid Løken's sites using DCA. The purpose of using the PCA was to see the correlation between species and sites, and to reveal any patterns of *Bombus* habitat preferences. The PCA ordination was log-transformed, while the DCA was created as a binary matrix where values (abundance) greater than five were considered as "presence". The abundance was transformed and only species that had more than 5 individuals were included.

Data availability and voucher specimens

The appendix contains detailed data for *Bombus* spp. samples by both Løken and me, table showing the most common flowering plants with index 3 and 4, a table showing all plants with an index from 0-4, PCA scores of both species and sites, and a historical map over Bergen and the surrounding area divided into districts (Appendix C, Fig. 22-23). A subset of my specimens will be available at the University Museum of Bergen. The full dataset of my pollinators is available on request.

3. RESULTS

3.1. Pollinator abundance

The highest abundance of pollinators was found in the rural region, with the next highest numbers in urban area and the lowest numbers in suburban area. The number of pollinators found during the season was a total of 2009 individuals. These were split into hoverflies (Syrphidae, 1096 individuals) followed by wild bees (Antophila, 286 individuals), bumblebees (*Bombus*, 256 individuals), honeybees (*Apis mellifera*, 247 individuals) and wasps (Apocrita, 124 individuals). Urban and suburban areas showed similar numbers in each pollinator group, apart from Syrphidae and Apocrita. The rural region had a particularly high abundance of Syrphidae (approximately 600 individuals) and Antophila. In fact, all groups had their highest abundance in the rural area, except Apocrita. *Bombus spp*. (about 100 individuals in the rural part) had approximately the same abundance in suburban and urban areas (about 80 individuals in each) (Figure 4. More information: Appendix A and B, Fig. 14 and 15).

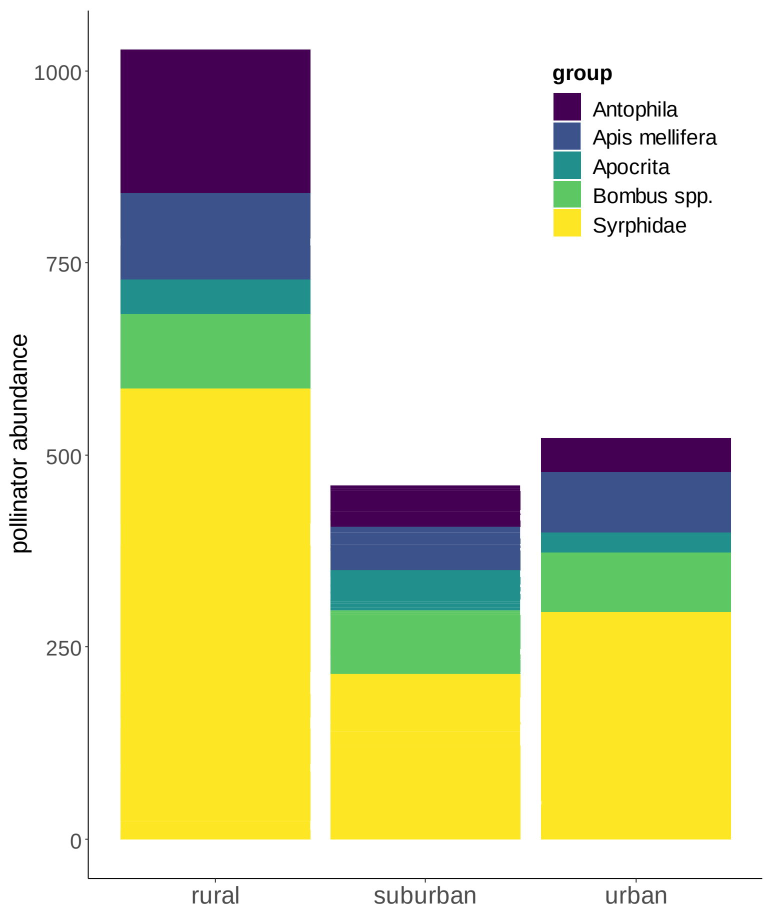

Figure 4: Abundance of all pollinator groups divided into rural, suburban, and urban areas of Bergen, Norway (2022).

The rural site Rambjorga revealed the highest abundance of pollinators among all sites, followed by the urban site Tippetue and the suburban site Svartediket. The suburban site Hasteinarparken had the lowest pollinator abundance. Rambjorga had exceptionally high numbers of Antophila and *Apis mellifera* (**Figure 5**). Rural sites have the highest abundance of pollinators, most clearly visible in Syrphidae and Anthophila (Both **Figure 4** and **Figure 5**). Pollinators display wide distribution in the suburban and urban areas (as for Bombus in **Figure 6**).

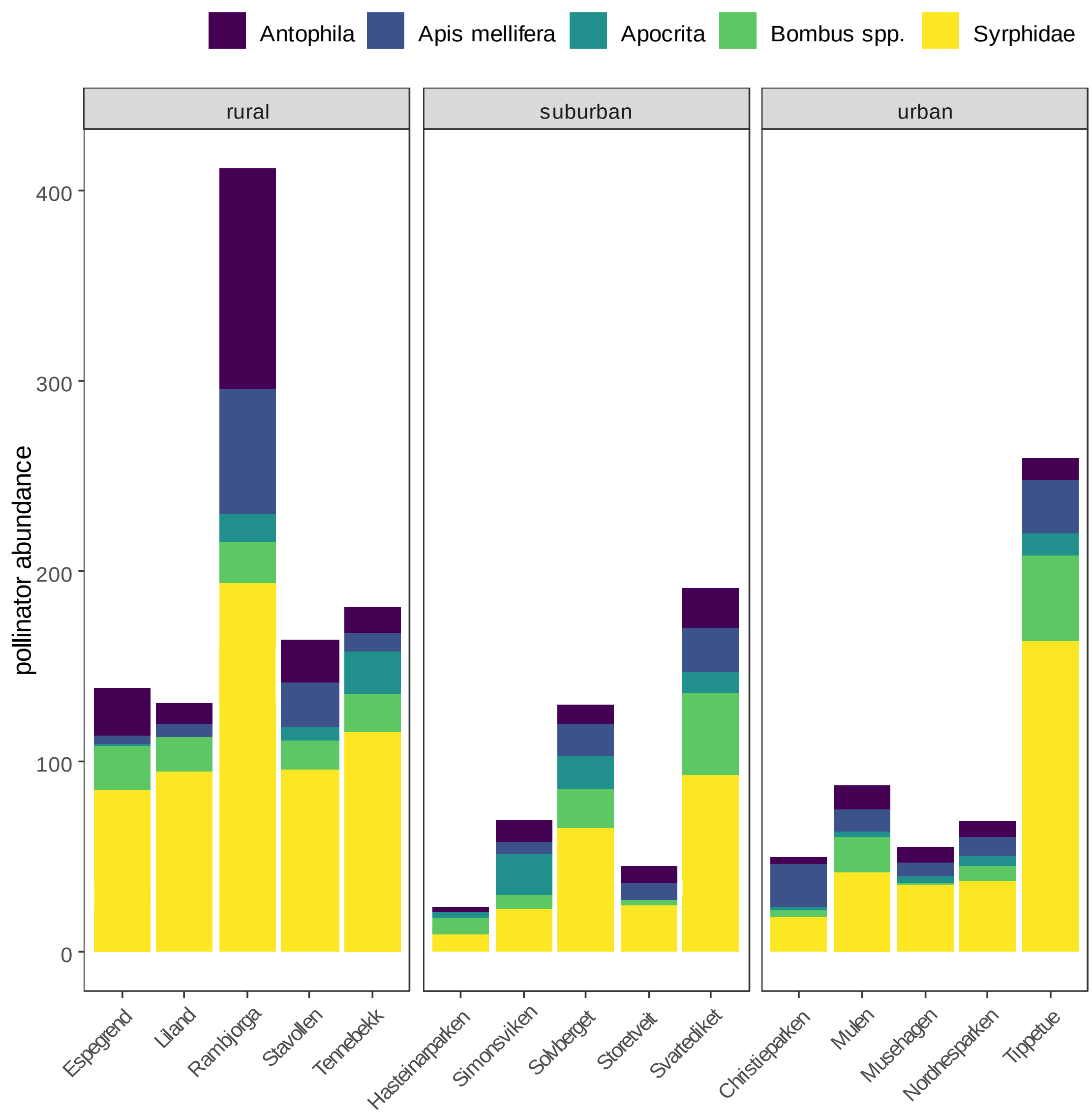

Figure 5: Pollinator abundance per site divided into rural, suburban and urban areas of Bergen, Norway (2022).

3.2 *Bombus* richness and abundance

The highest *Bombus* abundance was found in an urban site (Tippetue, 45 individuals), closely followed by a suburban site (Svartediket, 43 individuals). The lowest abundance was found in an urban site (Musehagen, one individual) and a suburban site (Storetveit, two individuals). The distribution of *Bombus* abundance was almost even across sites in the rural area, while abundance was more dispersed in the other regions. Comparing the *Bombus* abundance in this figure (**Figure 6**) and the pollinator abundance in the last figure (**Figure 5**) with patterns between sites and areas, they show strikingly similar trends. The only exceptions are that *Bombus* abundance is almost higher in one suburban site (Hasteinarparken) than the total number of pollinators here (**Figure 5**), and that the most rural sites (Espegrend and Liland) are slightly higher in abundance of *Bombus* relative to the number of pollinators (**Figure 5)** in the other rural sites. Respectively, rural sites had 97 individuals of *Bombus*, suburban had 82 and urban had 77 (Appendix B, Fig. 15).

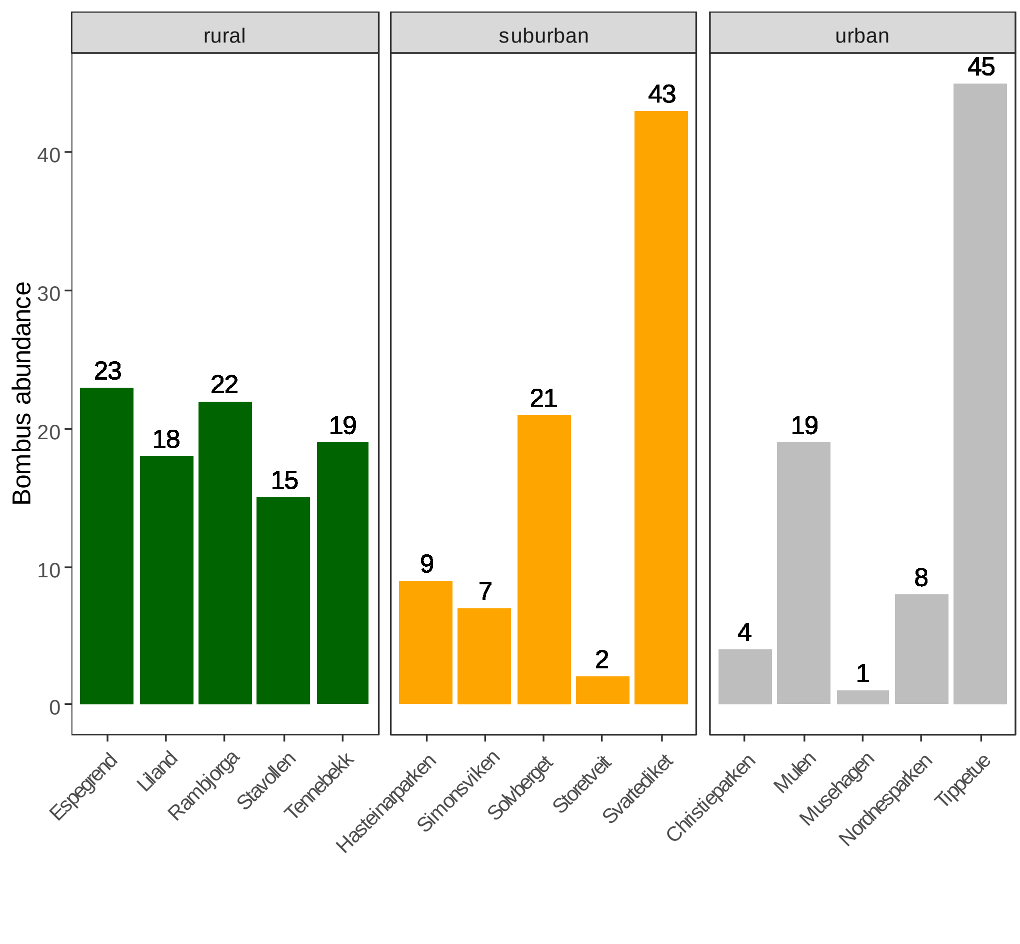

Figure 6: Bombus abundance per site divided into rural, suburban and urban areas of Bergen, Norway (2022). Levels of urbanization are differentiated by color, from the left; rural in green, suburban in yellow and urban in grey.

The richness in rural areas was a maximum of about 23 individuals divided by four species. However, when upscaling the abundance in this region by twofold, it yields more species than urban sites and that makes the rural region the second most optimally sampled.

The maximum predicted richness for the suburban region was ten species for approximately 43 individuals sampled and therefore proportionally higher than the other two areas. This indicates the most optimal sampling when retrieving as many species as possible for a certain number of individuals.

The urban sites had a maximum richness of seven species for a sampling of approximately 45 individuals and was the least successful of the urbanization levels (slightly less than the suburban areas) (**Figure 7**).

All sites had low sampling sufficiency. Nevertheless, based on the curvature of the lines, the rural sites were most sufficiently sampled. All lines in the rural region are more curved compared to the lines in other areas. However, this is the result of lower *Bombus* spp. richness in the rural region. The sampling success in the suburban areas was lowest, all curves show little tendency to flatten except the curve furthest to the right (Storetveit, two species). This curve reveals the most optimal sampling of all sites in the study, while the first and second curve to the right are the steepest amongst areas. Urban areas were the next optimally sampled, and only the longest curve (Tippetue, seven species) is close to sufficiently sampled. This is one of the few curves in the study that seems to have caught most of the species that one could expect to find (**Figure 7 and Figure 11**. More information: Appendix B, Fig. 16 and Tab. 8-11).

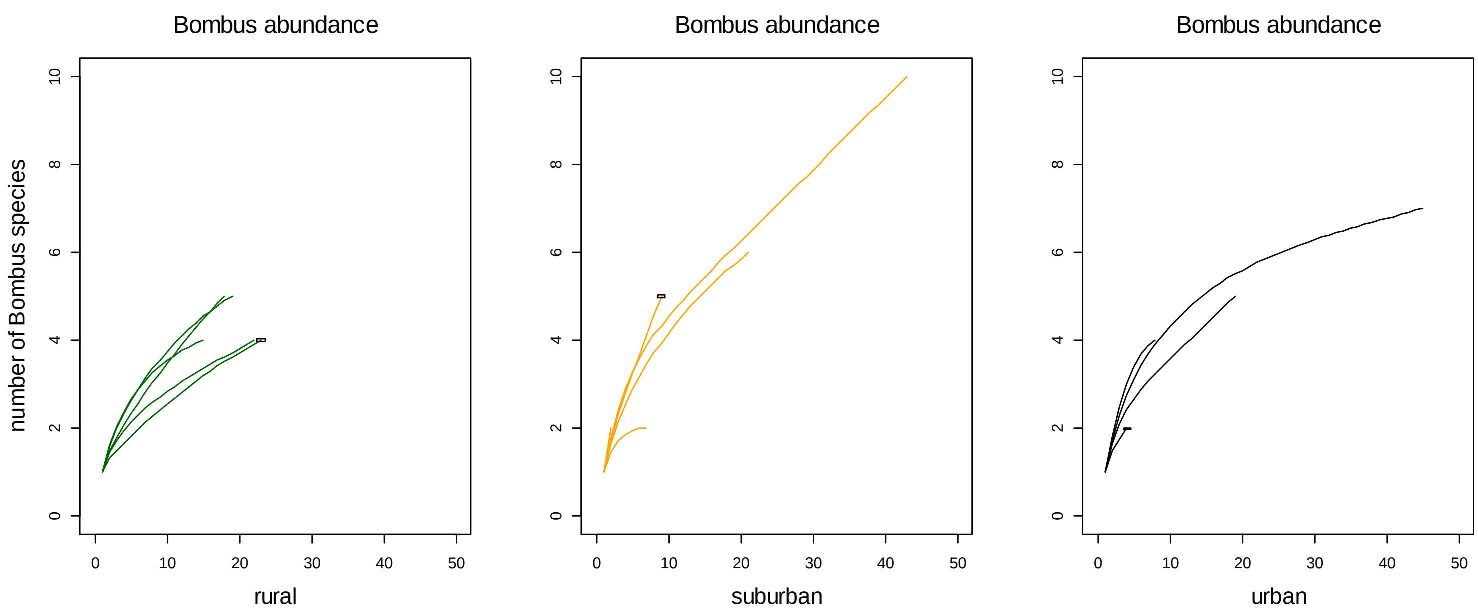

Figure 7: Rare faction with richness of Bombus per site, by abundance of these species (per new individual added) per site, divided by rural, suburban and urban areas of Bergen, Norway (2022). Levels of urbanization are differentiated by color, from the left; rural in green, suburban in yellow and urban in grey.

The rural region stands out by the low median position in **Figure 8**. The median reveals that the numbers of *Bombus* species are equal to or higher than four in all rural sites. Also, the whiskers are absent, which implies that the maximum and minimum values are limited to the Q1 and Q3 quartiles. No whiskers and concentration of data close to the Q1 quartile, implies low variance/ low spread of data and high concentration of data points within a narrow range. The position of the median represents left skewedness/ negative skewedness of data. The total number of species in the rural area was nine and reveal the second lowest *Bombus* richness, shown by the red dot (**Figure 8.** More information in Appendix B, Fig. 16)

The suburban area box has a long upper whisker, indicating presence of higher values that extends the range towards the upper end of the distribution (Q3). Richness is concentrated in Q3 with a median of five species throughout sites. Both whiskers and median show positive skewedness of data points. The position of the median also shows that there is a high distribution/ spread of species in Q1. Outliers make up four additional species, shown by the length of the upper whisker. Absence of the lower whisker means that there are no less than two species in any suburban sites. As the lower (min) whisker is absent and the upper (max) whisker is long, there are higher values/greater variability towards the upper portion of the data. The number of species found in the suburban area was 12 and is the highest Bombus richness of all areas (more information in Appendix B, Fig. 16)

The urban area has the most symmetric distribution of the three, with a median of approximately four and positive skewedness. While richness is concentrated in Q3, the spread of species is larger in Q1. The red dot above the urban box reveals the lowest maximum richness amongst regions, at eight species (**Figure 8.** More information in Appendix B, Fig. 16)

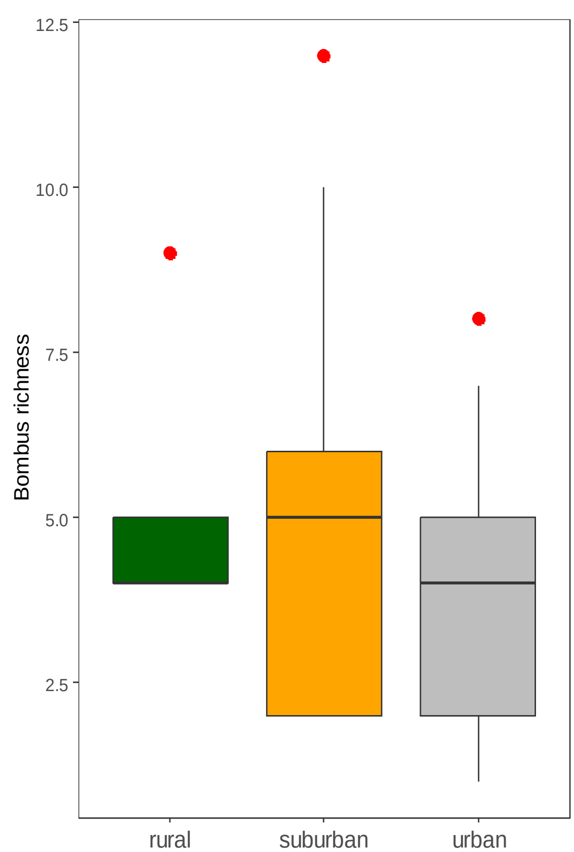

Figure 8: Variation of Bombus richness between sites, divided into rural, suburban, and urban areas of Bergen, Norway (2022). Levels of urbanization are differentiated by color, from the left; rural in green, suburban in yellow and urban in grey.

The overall richness was highest at the beginning of the season and declined thereafter. The total richness was also much higher in the first two sampling periods (ultimo June and primo July). The median stays the same during the first half (ultimo June to ultimo July), showing that two species were the norm in each period. The greatest difference between boxes is shown by the relatively high richness in T1 (ultimo June) and the low richness in T6 (primo September). Yet the whiskers from both boxes reveal the presence of higher values, as they are positioned on top of the boxes. However, T1 had a larger distribution of species than T6 and the median is significantly higher, well-mentioned that T6 had the lowest median of all sampling periods. T1 also had a roughly symmetrical distribution of data, but less than T2 (primo July) – both showing approximate normal distribution of the data.

The later periods all lack one whisker each per box, and the mean is positioned either on top of the boxes such as in T3 (ultimo July) and T5 (ultimo August), or at the bottom in the case of T4 (primo August) and T6. The lack of whiskers implies a simple distribution. T3 and T4 had positive skewness, as the whisker on top indicates that the upper distribution is compressed (most data points are positioned towards the bottom of the plot). The high median implies high central value. T5 is negatively skewed, as the whisker is facing downwards - although the median indicates high central value within the overall range of the data. T6 had a positive skewness as the tail is extending towards higher values, while the median is positioned at the bottom. The median suggests low central value of the data within the overall range. The only periods with outliers are T2, T5 and T6. These data points lie far beyond the typical range of values. T1, T2 and T3 had the median at 2 species, T4 and T5 had a median of 1 species and T6 had a median of 0. While most samplings have no *Bombus* occurrence in T6, the number of *Bombus* spp. lie between 0 and 1 during this period (Figure 9).

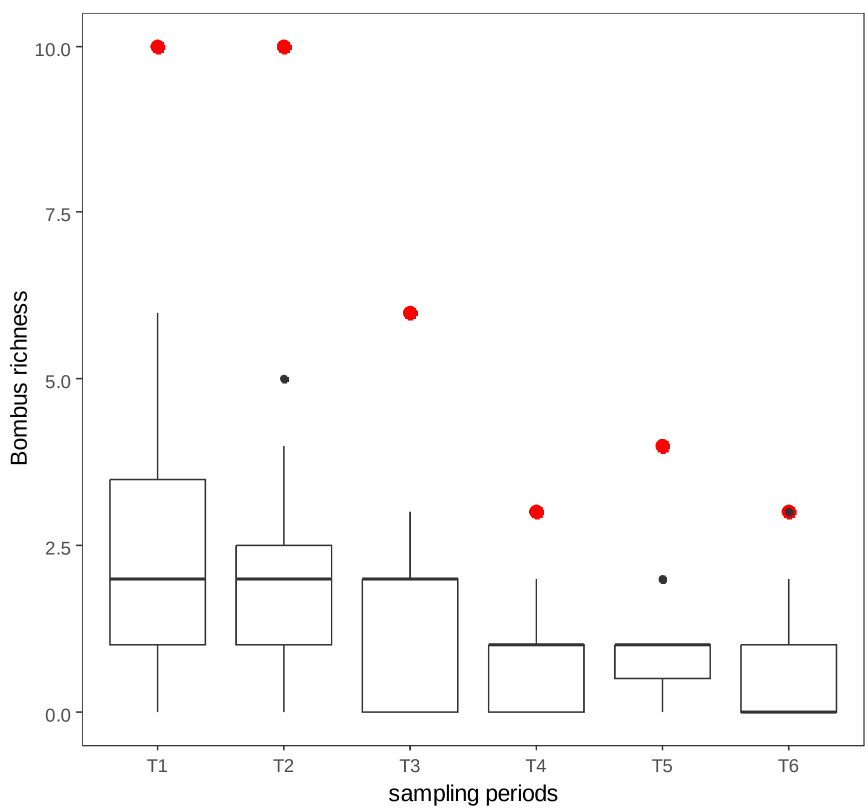

Figure 9: Variation of Bombus richness per sampling period in Bergen, Norway (2022). Black dots show outliers and red dots show the total number of species within each period. T1 being ultimo June, T2 equals primo July, T3 equals ultimo July, T4 equals primo August, T5 equals ultimo August and T6 indicates primo September.

Ultimo June had the highest abundance of *Bombus* overall, dominated by the suburban region. Primo August had the lowest overall abundance, while the urban area was lowest in abundance throughout all sampling periods except primo July. Ultimo July and ultimo August are similar in numbers, apart from ultimo August exhibiting only half the abundance in suburban areas (Figure 10).

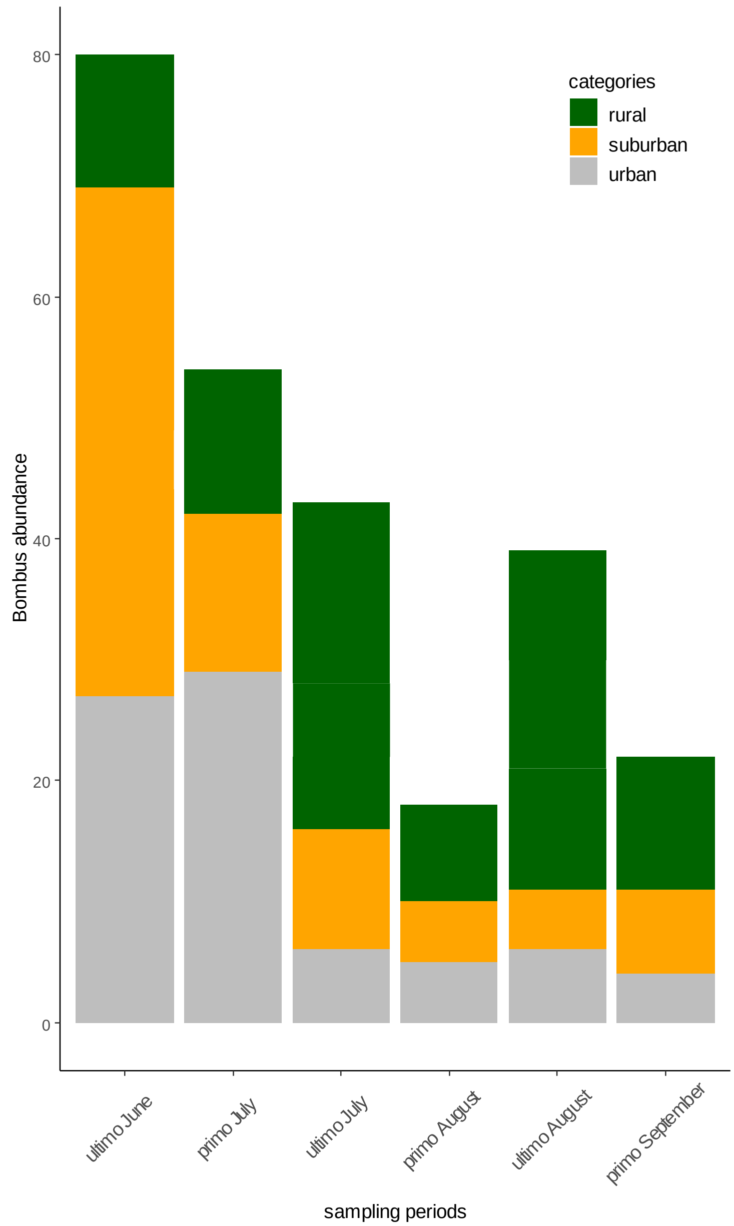

Figure 10: Bombus abundance per sampling period divided into rural, suburban and urban areas of Bergen, Norway (2022). Levels of urbanization are differentiated by color; rural in green, suburban in yellow and urban in grey.

B. pascuorum and *B. pratorum* were the most common *Bombus* species found during the season (detailed view of species richness in appendix). *B. pascuorum* became more frequent from suburban areas (~10 % - 70 %) to urban (~10 % - 75 %) and rural (~65 % - 85 %). *B. pratorum* showed the opposite trend from lowest numbers in the rural area (~ 5 % - 7 %) to higher numbers in suburban (~25 % - 55 %) and urban on top (~ 35 % - 60 %, and Musehagen at 100%) (More information in Appendix B, Tab. 8-11 for specific numbers per site).

Svartediket was the richest site, with 10 different species. The least diverse site was Musehagen where there was only found one *Bombus* species, closely followed by Christieparken and Simonsviken with only two species each. *B. pascuorum* was found in all sites except Musehagen, while *B. lucorum* and B. *hypnorum* had the next highest occurrence with 11 sites, and *B. pratorum* right behind with 10 sites (**Figure 11**). *B. lucorum* is a complex comprised of three different species: *B. lucorum*, *B. cryptarum and B. magnus* (Bossert, 2015). Three of the species were only found once, and they were all found in the suburban site Svartediket*: B. cingulatus, B. jonellus and B. quadricolor* (**Figure 11**. More information in Appendix B, Fig. 17 and 18, Tab. 8-11).

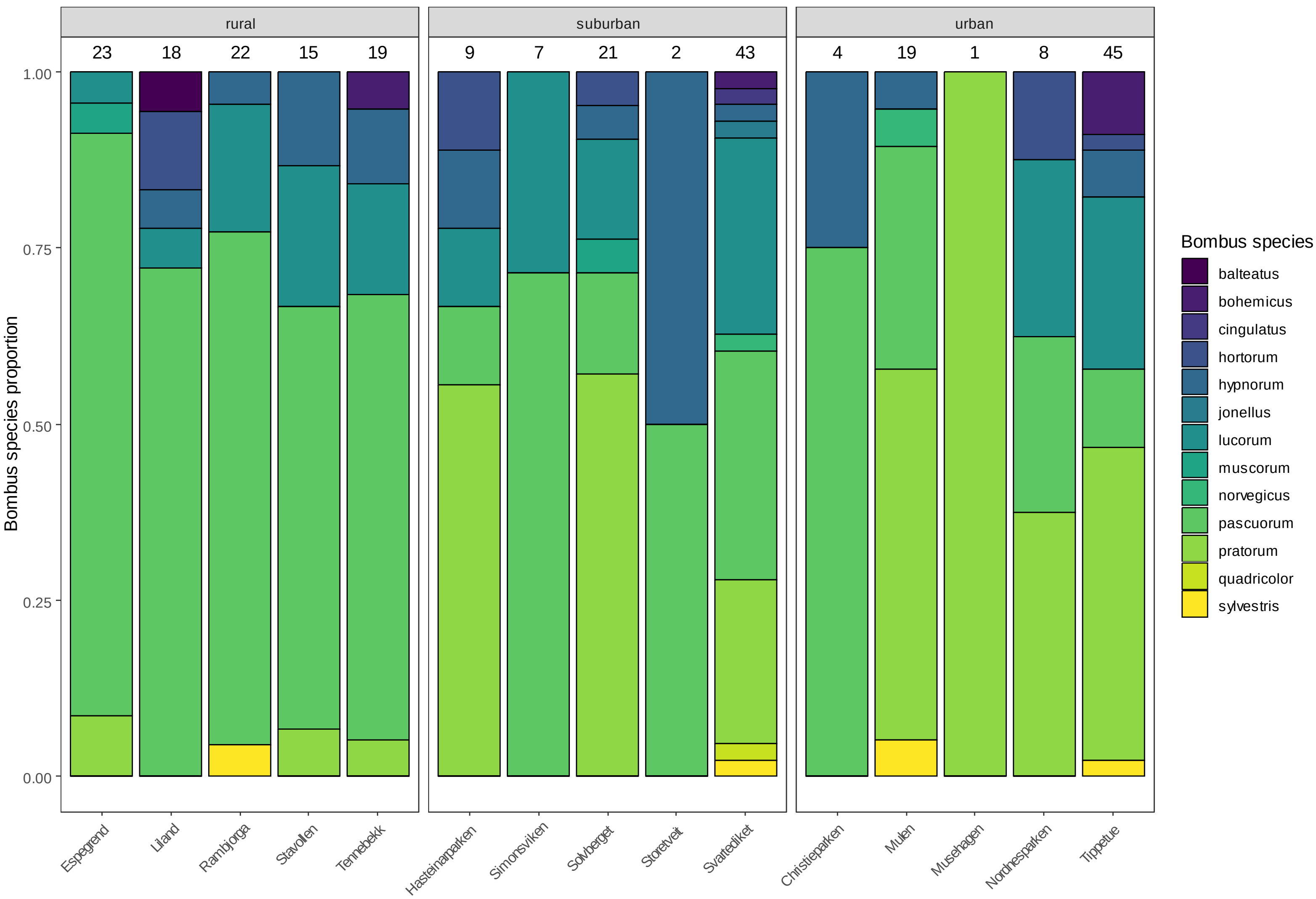

Figure 11: Bombus spp. proportion (relative abundance) between Bombus species, per site divided into *rural, suburban, and urban* areas of *Bergen, Norway (2022). The number above the bars indicates the total abundance of all species in that si*

3.3 *Bombus* composition and historical records

The most negatively correlated variables were *B. pratorum* and Rambjorga, as well as *B. pascuorum* and the most distant sites in the upper right square: Hasteinarparkenand Musehagen. *B. pratorum* thrived mostly in urban but also suburban sites, shown by the four closest sites in the plot: Tippetue, Mulen, Hasteinarparken and Solvberget. *B. pascuorum* had a strong positive correlation with the rural area cluster and particularly negative correlation to urban sites. The *B. lucorum* complex were most adjacent to the suburban site Svartediket, which also was the next most abundant site (**Figure 12**). PC1 explains 47 % of the variation while PC2 explains 28 % of the variance. Percentages decrease drastically, with PC3 explaining only 9 % and so forth (**Table 3**). *B. pratorum* had a high PC2 score but low PC1 score, as for Tippetue and especially Solvberget (all positively correlated to PC2 and negatively to PC1). Overall, there is a positive, linear pattern between *B. pratorum* and all sites above (in addition to Tippetue). *B. pascuorum* had a low PC2 score and just below medium on PC1. Rambjorga is closely linked to *B. pascuorum*, with a low PC2 score but above medium on PC1. Thus, Rambjorga is positively correlated to PC1 while *B. pascuorum* is negatively correlated to PC1 (both negatively correlated to PC2). Musehagen had a high PC1 and PC2 score. *B. lucorum* is positively correlated to Svartediket, both having just below a medium PC2 score and low PC1 score (both negatively correlated to PC1 and PC2) (**Figure 12 and Table 2.** More information in Appendix B, Tab 8-13).

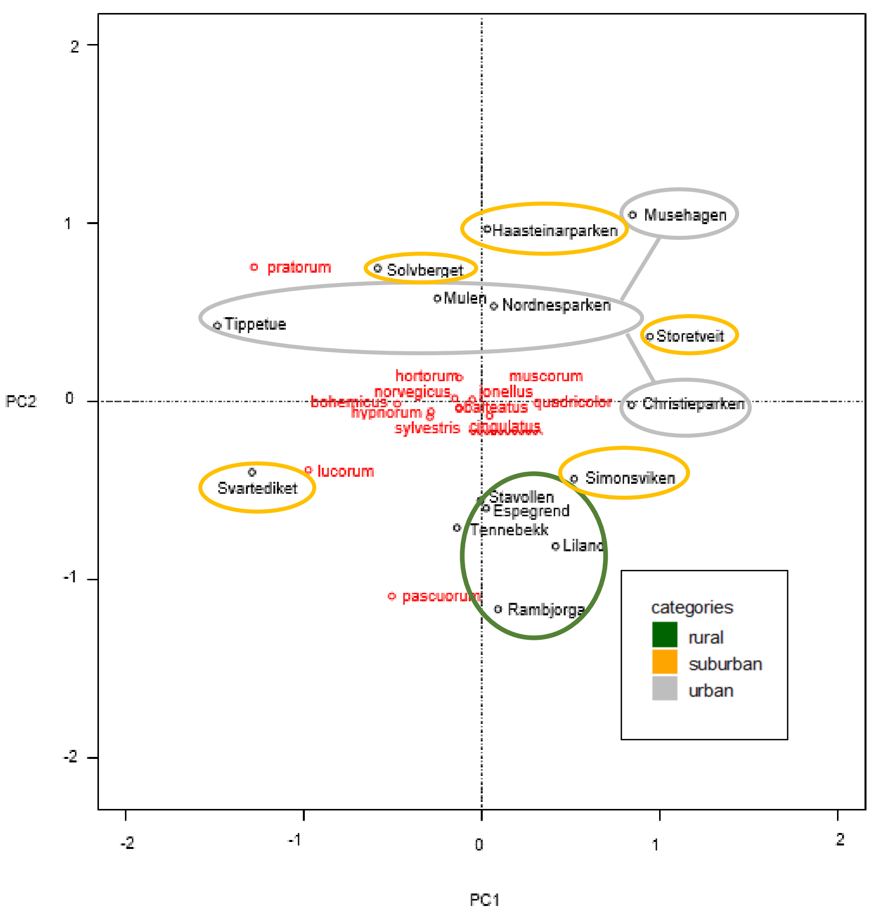

Figure 12: PCA revealing correlations and patterns between Bombus spp. and sampled sites in Bergen, Norway (2022). Sites are divided into areas by color; rural in green, suburban in yellow and urban in grey.

Table 2: Partitioning of variance and importance of components in PCA analysis for Fig. 12. Total variance considers total variability across all variables in the PCA. Total inertia is 3.58.

Importance of Components	PC1	PC2	PC3	PC4
Eigenvalue	1,70	0,99	0,31	0,19
Proportion Explained	0,47	0,28	0,09	0,05
Cumulative Proportion	0,47	0,75	0,84	0,89
% Eigenvalues	47	28	9	5

The only sites I sampled containing the exact same *Bombus* species were Christieparken and Storetveit, while many of Astrid Løken's sites had the exact same species as one another (overlapping sites). Two of these sites were Milde and Munkebotn, which also overlapped with my sampling in Musehagen. My sites are clustered on the mid to lefthand side of the plot while Løken's sites are spread around mine, around the middle and to the upper left and bottom left corners. Løken's sites showed a geographical correlation, as most were found in close approximation to each other both on the plot and out in the open. This is not the case for my sites as they are connected by abundance and richness, just above zero on both the DCA1 and DCA2 axis (Svartediket, Tippetue, Solvberget).

DCA1 explains most of the variance in species composition by site (environmental effect) with 41 % and is equivalent to the explanatory variable "site", DCA1 also has a longer axis than DCA2. Variance of species richness (species effect) also correlates to DCA2 and explains the next most variance at 28 % (**Table 3**). My plot contains five sites that were common between me and Løken and three of them had a much stronger similarity (Musehagen/ Musehagen, Munkebotn/ Solvberget, Espegrend/ Espegrend) than the two remaining sites (Mulesvingen (Mulen)/ Sandviken and Svartediket/ Svartediket). These are all aligned vertically along the DCA2 axis and the sites closer to each other show similar species composition. The sites overlapping (by shared square shape) contained the exact same species. These clustered sites were primarily found in the rural areas, while one was found in the transition between urban and suburban, and one cluster contained only urban sites (**Figure 13**, **Table 3**. More information in Appendix C, Tab. 15).

B. pratorum and *B. pascuorum* were found in all but one of the sites I had in common with Løken, while *B. hypnorum* was found in five of seven sites in total (**Table 4**). Løken sampled *B. pratorum* only in three out of those seven sites. *B. hortorum* and *B. hypnorum* had the next highest recording, with two sites each (**Table 5**). The reoccurrence of species was also lower in the Løken sites which were not common to my seven sites, where *B. pascuorum* was the most recorded species in five out of 10 sites (**Table 4** and **Table 5**. More information in Appendix C, Tab. 15).

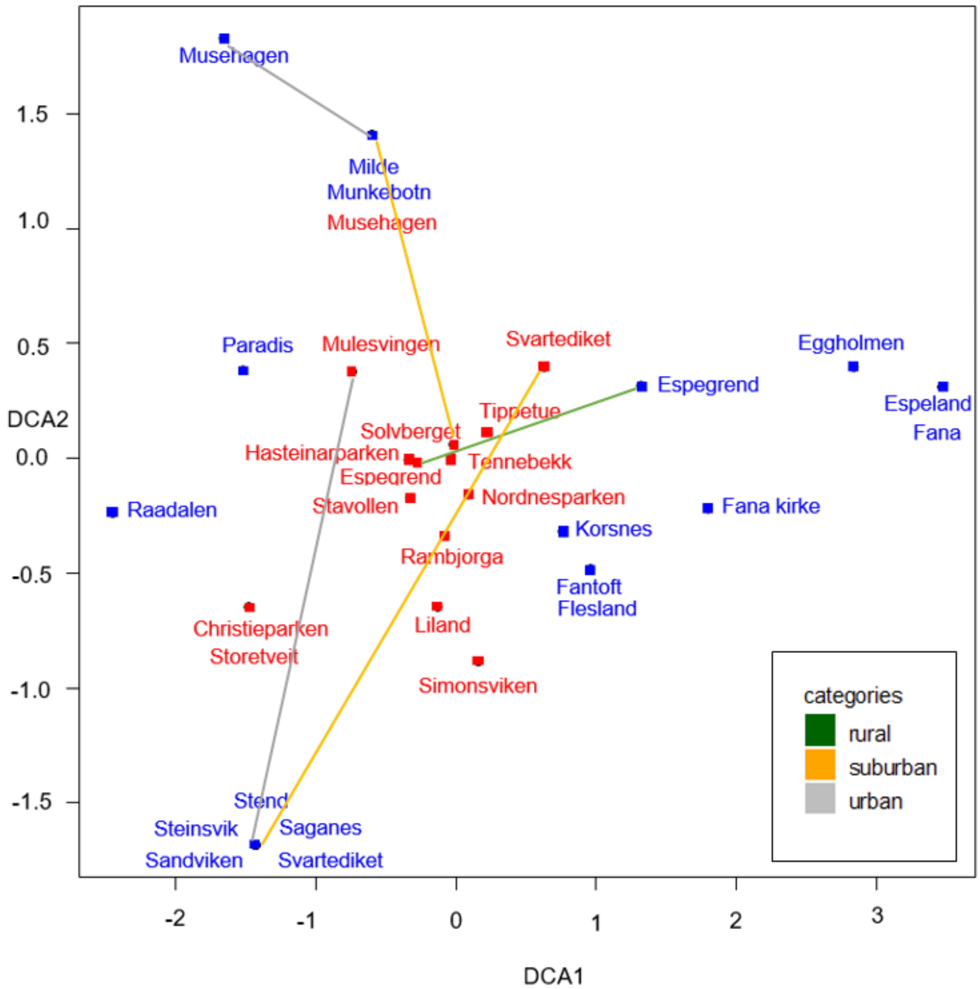

Figure 13: DCA with focus on the Løken sites (blue) that are adjacent to mine (red), specifically sites with > 10 individuals that were sampled by both me and Løken in Bergen, Norway (2022). These common sites are the ones with lines in between, colored by area (green for urban, yellow for suburban and grey for urban). Sites containing the exact same species are shown by the overlap where several sites share the same square shape.

All my sites had more than 10 specimens except the parks: Musehagen, Storetveit and Simonsviken (urban and suburban sites). The Løken sites that were not sampled by me, but had > 10 specimens were Fantoft, Flesland, Korsnes, Paradis, Raadalen, Saganes, Steinsvik and Stend. Løken also sampled in Christieparken and Tippetue but her sites had < five specimens and are therefore excluded. All Løken sites in this plot have > five individuals.

Table 3: Eigenvalue representing the amount of variance explained by each DCA component. Total inertia (scaled Chi-square).

Analysis	Eigenvalues	% Eigenvalues	Additive Eigenvalues	Decorana values	Axis lengths
DCA1	0,5962	41	0,5962	0,7003	5,2023
DCA2	0,4073	28	0,411	0,444	3,1765
DCA3	0,2295	16	0,225	0,1666	2,0399
DCA4	0,21762	15	0,20114	0,08054	1,98344

*Table 4: Species in my study that were recorded in sites also sampled by Løken, and number of sites where each species was found in Bergen, Norway (2022). The table is sorted from the highest to the lowest number of sites per species. The yellow color marks the cells with > zero individuals. *"Mulen" is the same site as "Mulesvingen" in Fig. 13, and Løken's site that is equivalent to my *"Mulen" is "Sandviken". Note that the species in the B. lucorum complex are not separated.*

Common name	Latin name	Christie parken	Espe grend	*Mulen (S.viken)	Muse hagen	Solv berget	Svarte diket	Tippe tue	Occurrence per site
akerhumle	*B. pascuorum*	3	19	6	0	3	14	5	6
markhumle	*B. pratorum*	0	2	10	1	12	10	20	6
trehumle	*B. hypnorum*	1	0	1	0	1	1	3	5
lys jordhumle	*B. lucorum*	0	1	0	0	3	12	11	4
markgjøkhumle	*B. sylvestris*	0	0	1	0	0	1	1	3
hagehumle	*B. hortorum*	0	0	0	0	1	0	1	2
jordgjokhumle	*B. bohemicus*	0	0	0	0	0	1	4	2
kysthumle	*B. muscorum*	0	1	0	0	1	0	0	2
tregjokhumle	*B. norvegicus*	0	0	1	0	0	1	0	2
barskoghumle	*B. cingulatus*	0	0	0	0	0	1	0	1
lundgjokhumle	*B. quadricolor*	0	0	0	0	0	1	0	1
lynghumle	*B. jonellus*	0	0	0	0	0	1	0	1

*Table 5: Species in Løken's study that were recorded in sites also sampled by me, and number of sites where each species was found in Bergen, Norway (2022). The table is sorted from the highest to the lowest number of sites per species. The yellow color marks cells with > zero individuals (Fig 1. for visual overview). *"Mulen" is the same site as "Mulesvingen" in Fig. 13, and my site that is equivalent to Løken's *"Sandviken" Is "Mulen". Note that the species in the B. lucorum complex are separated into B. cryptarum, B. magnus and B. lucorum.*

Common name	Latin name	Christie parken	Espe grend	*S.viken (Mulen)	Muse hagen	Munke botn	Svarte diket	Tippetue	Occurrence per site
markhumle	*B. pratorum*	0	0	11	77	10	0	0	3
hagehumle	*B. hortorum*	0	23	0	0	0	0	1	2
trehumle	*B. hypnorum*	2	0	0	17	0	0	0	2
akerhumle	*B. pascuorum*	0	0	19	0	0	12	0	2
lys jordhumle	*B. lucorum*	0	0	6	0	0	0	1	2
kilejordhumle	*B. cryptarum*	0	3	0	0	0	0	0	1
kragejordhumle	*B. magnus*	0	20	0	0	0	0	0	1
kysthumle	*B. muscorum*	0	1	0	0	0	0	0	1
lundgjokhumle	*B. quadricolor*	0	1	0	0	0	0	0	1
lundhumle	*B. soroeensis*	0	16	0	0	0	0	0	1
jordgjokhumle	*B. bohemicus*	0	1	0	0	0	0	0	1
steingjokhumle	*B. rupestris*	0	0	0	25	0	0	0	1
steinhumle	*B. lapidarius*	0	0	0	1	0	0	0	1
tregjokhumle	*B. norvegicus*	0	0	0	3	0	0	0	1

3.4 Plant abundance, richness, and occurrence

I examined 44 species of the most abundant plants in my study. The highest richness was found in the rural area (23 genera), closely followed by suburban (22 genera) and urban (21 genera) areas. The abundance of the most numerous plant genera was highest in the suburban area (42 in total occurrence), second highest in rural (41 in total occurrence) and lowest in the urban area (37 in total occurrence). Considering that the different genera had an abundance score of 3 or 4 and were roughly counted, these numbers are not fully reliable. Genus's occurrence was highest in the suburban area (15 times), followed by rural (14 times), and urban (12 times) (More information in Appendix D, Tab. 5). All genera were represented amongst the sites. The flowering plants of the genus *Epilobium* sp. (white/ purple), *Hieracium* sp., *Ranunculus* sp. (yellow), *Trifolium* spp. (three purple, 10 white – most common in suburban and urban areas), and *Valeriana* sp. (purple and white flowers) were common in all areas (Table 6. More information in Appendix D, Tab. 16-18).

Trifolium spp., (11 occurrences of the white flowers, six occurrences of the purple) had the highest plant abundance overall, followed by *Ranunculus* sp. (nine occurrences, yellow flowers) and *Aegopodium* sp. (eight occurrences, highest score of 4, white flowers). *Heracleum* sp. (white), *Valeriana* sp. (white) and *Chamerion* sp. (purple) were also high in abundance (6 occurrences each). All flowers were yellow, white, purple, or white but white was the dominant color overall (Table 6. More information in Appendix D, Tab. 16-18).

Of the 23 species of flowers found in the rural site, eight were purple and three of them were abundant. Six were white but only two of those species were registered frequently, six were yellow and three of them had high occurrence, the rest occurred frequently; two white/ purple species and one purple/ pink species. About 13 were purple or a purple mix, seven were white or a white mix, six were yellow and had overall the same occurrence as the white/ white mix flowers. Comparing this to the plants that were found in suburban area, there is almost equal occurrence of yellow and purple flowers but a bit less of the white color. The urban area has slightly more purple/ pink/ red flowers than white, and less of (Table 6. More information in Appendix D, Tab. 16-18). While the occurrence is mapped in approximate terms per area, the in-between area examination reveals a slight trend towards more purple and pink species in the rural area, more yellow in suburban and more white species in the urban area.

<u>Summary of the colors in Table 6 from the top down (colors in brackets has relatively low abundances):</u>

Score 3 is the same for all levels of urbanization, except more purple *Trifolium spp.* in rural sites: white/purple, yellow, yellow, white and purple, white/purple.

Rural area (purple and partially pink are the main colors) score 2 from the top down: white/purple, purple, purple/ pink, (yellow), yellow, (yellow), (white), (white), (purple), purple, (purple), (white), (pink), (yellow), (pink), (purple), (white), (purple).

Suburban area (yellow and partially purple are the main colors) score 2 from the top down: (green/ yellow), (purple), purple/ pink, (yellow), white, (purple), (white), yellow, (yellow), (white), (white), (purple), (white/ yellow), (purple/ blue), (yellow), (yellow/ orange), (burgundy).

Urban area (white and partially yellow are the main colors) score 2 from the top down: white/purple, (green/ yellow), white, (purple), (white), (white), (white), (white/purple), (yellow), (deep purple), (yellow), (pink/ red), (white), (pink), (yellow), (yellow).

Table 6: plants with the highest scores (3 and 4). The sampling was conducted rural, suburban, and urban areas in Bergen, Norway (2022) (Tab. 16-18 in appendix D for details). The yellow color marks cells with > zero individuals. Espegrend and Musehagen had the white fenotype of Hieracium sp. while Solvberget had the yellow fenotype.

Latin name	Rural	Suburban	Urban	No. of areas	Color
Epilobium sp.	1	1	1	3	white/purple
Hieracium sp.	1	1	1	3	Yellow
Ranunculus sp.	1	1	1	3	Yellow
Trifolium sp.	1	1	1	3	WHITE and purple
Valeriana sp.	1	1	1	3	white/purple
Aegopodium sp.	1	0	1	2	white/purple
Alchemilla sp.	0	1	1	2	green/ yellow
Carduus sp.	1	1	0	2	purple
Geranium sp.	1	1	0	2	purple/pink
Geum sp.	1	1	0	2	yellow
Heracleum sp.	0	1	1	2	white
Hosta sp.	0	1	1	2	purple
Ligustrum sp.	0	1	1	2	white
Lysimachia sp.	1	1	0	2	yellow
Potentilla sp.	1	1	0	2	yellow
Rubus sp.	1	1	0	2	white
Sambucus sp.	1	0	1	2	white
Allium sp.	1	0	0	1	purple
Antirrinum sp.	0	0	1	1	white
Apiaceae sp.	0	1	0	1	white
Calluna sp.	0	1	0	1	purple
Chamerion sp.	1	0	0	1	purple
Cirsium sp.	1	0	0	1	purple
Claytonia sp.	0	0	1	1	white/ purple
Conopodium sp.	1	0	0	1	white
Digitalis sp.	1	0	0	1	pink
Filipendula sp.	0	1	0	1	white/ yellow
Helianthus sp.	0	0	1	1	yellow
Hypericum sp.	1	0	0	1	yellow
Knautia sp.	0	1	0	1	purple/ blue
Scorzoneroides sp.	0	1	0	1	yellow
Lotus sp.	0	1	0	1	yellow/orange
Lychnis sp.	1	0	0	1	pink
Malva sylvestris sp.	0	0	1	1	deep purple
Melampyrum sp.	0	0	1	1	yellow
Pelargonium sp.	0	0	1	1	pink/red
Prunus sp.	0	0	1	1	white
Rosa sp.	0	0	1	1	pink
Rudbeckia sp.	0	0	1	1	yellow
Sanguisorba sp.	0	1	0	1	burgundy
Sanvitalia sp.	0	0	1	1	yellow
Spergularia sp.	1	0	0	1	purple
Stellaria sp.	1	0	0	1	white
Syringa sp.	1	0	0	1	purple

The plant richness was highest in July (30 species), August had the next highest richness (28 species), and September had significantly less (14 species). *Heracleum* sp., *Hosta* sp. and *Trifolium* sp. were the only plants that were found across all months (**Table 7**). Abundance was high in July but peaked in August and decreased severely in September.

Table 7: Plants with the highest scores (3 and 4). The sampling was conducted during primo July, primo August and primo September in Bergen, Norway (2022) (Tab. 18-21 in appendix D for details). Yellow marks cells with > zero individuals.

Latin name	July	August	September	No. of months
Heracleum sp.	1	1	1	3
Hosta sp.	1	1	1	3
Trifolium sp.	1	1	1	3
Aegopodium sp.	1	1	0	2
Alchemilla sp.	0	1	1	2
Chamerion sp.	0	1	1	2
Claytonia sp.	1	1	0	2
Epilobium sp.	1	1	0	2
Filipendula sp.	1	1	0	2
Geranium sp.	1	1	0	2
Geum sp.	1	1	0	2
Helianthus sp.	0	1	1	2
Hieracium sp.	1	1	0	2
Knautia sp.	1	1	0	2
Scorzoneroides sp.	0	1	1	2
Ligustrum sp.	1	1	0	2
Lotus sp.	1	1	0	2
Lysimachia sp.	1	1	0	2
Melampyrum sp.	1	1	0	2
Pelargonium sp.	0	1	1	2
Potentilla sp.	1	1	0	2
Ranunculus sp.	1	0	1	2
Rudbeckia sp.	0	1	1	2
Sanguisorba sp.	0	1	1	2
Sanvitalia sp.	0	1	1	2
Allium sp.	1	0	0	1
Antirrinum sp.	0	0	1	1
Apiaceae sp.	0	1	0	1
Calluna sp.	0	1	0	1
Carduus sp.	0	1	0	1
Cirsium sp.	1	0	0	1
Conopodium sp.	1	0	0	1
Digitalis sp.	1	0	0	1
Hypericum sp.	0	1	0	1
Lychnis sp.	1	0	0	1
Malva sylvestris sp.	0	0	1	1
Prunus sp.	1	0	0	1
Rosa sp.	1	0	0	1
Rubus sp.	1	0	0	1
Sambucus sp.	1	0	0	1
Spergularia sp.	1	0	0	1
Stellaria sp.	1	0	0	1
Syringa sp.	1	0	0	1
Valeriana sp.	1	0	0	1

4. DISCUSSION

My study shows that the rural part of Bergen had the highest abundance of both *Bombus* and pollinators in general. Moreover, abundances were more even between sites within the rural areas compared to abundances found in urban and suburban sites. *Bombus* occurrence, richness, and sampling sufficiency were highest in the suburban region. *B. pascuorum* had both the highest occurrence and abundance of *Bombus* species in general, while *B. pratorum* was one of the most abundant species in urban areas. *Syrphidae* was the most abundant pollinator group, both across all urbanization areas and the majority of sites. Pollinators rely on their plant hosts, but they also have habitat preferences such as nesting opportunities and proximity to water. The richness of plants declined after the first sampling in July, while abundance had a peak in August. The most abundant genus across all samplings was *Trifolium* spp*.*

4.1 Pollinator abundance

I found that rural areas had a higher abundance of pollinators than the urban areas, followed by the suburban parts of Bergen. This was mainly due to the number of Syrphids. All pollinator groups in the urbanized areas except Syrphids, had roughly the same abundance. The difference in abundance of pollinators between sites was largest in the urban and suburban areas. These results may indicate variation in preferences for habitats and resources between pollinator groups. Factors such as vulnerability to fragmentation, dietary requirements, limitation of nest sites and overwintering possibilities, are species specific (to a certain extent) and will cause various responses between pollinator groups (Bates et al.). Some pollinators also include genus with specific requirements, for example the genera of cleptoparasitic bees (Falk, 2015).

Urban areas are known to have high degrees of heterogeneity, providing beneficial nesting sites for bees and great diversity of both natural and introduced forage plants. This has shown to increase the diversity of bees (Banaszak-Cibicka et al., 2018; Ives et al., 2016), although urban vegetation is typically dominated by non-native plants (Wenzel et al., 2020). Parks may include a wide diversity of micro-habitats and botanical gardens tend to have a large variety of introduced plants, both catering for species with distinct ecological requirements (Banaszak-Cibicka et al., 2018). Studies show that high a concentration of forage plants in a diversified urban area, can have similar abundance and richness of bees as in any natural environment (Baldock et al., 2015; Banaszak-Cibicka et al., 2018). It has also been demonstrated a larger overall diversity of pollinators in urban regions, but not higher than in natural and semi-natural areas (Wenzel et al., 2020). However, a study by Wenzel et al. (2020) address that a large proportion of modified and introduced flowers can displace endemic plants and thereby impose a negative effect on native pollinators.

According to Wenzel et al. (2020), agricultural areas close to the city are often intensively driven with large fields of monocultures and widespread use of agrochemicals. They further claim that urbanization of this type of landscape could in fact increase pollinator reproductive success, survival, and induce colony expansion. Nevertheless, fragmentation due to urban densification and housing showed a reduction in pollination and flower visitation. Plant-pollinator connection in cities had a negative effect on forage specialists and increased pollinator generalist species, thereby increasing flower-visitor generalism and the competition for widely dispersed flowers (Baldock et al., 2015; Banaszak-Cibicka & Żmihorski, 2012; Wenzel et al., 2020).

Bergen is a city with high habitat heterogeneity, including versatile and green environments that occupies a relatively small and narrow surface area. This becomes evident when faced with the city's steep hills, dense building space, roads, small and large parks, fresh and saltwater ponds, and small pockets of green.

The urban and suburban range also includes cemeteries, botanical gardens, green hiking areas, pine and broadleaf forests, private gardens, allotments, green roofs, greenhouses, and flower meadows. This may be the main reason why numbers of pollinator groups are dynamic in the urban and suburban areas. The rural range includes a less heterogenous structure, which may explain the relatively stable numbers across sites; abandoned farmland, active farmland, wetlands, areas of protected nature, less trafficked roads (roads are a major cause of *Bombus* mortality), green hiking areas and the occasional residential area or industrial site (Bollingmo, 2012; Ødegaard, 2015). However, rural areas are usually characterized by higher richness and abundance of blooms (Bates et al., 2011).

The suburban and urban sites are located between mountains, in contrary to most of the rural sites. This can make a great difference for local weather patterns, precipitation especially. The topography of Bergen also affects vegetation in respect to different elevations and solar radiation. The rural sites are closer to sea level and not surrounded by mountains and hills such as the other sites. Thus, rural sites get more sun exposure but may also be more exposed to wind and salt spray from the sea. The wind can affect the local richness and the abundance of certain species, while the solar radiation and the salt affects the soil and local vegetation (Hjelle et al., 2018). The preferred windspeed for bees and hoverflies is < 15 km/ h with an optimum of low to none, while the ideal temperature for bees is a minimum of 20 ∘C and preferably 18-25 ∘C for both bees and hoverflies (Banaszak-Cibicka et al., 2016; Bates et al., 2011).

Another non-human induced difference between my areas of urbanization is the proximity to large bodies of water. The urban sites are exclusively connected to saltwater, suburban sites are closer to freshwater and rural sites are connected to either/ or. Proximity to water can indicate the presence of favored flowers and sites closer to the shore may contain more richness of nectar-rich flowers and flowers in general (Sjödin et al., 2008). An increase in pollen and nectar availability is beneficial to many valuable insects such as pollinators, boosting their richness and abundance (Sivakoff et al., 2018).

The rural region had less variation between sites but included a site (Rambjorga), with much higher abundance than all other sites. This site had particularly high numbers of Syrphidae, Antophila and *Apis mellifera*. The high numbers of *Apis mellifera* could be explained by ecological dominance and that social bee species generally are more abundant than solitary bee species. Social species may have higher survival rates in urban areas as their behavior and ecology allows them more flexibility. Antophila has smaller foraging ranges which makes them less adaptable, and local structure of the landscape is important for their communities. In this study, Antophila is considered all solitary bees (Banaszak-Cibicka et al., 2018; Banaszak-Cibicka & Żmihorski, 2012; Wenzel et al., 2020).

The least abundant pollinator group was Apocrita (parasitic wasps, stinging wasps, and the likes), with particularly low numbers in urban areas and most sites overall. The low abundance may be due to their solitary nature and generally low abundances amongst the key pollinators. (Banaszak-Cibicka et al., 2018; Wenzel et al., 2020).

The rural sites contained features that may explain Syrphid abundance. One example is the site with the highest pollinator abundance and the highest Syrphid abundance (Rambjorga), as it includes elements that prove important for hoverflies; running and still freshwater for larval development and delayed mowing for maximum resource exploitation (Doyle et al., 2020). Low intensity grazing by sheep is a feature that separates this site from all the other sites in this study and may be a clue to the local syrphid abundance. Sheep eat grass, woody plants, legumes and forbs and this is thought to have a negative impact on insects that are dependent on nectar, such as bees and butterflies (Scohier & Dumont, 2012). However, I found more butterflies on this site than anywhere else, and the exact location of my traps was not exposed to grazing although mowed. This implies that the grazer effect on local plants had no effect on local insect communities, but the manure from grazers nearby may create exceptionally good conditions for hoverfly larvae (Doyle et al., 2020).

In addition, the traps were surrounded by tall vegetation and vascular plants which is expected to increase insect diversity in general, specifically diversity and abundance of hoverflies and beetles (Sjödin et al., 2008). Both the trap location and the surrounding landscape had features that resembled flower meadows. A study of pollinator assemblages has shown that farmland has a higher abundance of hoverflies than urban areas. One of the reasons for this may be that flower meadows can increase biodiversity. Native weed is of particular importance early in the season but non-native species also provides pollinators with resources of high significance, which is evident in urban areas (Hicks et al., 2016).

Syrphidae was the most abundant pollinator group in all levels of urbanization and in all sites. One explanation for the high abundance of Syrphids may simply be that these areas have a higher quantity of grassland and complex agricultural landscapes than urbanized areas (Verboven et al., 2014; Walz, 2011). These areas partially remain after small-scale farming and hay meadows. Agricultural landscapes provide shelter, food, and larval habitat in a steady, temporal supply. This ecosystem is particularly attractive for hoverflies when connected to a forest, as woody elements increase local hoverfly abundance (Doyle et al., 2020). The rural sites in my study had a high proportion of woody elements like hedgerows, pine trees and broad leaf trees. Homogenous grassland, organic farms and more floral resources have also shown to increase hoverfly abundance and richness (Power et al., 2016). A study by Walcher et al. (2020) claimed that plant richness is an important factor for both Syrphid richness and abundance, and that the composition of species is roughly the same in both managed and abandoned meadows. Another study on urban grassland found that patches of wildflowers can also increase Syrphid abundance, but that sown and non-sown meadows show no difference (Griffiths-Lee et al., 2022). Nevertheless, hoverfly abundance was lowest in suburban areas although plant richness was highest in this region. The reason may be that the suburban areas are highly cultivated compared to the other areas.

Two Syrphidae species are typically found in agricultural land and flower meadows in the south of Norway; *Episyrphus balteatus* (marmalade hoverfly) (Sundbye, 2022) and a mimic of the honeybee; *Eristalis tenax* (common drone fly) (Hannah et al., 2019; Humleskolen, 2019; Wikipedia, 2022). These may well have been the dominating species in my rural samples, and a search in Artsdatabanken (2023) shows that *E. balteatus* has been registered along the east side of Bergen city and halfway down the valley south of the city (about 27 individuals in my study area and 245 individuals in Hordaland from 1950 until 2019). *E. tenax* was mostly registered downtown Bergen but also throughout the valley south of the city (13 individuals in my study area and 173 individuals in Hordaland from 1950 until 2019). Another explanation of high abundances could be that the hoverflies I found were migratory, as migratory species can appear in high densities. This may be the case for the hoverflies in my rural sites (particularly Rambjorga) (Doyle et al., 2020; Walcher et al., 2020).

Hoverflies are dependent on nectar for food and pollen to develop their ovaries. Floral competition from bees should not be an issue, as Syrphids travel across much longer distances and are usually much more prevalent than all wild bee species in and around agroecosystems (Doyle et al., 2020). Studies have shown that 52 % of 105 global crop plants are visited by hoverflies, which aligns well with my results on Syrphid abundance in the rural region (Rader et al., 2020). Delayed mowing can also contribute to an increase in hoverfly abundance, which is the practice in two (partly three) of the five rural sites (Doyle et al., 2020) On the contrary, four of five (partly all) suburban and urban sites are mowed one or several times during the season.

The high abundance of Syrphids could not be explained by richness, abundance, or occurrence of plants. All three parameters showed minor deviations between the three different urbanization areas. The richness of the most abundant plants in the rural area was barely higher than suburban and urban areas, while occurrence and abundance was slightly lower than suburban and slightly higher than urban. The only other connection to plants that I could measure within the limitations of my study, was the flower color. As purple was the most prevalent flower color in the rural sites, it is reasonable to think that purple is the most favorable color for Syrphids. However, yellow pan traps were most attractive to Syrphids, followed by white pan traps (78 to 58 occurrences). Hickman et al. (2001) supports this by claiming that yellow and particularly fluorescent yellow is very attractive to Syrphids. For that reason, yellow pan traps have frequently been used to trap adult hoverflies. Hickman et al. (2001) also stress that flowers adjacent to the traps function as a counter attractant and may distract hoverflies away from the traps. This does not explain the higher numbers of Syrphids in rural areas where there are less distractions due to the high occurrence of purple. However, it could explain lower abundances in urban areas where there were mostly white flowers, and even lower numbers in the suburbs where yellow colors were dominant.

The other pollinators are also highly attracted to yellow colors. Vane traps and the color yellow are typically used to attract *Bombus* spp., while yellow pan traps are supposedly more attractive to Antophila, *Apis mellifera* (Falk, 2015) and Apocrita (Freeman, 2013). However, *A. mellifera* also shows a preference for blue over white color (Falk, 2015, (Saunders & Luck, 2013)) and wild bees prefer blue vane traps over yellow (Hall, 2018). Studies have shown that vane traps with UV blue colored windows are well suited to capture both *A. mellifera* and wild bees, allegedly because blue or violet flowers look appealing for certain bee species in specific habitats (Saunders & Luck, 2013).

The preference for yellow vs. blue vs. white has differed between pan trapping surveys, implying that bees do not have a particular color preference (Saunders & Luck, 2013). In my study from 2021, the yellow vane traps were of no use while the blue vane trap revealed great sampling success of bumblebees (74 individuals in two collections) compared to the blue vane trap sampling in 2022 (158 individuals in six collections). However, the sampling success of the blue vane traps was the absolute highest amongst traps and amongst pollinator groups. I started my sampling in 2021 about two weeks earlier than in 2022, implying that I might find more bumblebees in case of many early emerging species in my sites. Then again, I only had seven sites in 2021 and most were urban or suburban (rural traps sampled more individuals in 2022), making any comparison highly uncertain. Only four of them were close to the 2022 sites, making it hard to compare sites and samplings across years. All considered, I still would expect more *Bombus* samples from blue vane traps in 2022. In my study from 2022 the yellow pan had the highest trapping rate for Antophila, Syrphidae and Apocrita, but only average trapping success for *A. mellifera* and *Bombus* spp. The white pan traps caught the least numbers of *A. mellifera*. *Bombus* spp. were mostly caught in the blue vane trap, while the other pollinators were mostly caught by the pan traps. These discoveries are in line with the previous studies mentioned above.

In some sites the relative abundance of each pollinator group co-varied with relative abundances of other groups, which could suggest influence of similar effects that takes place between different levels of urbanization. Local variation of flower composition, nesting sites, and human disturbance and of course, natural occurrence by the specific pollinator group. There may also be higher competition between pollinator groups (Ødegaard, 2015). Exposing semi-natural habitats to exotic plants may also interfere with pollinator communities (Banaszak-Cibicka & Żmihorski, 2012).

When *Bombus* abundance was high so was usually Syrphid abundance (Fig. 5), and when there were low numbers of Syrphids there was relatively more Antophila. The latter group was either roughly equally distributed with *Apis mellifera* or their numbers were clearly polarized (Espegrend, Christieparken, Tippetue). The polarization between them seems to have no link to the other pollinator groups but is likely the result from sampling in three very different habitats. One habitat was rural and close to the sea (Espegrend), another was an urban/ suburban park (Christieparken) and the third is an urban site (Tippetue) on the slope of an old agricultural field surrounded by forest. *Apis mellifera* had more affection for the urban sites while Antophila were more attracted to rural sites. *Apis mellifera* is frequently used for beekeeping in urban areas (Rahimi et al., 2022), and this could explain my findings there.

The high numbers of Antophila (and Syrphids) in rural areas may imply low use of pesticides, and high resources. It did not seem to be in any competition with *A. mellifera*. Rahimi et al. (2022) support this claim, as they found no apparent competition between honeybees and wild bees. However, my results showed that all sites contained more *Bombus* than *A. mellifera*, except for the same urban/ suburban park which had divergent numbers of *A. mellifera* and Antophila (Christieparken, swarming was observed), the rural site with the highest abundance of Syrphids and pollinators in general (Rambjorga), a recently abandoned agricultural field within a rural site (Stavollen), and a vast suburban meadow which were frequently mowed (Storetveit) but also had high density of some attractive plants for pollinators (particularly *Trifolium* spp.) and a large community garden in close proximity (Ødegaard et al., 2015). If there in fact was an exclusion of *Bombus* by *A. mellifera* in these areas, then any low numbers of *Bombus* could result from a virus being transferred from the honeybees (or domestic bumblebees) to plants targeted by both groups. This is a common phenomenon, and these areas have potential to sustain honeybees. However, the numbers may merely be coincidental, as multiple studies from eight different countries showed that 38 % of the most dominant species in urban areas are honeybees and that merely 19 % is bumblebees (Rahimi et al., 2022).

4. 2. *Bombus* richness and abundance

The variation of *Bombus* abundance between sites was strikingly similar to that for pollinator abundance, except that no rural site was particularly noteworthy for *Bombus*. This pattern supports my hypothesis stating that *Bombus* abundance is more variable between urbanized areas, but this also implies that *Bombus* spp. may not be as site specific as the other pollinator groups. Bumblebees also has a flight range of more than 1500 m and can easily fly between some of my most adjacent sites. This is not as feasible for small solitary bees, as their foraging range is between 100-600 meters (mainly between 150-750 m). Hoverflies can fly further than bees, and thus is believed to be less vulnerable to human disturbance (Dylewski et al., 2019; Verboven et al., 2014).

Bombus were most abundant in the rural region overall, then suburban closely followed by urban. The urban areas had both the highest and lowest abundance of *Bombus* across different levels of urbanization, closely followed by the suburban area. A similar study by Bates et al. (2011), found the same patterns for bees (and hoverflies) when using the same-colored pan traps with the same colors in the same numbers of traps per site. Two of the rural sites had slightly lower *Bombus* abundances (Liland and Stavollen) and were different from all other sites by being recently abandoned agricultural land. Still, the abundance did not differ much between rural sites and a bias for one of them (Liland) was inactivation of the vane trap at two occasions. These two sites also had a particularly low abundance of plants at the end of the season, which is likely to have caused the relatively low numbers of *Bombus* in those areas. As mentioned earlier, purple flowers were most abundant in rural sites. Some of the plant species had a tint of blue and red and as blue is an attractive color to *Bombus*, this could be the reason why *Bombus* was more abundant in rural areas. And although bumblebees do not perceive the color red, they still visit red flowers (Røsok et al., 2018). In fact, a study by Reverté et al. (2016) found that both purple flowers and lilac-pink flowers reflect in the blue and red region. Purple flowers also reflect in the UV region and lilac-pink flowers partially reflect in the yellow region, whereas the latter also makes sense of using yellow traps to attract *Bombus*.

As stated by previous studies and in my analysis of Bergen as a heterogeneous city, the variety of bumblebee abundance in urban areas underlines that these areas are more heterogeneous than rural regions, (Ives et al., 2016). This implies that some urban sites are more suitable for *Bombus* than others. The highest abundance was found in urbanized forest ecotones, edge structures that separates different habitats such as the vegetational zone between a forest and a road. This environment has shown to improve local biodiversity and create a space for hibernation and settlement (Walz, 2011). Low abundances may be connected to low availability of nesting areas, as it negatively affected bees' density and subsequently bee abundance. Nest building in some urban areas would prove impossible due to impermeable surfaces such as concrete, but vegetation with dense undergrowth and scrubs creating humidity and shade could also make nest building impossible (Banaszak-Cibicka et al., 2016).

When comparing the sites which had similar abundance in urban and suburban sites, I first examined the habitat. The high abundances (19-45 individuals) were recorded in traps positioned between extensive forest and residential areas/ roads/ hiking area (suburban Solvberget and Svartediket, urban Mulen and Tippetue). These characteristics may prove significant as they are also shared with the most pollinator abundant sites in the rural region (Espegrend, Rambjorga and Tennebekk), although to a lesser extent. The remaining low abundance sites have much less forest than the high abundance sites, they are positioned in flat and low altitude areas (specifically the urbanized areas) and do not border to distinctively different habitats (ecotones) and are more influenced by human activity such as planting, mowing and agriculture. These characteristics seem to have a significant impact on *Bombus* abundance (Verboven et al., 2014).

Suburban and urban sites with low abundance of *Bombus* (< 10 individuals) were similar in terms of large-scale mowing and management regimes. Although the most abundant of these sites (7-9 individuals and lowest of suburban sites; Hasteinarparken then Simonsviken and Nordnesparken) had particularly high richness of plants, and the ones with the lowest *Bombus* abundance (1-4 individuals and lowest of urban sites; Christieparken then Storetveit and Musehagen) also had the lowest richness of plants. However, a study by Banaszak-Cibicka et al. (2016) shows that plant richness does not have significant influence on the abundance of bees. This is further exemplified by the low abundance in a city site (Musehagen) that at multiple times were subject to drought, flooding, poor assembly and/ or vandalism. The exceptionally high richness of plants in this site did not mitigate the low abundances (the traps only caught one bumblebee throughout the season). Also, the samples were dominated by stinging wasps – more so than any other site, suggesting competition between the groups. The traps were positioned close to a small unmanaged, wildflower meadow but that did not seem to excel trapping success so perhaps this corner of the garden was too shaded. The pan traps were also dry or empty on several occasions. The higher abundance sites were also subject to drought, flooding, poor assembly and/ or vandalism, but this clearly did not seem to matter much.

Based on the rarefaction curves, the rural sites were most sufficiently sampled, followed by urban, then suburban sites. However, all areas would have the potential to catch more species with increased sampling effort. The insufficient sampling could result from not enough sampling periods, the proximity between sites and possible overlap of populations as some of my urban sites were below the flight range of bumblebees (Verboven et al., 2014). Local effects could be the placement of traps relative to plant abundance and richness, competition for resources (flowering plants and nesting availability), overwintering resources, climate conditions (Pontoppidan, M. Personal comm., 2023) and the potential loss from traps being inactive for shorter periods. Overlapping populations would be more likely across my urban sites than in the other areas, due to relatively short distances between the sites.

The weather and the temperatures fluctuated more than usual during the season and that could have an impact on the number of pollinators caught, or even richness of both pollinators and flowering plants (Bates et al., 2011). The 2022 season's weather was significantly different from the average recordings made between 1991 and 2020. May had a lot more precipitation than usual (more than 100 % above normal) and lower temperatures. July had the same deviations, only less profound. August and September were drier and warmer than normal (Norsk klimaservicesenter, 2023; Pontoppidan, M. Personal comm., 2023). Climate change specifically affects species that are vulnerable to climate variation and that are already living on the brink of what they can tolerate. A reduction in flower resources can accelerate these mechanisms. However, good access to flower resources and healthy habitats can help the most vulnerable bees (Ødegaard et al., 2015).

Starting the sampling earlier in the season could increase the sample size of *Bombus* and possibly the richness too, as some species emerge earlier than others. An example of this is *B. pratorum*, one of the earliest emerging species in Norway. In the latitude of Bergen and surrounding areas the queen is usually active from April but has been observed in March (Hatteland, B.A., pers. comm., 2023), and May to August is the peak period for many *Bombus* species (Røsok et al., 2018; Ødegaard, 2015). The potential for increased numbers of expected species could also be exemplified through my examination of *Bombus* abundance in blue vane traps from 2021 vs. 2022.

Only three out of nine *Bombus* spp. were particularly abundant in the rural region. This may indicate that the most numerous *Bombus* species were generalists, exploiting local resources before less abundant bumblebees could benefit from them. The most abundant species from high to low were *B. pascuorum, B. lucorum* and *B. hypnorum*. By examining their traits and preferences, I find that they are all very common and prefer to reside in the lowlands. *B. pascuorum* is a flexible species and can be found everywhere, although rarely in the mountains but vast in urban areas (Verboven et al., 2014; Ødegaard et al., 2015). Its tongue is noticeably long and enables the bee to visit a wide range of flowers. This species should be well adapted to rural areas of Bergen too, as plant richness is high here. *B. lucorum* is common from the sea to the mountain, where they live in large colonies underground (Ødegaard et al., 2015). This is a short tongued bee and amongst the most common *Bombus* species in Norway (Bossert, 2015). The short tongue is an advantage, as they can nectar rob flowers by biting a hole through the corolla base (Falk, 2015; Røsok et al., 2018).

Bees depend on nest provisioning and cities offers many opportunities for nesting places (Banaszak-Cibicka et al., 2016; Wenzel et al., 2020). However, ground nesting is more available in rural areas, as there is more suitable soil for nest building than in urbanized areas with high levels of impermeable ground cover. 75 % of all bees are ground nesting and are negatively affected by urbanization. However, 60 % of urban bees are ground nesting but cavity nesting species are more abundant in cities (Sivakoff et al., 2018; Wenzel et al., 2020). According to Banaszak-Cibicka et al., (2016) High occurrence of small, cavity-nesting species implies high habitat fragmentation. Thus, extending non-sealed surfaces in urban areas is important for the promotion of ground nesting species. (Wenzel et al., 2020).

B. hypnorum are found anywhere below the tree line and is common both in the city and the forest. Their large colonies are created in nests somewhere dark and shielded above ground, usually in a bird house, a hollow tree or even within a house wall. Their nest preferences would be suitable for the rural areas as there is less light pollution and an abundance of trees for nest building. Common nesting sites in agricultural areas are edge of pastures, elevated mounds in the fields, along water streams and in grass-covered hills (Ødegaard et al., 2015). The high abundances of *B. pascuorum, B. lucorum* and *B. hypnorum*, suggest that they are well adapted to their environments. They are all social species and studies have shown that these do better in urbanized areas due to high adaptability to changing environments, than solitary species (Banaszak-Cibicka et al., 2018).

The suburban area had a higher richness of *Bombus*, higher species occurrence, and a greater median richness than rural and urban areas. Only three of 12 species dominated the suburban samples, which may imply high richness of plants and less competition between species but also high habitat heterogeneity. Banaszak-Cibicka et al., 2016 argues that richness of bees is not particularly affected by plant richness but another study by Buhk et al. (2019) shows positive correlations between number of plant species and pollinator richness. The most abundant species I found are also amongst the most common ones; *B. pratorum, B. pascuorum and B. lucorum*. *B. pratorum* is particularly common and nests either underground or on the surface*, B. pascuorum* nests on the surface but can also nest over ground, while *B. lucorum* is ground nesting. They emerge early and stay below the tree line (Ødegaard et al., 2015).

The number of species was much more variable between sites in the suburban and urban areas than in rural areas (although towards the lower end of the data), but the concentration of richness was high in both. This implies that only a few individuals belong to most of the species sampled (below the median), and that most individuals belong to a few of the species (above the median). This was specifically evident in the suburban areas. Ecotones play an important role in the richness of species as well as abundance. High structural heterogeneity within an ecotone, such as hedgerows, forest fringes, natural disturbances and variation of land use improves regional biodiversity. The urbanized part of Bergen includes those type of environments (Walz, 2011).

Bees depend on flowering plants. Adding floral resources, applying agricultural activities, and providing artificial nests are simple actions that encourage the presence of both specialist and generalist pollinator species (Rahimi et al., 2022). For instance, sustaining bee diversity requires a minimum of 25 % semi-natural habitat including natural and semi-natural plant communities (Zajdel et al., 2019). Further, bee richness is likely to increase with richness of floral species, which in turn is linked to increased urbanization (Dylewski et. al., 2019). Plant richness and abundance is large for both suburban and rural sites, there are less impermeable surfaces than the urban sites and possibly less competition for nesting sites (higher proportion of natural and semi-natural areas). Suburban sites were slightly higher in abundance of flowering plants, which I believe Is the decisive reason behind the high richness of *Bombus*. The fact that many species are found in this area of urbanization also suggests that there is low competition between them, and that they live in an ecologically balanced environment.

Three out of eight species dominated the urban samples, suggesting that these three may be well adapted to the urban environment compared to the less abundant species. It could also mean they compete for resources, implied by the low richness of plants and overall low richness of *Bombus*. However, the few dominant bees are polylectic (plant generalist) bees and highly flexible (Banaszak-Cibicka & Żmihorski, 2012; Bogusch et al., 2020; Sivakoff et al., 2018). Generalist bee species rely mostly on plant cover, not on specific plant species. Urban areas are often dominated by cultivated and exotic plants, but most pollinators do not distinguish between flowers that are native or non-native, and exotic or horticultural blooms do not necessarily equal less attraction (Banaszak-Cibicka et al., 2016; Banaszak-Cibicka & Żmihorski, 2012; Wenzel et al., 2020).

The richness of bees in cities relies on the migration of bees from suburban areas with connections to large green areas (Banaszak-Cibicka et al., 2016). This seems to be reflected by the most abundant bees in my urban sites, as they are the same as in suburban sites but also in the same relative proportions to one another; *B. pratorum, B. pascuorum and B. lucorum.* However, the urban sites are low in richness and low in abundance of bumblebees. Richness can be negatively affected by inadequate nesting and/ or hibernation soil substrates which are connected to high proportions of impervious surfaces, which is often correlated to urban areas. If my assumptions of high competition is right then competition will be high for nesting sites, as the most abundant urban species nest on or below ground level (Banaszak-Cibicka et al., 2016). This may be the reason why so few of the species are dominating the total abundance of *Bombus.* However, a study by Sivakoff (2018) claimed that within a 1000 m radius scale, impervious structures such as fences and buildings increased abundance and richness of cavity nesting bees. However, within a 100-meter range, the results were detrimental to the bees.

Another explanation for the divergence of richness in the urbanized landscapes is high heterogeneity. Different habitats provide opportunities for species in need of different requirements. This is particularly true for bees, as they are less affected by the negative consequences of urbanization than other insects (Banaszak-Cibicka et al., 2016). This also applies to strong flying generalist species such as *Apis mellifera* and certain *Bombus* species (Bates et al., 2011). As the suburban areas in my study have high species richness it suggests that the suburban sites have both high heterogeneity and adequate nesting opportunities.

During the period of my study, overall richness was highest at the end of June and the beginning of July. Until primo August the species richness was mainly two or less, while declining to one and below until the numbers were fixed at one or no species in primo September. The high richness at the beginning of the season may not have been the highest during the months when *Bombus* is active, as my sampling started approximately in the middle of the season.

The most occurring and most abundant species in my samples (*B. pratorum, B. pascuorum and B. lucorum*) have different peaks for separate members of the hive. The queen of *B. pratorum* emerge mid-March and is active until early September, the worker appears late April and is gone by the end of September, while the males are active a month later than workers and stays active until mid-September. *B. pascuorum* only has one generation in the latitude of Bergen and queens may appear as late as May but are registered from late March until early November. Workers appear between the beginning of May and mid-October, while males appear in mid-June and are gone by mid-October. The *B. lucorum* queen is on her wings from March until mid-

October, while workers appear in April and are gone by October. Males appear in May and has been registered until the start of October (Falk, 2015; Ødegaard 2015*)*

As previously mentioned, the richness of flowering plants can increase the richness of pollinators. Therefore, the June/ July period was likely more successful than the subsequent periods due to high levels of blossoming, more abundance and richness of flowers and possibly an overlap of early and late emerging *Bombus* spp. Most bumblebees emerge when the sun heats the nest sites in early spring, along with the blossoming of *Salix* (Bollingmo, 2012; Ødegaard et al., 2015), but some *Bombus* species such as *B. soroeensis* and *B. quadricolor* queens emerge later than most species (Medio April and ultimo July) (Ødegaard et al., 2015). The decline further into the season may be a combination of less abundance and richness of blossoming vegetation, less nesting opportunities (nests already occupied early in the season), less emergence of new species and declines of early emerging species. The bees depend on a continuous supply of nectar and pollen rich plants during the season all throughout the autumn (Ødegaard et al., 2015).

Bombus abundance showed the same trend as richness across the season, numbers were highest at the beginning of the season then declined by each subsequent sampling period. Abundance of *Bombus* is driven by mainly the same mechanisms as richness of *Bombus*, although abundance of bees are not significantly influenced by plant richness (Banaszak-Cibicka et al., 2016). Abundance of *Bombus* relies on abundance of flowering vegetation, nesting opportunities, time of emergence and competition, predator pressure, human disturbance such as traffic and the use of chemicals, changes in temperature, weather and the spread of disease (Baldock et al., 2019; Banaszak-Cibicka & Żmihorski, 2012; Ødegaard, 2015). These terms will vary across the season. *Bombus* species that emerge early in the season will have more resources and larger colonies, less competition for nesting sites and floral resources. However, competition can rise when there is low abundance of flowering plants, particularly in early spring, late fall, and right after mowing in summer (Ødegaard et al., 2015).

The dominant flowers at the start of my field season were *Heracleum sp., Hosta sp., Trifolium sp., and Aegopodium sp.*. *B. pascuorum* was the most abundant *Bombus* species in my study and seems to be particularly attracted to *Trifolium pratense*, the red clover (Buhk et al., 2018). This plant species was abundant throughout the season, and particularly the white subspecies (*Trifolium repens*), which bumblebees also have an affection for (Verboven et al., 2014). The queens of my most abundant species (*B. pratorum, B. pascuorum, B. hypnorum and B. lucorum*) all visit *Prunus sp.* in spring (Falk, 2015). However, *Prunus sp.* was only found in the urban sites and only in July.

B. pascuorum and *B. pratorum* covered the largest proportion of species throughout the season. B. pascuorum was most common in rural sites while *B. pratorum* was most frequently found in urban sites. My findings are in line with the habitat characteristics associated with these species. *B. pascuorum* (also known as “field bee” in Norwegian) is commonly found in rural sites. However, it can also be found in urban green space and gardens (Falk, 2015; Ødegaard et al., 2015). *B. pratorum* is usually found in gardens, wooded settings, brownfield land and scrubby areas (Falk, 2015). *B. pascuorum* was the most occurring species overall (14 sites) and the *B. lucorum* complex had the second highest occurrence (11 sites). As mentioned earlier, *B. pascuorum* and *B. lucorum* are found everywhere in the lowland. *B. pascuorum* can easily fly in harsh weather and keeps active throughout the autumn (Ødegaard et al., 2015). However, they have small colonies in comparison to *B. lucorum* which can explain why *B. lucorum* was found in almost as many sites (Falk, 2015). However, the *B. lucorum* complex includes three species (*B. lucorum, B. cryptarum, B.magnus*) and the numbers could be high solely for that reason. These sub species are also amongst the most common *Bombus* species in Norway (Bossert, 2015).

One of the urban sites (Svartediket) had three of the four species that I recorded only once, *B. cingulatus, B. jonellus and B. quadricolor*. The two former species are similar in their affinity for heather plants and forest habitats at higher altitudes. The site they were found in is relatively high in altitude compared to the other sites and is situated close to extensive forest and alpine habitat characteristics such as heather, mountain birch and bare rock. *B. jonellus* is quite common, particularly in areas with *Calluna vulgaris* (*C. vulgaris* occurred in this site, yet no bloom was observed, and the species was not registered although it should bloom in late July). *B. cingulatus* is less common and is only found once in the county of Hordaland. I found a queen, but it can be easily mixed up with the queen *of B. hypnorum. B. quadricolor* is a social parasite on the rather common species of *B. soroeensis*, but it does not share the habitat preferences of the two other species I found. It is one of the rarest species in Norway and its identity has not been verified by DNA analysis. However, an overwhelming number of records on *B. quadricolor* are from Bergen. The determining factor for identification was its genitals (male), ruling out other species characteristics such as the number of stripes and the hatch in tergite number seven (Ødegaard et al., 2015). Several things could have brought it to this site from afar, e.g., strong winds or by human mediated transport. This may also be the case with the other less common or rare species I found, or identification was erroneous.

This specific site (Svartediket) also had the highest richness of all sites in general and seems to be an ideal site for several reasons; it is an ecotone situated inside a broad leaf forest, on the border between urban gardens and a pine forest with a busy hiking trail. It is also located in an old abandoned agricultural area, on a steep slope with primarily native species of high abundance (specifically during my early samplings). The site sits above a large dam at the end of a narrow valley surrounded by steep mountains, which suggests that this area may experience very local weather patterns. It would be interesting to see if this influenced local pollinator communities.

I investigated how the numbers and proportions of these species compare to the same species found in other parts of the country. According to records in artsdatabanken (2023), the typical species found in the city versus the countryside in the last 30 years or so were from highest to lowest: *B. pratorum, B. hypnorum, B. lucorum* and some *B. pascuorum* in the city, while *B. terrestris, B. hypnorum, B. pascuorum* and some *B. pratorum* were more common in the rural area. However, light colored *B. terrestris* can sometimes be hard to tell apart from *B. lucorum*, so these observations may not be reliable (Ødegaard et al., 2015). These findings are mostly in line with my results.

The fourth species that was registered only once is *B. balteatus*, while *B. muscorum, B. norvegicus, B. bohemicus* and *B. sylvestris* were low in abundance. *B. bohemicus and B. sylvestris* were found in all my study areas. *B. bohemicus* is the most common cuckoo bee, a social parasite on *B. lucorum* and found anywhere *B. lucorum* is. *B. sylvestris* is quite common, a social parasite on *B. pratorum* that is found anywhere the host is but below the tree line. *B. norvegicus* is usually quite common and was found in the urbanized areas, *B. muscorum* was found in both suburban and rural areas but is usually found closer to the coast, while *B. balteatus* was found in a rural site (Liland). This species normally lives above the tree line, from mountain birch forest habitats to the mid-alpine zone (Ødegaard et al., 2015). All these species have had low occurrences in Bergen (Artsdatabanken, 2023). *B. balteatus* registered once in Bergen in 1898, *B. muscorum and B. bohemicus* were each found four times in the late 1800 and once in the 60's*, B. norvegicus* two times in the 50's*,* and *B. sylvestris* has been registered 12 times, where three of them were in the late 1800 and the rest between 1950 and 1970. Although none of my species have been verified by DNA-tests yet, I believe there must have been found more of these bumblebees in Bergen, but that they have not yet been identified and/ or verified and registered in public data records.

4.3 *Bombus* spp. composition per site

There was a strong correlation between the three most abundant *Bombus* spp. and a few specific sites. *B. pratorum* was most abundant in urban sites but it was also frequently found in suburban sites, while *B. lucorum* thrived best in suburban sites, and *B. pascuorum* was most abundant in rural sites. As previously mentioned, these are generalist species with characteristics that make them highly adaptable to most environments. *B. lucorum* does not have specific habitat preferences either (Ødegaard, 2015), yet this may be the exact reason why it was most abundant in suburban sites, which include both urban and rural qualities.

The variation between sites could not be explained by my urbanization labels, as they are only terms made by my subjective assessment of the landscape. However, the rural sites were clustered along the PC2 axis, indicating that some of the variation could be explained by habitat characteristics or perhaps similarities in species' composition due to relatively high habitat homogeneity. Suburban sites were more spread out across the plot than the other sites, which makes sense in terms of longer geographic distances between sites than the other areas and the highest richness of *Bombus*. The distance in the plot implies generally high variation between sites. On the other hand, some of the urban sites were positioned far apart despite the lowest richness of my three urbanization areas and tight geographical location between sites. The urbanized areas were fairly aligned with the PC1 axis, urban areas in particular. This implies that the variation in these sites were mostly explained by one or several underlying factors along this axis. This variation could be one or several common characteristics between sites such as species composition or traps being positioned in open habitats, on a hill, surrounded by a landscape with grass mounds or in an ecotone. This type of habitat is also excellent for nest building, which may well be the main explanation for variation as nest availability is important for bees (Wenzel et al., 2020).

Aside from site classification, it appears that high elevation, forest ecotones are positioned on the left side along the PC1 axis while parks, hiking and recreational areas are found on the right end of the PC1 axis. From this point of view, the variation explained PC1 may be linked to high abundance and/ or high-quality habitats for pollinators on the left side, and low abundance and/ or low-quality habitats for pollinators on the right side. By also analyzing PC2 from a new angle, there may be some influence by flower richness as most of the high richness sites are adjacent and aligned vertical to the PC2 axis.

The most common species I caught in the five sites that both me and Astrid Løken sampled was (from highest to lowest); *B. pascuorum, B. pratorum, B. hypnorum and B. lucorum.* They also held the highest number of sites per species and total richness in these sites was 13. The same species were most abundant throughout all my data from 2022. Astrid Løken found many of the same species as me, and then (from highest to lowest); B. *pratorum, B. rupestris, B. hortorum, B. magnus, B. hypnorum* and *B. soroeensis*. I did not find any individuals of the cuckoo bumblebee *B. rupestris,* nor the more common species that it preys on; *B. lapidarius.* However, not many of those species have been found in the Bergen area, although they thrive in both cultural landscapes and suburban areas (Ødegaard, 2015).

The richness from her sampling in the common sampled sites was 12 but the number of sites where each species occurred was also lower than mine, although more even across species. These findings tell me that there have been some major changes over the last seven or so decades, and historical maps can reveal that Bergen has indeed gone through some large transitions from vast green areas to a more urbanized landscape, particularly between 1960 to 1980 (Bergenskart, 2023; Bergen kommune, n.d.). Although she sampled over a longer period many years ago and used a different method than me, she found less species but both the numbers per species and the occurrence per site were more evenly distributed. I suspect that this is partially due to less variation between urban, suburban, and rural areas between the 50's and the 80's than now.

Many of Løken's sites contained the same species as my sites and whilst her most adjacent sites showed a geographical correlation, my adjacent sites were connected by similarities in abundance and richness regardless of geographical proximity. Most of the variance in species composition by site were explained by site characteristics. There were close connections between my sampling in a midtown city location (Musehagen) and Løken's sampling in one suburban and one rural site (Milde and Munkebotn). The most obvious connection between those sites is the total dominance of *B. pratorum* in each of them.

The midtown city site just mentioned (Musehagen) is the only site sampled by both me and Løken that for certain has the exact same location. The variation between our samplings in this location is small compared to the variation in the two other matching sites above. *B. pratorum* was also dominant in Løken's samples here, although she found other species too. There were two more connections that showed little variation, one suburban (Munkebotn/ Solvberget) and one rural site (Espegrend/ Espegrend). The relatively close connections could result from low levels of urbanization in these sites during the past 70 years of sampling.

The two last matching sites that were sampled by both me and Løken, also had approximately the same measure between sites - yet of greater magnitude than the other common sites mentioned. One site was urban (Mulen (Mulesvingen)/ Sandviken) and the other was suburban (Svartediket/ Svartediket). The urban site had *B. pratorum* as the most dominant species, although there was only one individual recorded in this site by Løken and 10 in my samples - which is likely the reason for the large variation. The suburban site showed a similar trend as I found most of *B. pascuroum*, although 14 individuals against Løken's 12 but then again, the only species in her samples from this site.

The large differences across time could be explained by more urbanization in these areas, particularly by increased building activity and the time passed since the areas were used for agricultural purposes (Appendix C, Fig. 23) (Åström et al., 2021). Both areas are located close to the forest and are found in steep terrain. However, I have not been able to find a solid source for the specific usage of these exact areas, but the University of Bergen has a collection of old photographs from one of the suburban sites (Svartediket) showing how it may have looked like in the last half of the 20th century (Universitetet i Bergen, n.d.)

4.4 Limitations of methods

Sites

Some sites could have been classified on a different urbanization level. This is primarily the case for some of the sites classified as urban, that could as well have been suburban based on the distance from the city center (e.g., Svartediket, Håsteinarparken). Another site could have been labeled the other way around (Christieparken), both because of proximity to the city but also by being positioned within a residential area. However, it is challenging to identify and set any boundaries between the different levels of urbanization. The short distance between some of the sites could cause an overlap of the same *Bombus* species making it challenging to see which species are adapted to and living in the environment they are found in, or if they were just passing by. Species found in adjacent sites could also be from the same colony and easily fly between sites.

Traps

The number of active pollinators is likely reduced with the amount of precipitation and wind, also reducing the number of pollinators getting caught by the traps. Bumblebees is an exception, as they are robust and can handle cold weather (Røsok et al., 2018; Ødegaard, 2015). Also, traps positioned in open and unmanaged green space may increase the number of bumblebees caught (Ødegaard et al., 2015). When the number of *Bombus* is high in vane traps compared to pan traps and the number of hoverflies in pan traps are high, it can make an illusion of less *Bombus* in the system than Syrphidae, when the reason might just be that vane traps are not as successful at catching *Bombus* as pan traps are at catching Syrphidae. Sampling bias can also occur when traps are flooded and/ or dismounted.

Sampling methods

The different sampling methods used by me and Løken probably yielded different results. Løken most likely used active methods of sweep netting and observations while I used several passive sampling methods. However, it is not possible to distinguish all samples in the field or even make reliable estimates from observations. Many of the samples would need to be killed either by killing jars or passive traps (Falk, 2015).

Løken distinguished between the three species in the *B. lucorum* complex *B. cryptarum, B. magnus* and *B. lucorum* in her dataset, while I did not sort these by species. She advocated for their status as species, as she measured differences between their queens in a morphometric analysis (Bossert, 2015). Nevertheless, all her individuals in the *B. lucorum* complex were found in Espegrend so it does not interfere with the DCA.

I could not find the exact position of Løken's sites as locations such as Sandviken, Munkebotn and Svartediket cover a large and versatile area. Hence, I could only set the boundaries of these areas by comparing the distance against the illusory boundary of other nearby sites.

4.5 Future research

As both urbanization and the natural environment have immense impacts on pollinator communities, it would be valuable to get a more thorough overview of Bergen and surrounding areas. An MCE analysis in GIS would be useful for evaluation of these factors. This feature is widely employed as a measure of urbanization (Ahrné et al., 2009; McKinney, 2008). Every study site would be divided into one or several buffer zones with detailed information about the extent of human induced modification, the percentage of flowering plants, roads, buildings, and the population density. Adding more layers to the map could be helpful, calculating slope angle, aspect (which may indicate the number of nests) and sun exposure (optimal areas for plant growth and pollination). Comparing zones with the same radius between sites could be a baseline for further discussion of the potential in these areas and how to sustain a rich community of pollinators.

It would be interesting to explore possible effects of local nesting opportunities, climate, rare plant genus and/ or species, and species of all sampled pollinator groups, *Bombus* spp. gender data and to do a DNA verification of the rarest *Bombus* species I found. Certain pollinators are challenged when then temperature in cities are rising, and knowing which species that reside in the urban areas would be valuable in order to protect them (Harrison & Winfree, 2015; Venter et al., 2020). Conservation and creation of green space and maintaining pollinator abundance and diversity, requires engagement of both city residents and city planners (Hall et al., 2017). My research on pollinators inspires me to further investigate the precise methods in which I could contribute.

5 CONCLUSION

Pollinators were more abundant in the rural region, with declining numbers following an increase of urbanization. The abundance between pollinators was roughly the same across all areas except significantly higher numbers of hoverflies, solitary bees, and honeybees in the rural region.

I found a slight increase of *Bombus* abundance with distance from the city and richness followed the same overall trend. However, the rural region had less richness than the suburban area and was only slightly more species rich than the city. Also, both the highest and the lowest abundances were found in urbanized sites. The richness of plants seemed to influence the richness of *Bombus*, as there was a distinct increase of plant genera with increased distance from the city center. Plant abundance followed the same tendency as *Bombus* richness, with lowest numbers in the city, higher abundance in the suburbs, then slightly dropping in the rural region. This implies that the abundance of *Bombus* may have fluctuated proportionally with the abundance of plants, but something else contributed to the high numbers of *Bombus* in the rural area. Some possible explanations could have been less human induced disturbance such as less traffic and less fragmentation, less competition, higher nesting availability and more mating opportunities (Ødegaard, 2015). The general increase of pollinators from urban to rural areas may imply that plant richness and abundance have a great impact on pollinators overall. However, hoverflies and honeybees had their lowest abundances in the suburban region despite the high richness of plants.

Although the rural and suburban regions seemed to have more resources and green space than the urban areas, I found that urban and particularly suburban areas were more heterogenous than the rural region. I have learned that this feature is neither particularly positive nor negative for bees in general, but it seemed as if most bumblebees favored the intermediate conditions of the suburbs after all.

Urban and especially suburban areas showed larger disparity of species composition between sites sampled by both me and Løken, than rural areas. Most of the species with the highest abundance were common in both our samplings, except that Løken sampled higher numbers of *B. hypnorum.* She also found high numbers of a species that I did not find, *B. rupestris*. The species richness and abundance of *Bombus* in Løken's sites could mostly be explained by environmental characteristics, while the composition by site of my specimens were more species related. The different species in my study were much more active, visiting a lot more sites than Løken's specimens. The species she sampled were highly site specific. This implies that there are more diffuse limits between urbanized and less urbanized areas of Bergen now than between 1950 and 1978.

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APPENDIX

Appendix A – Pollinator abundance

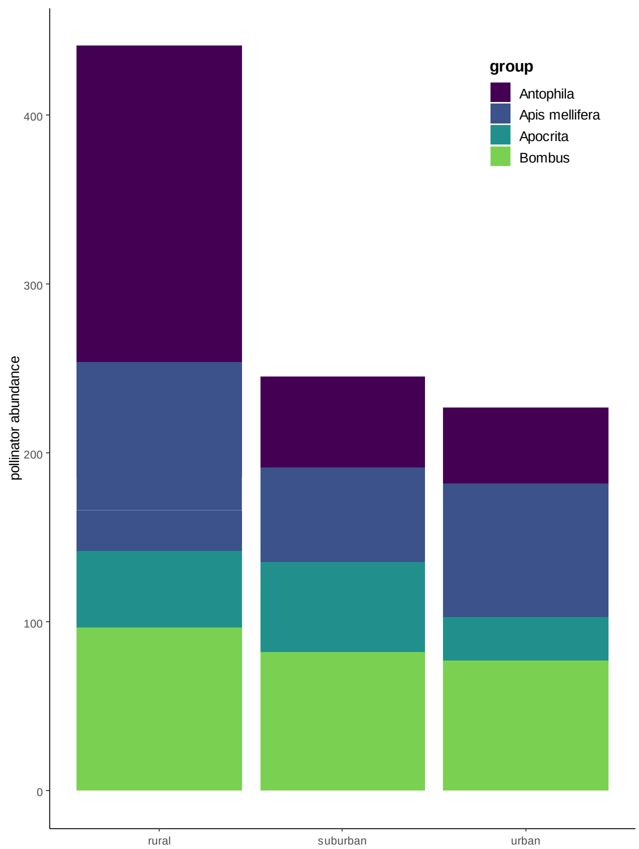

Figure 14. Abundance of all pollinator groups except Syrphidae, in Bergen, Norway (2022). Sorted by level of urbanization, from the left; rural, suburban and urban.

Appendix B – *Bombus* abundance and richness

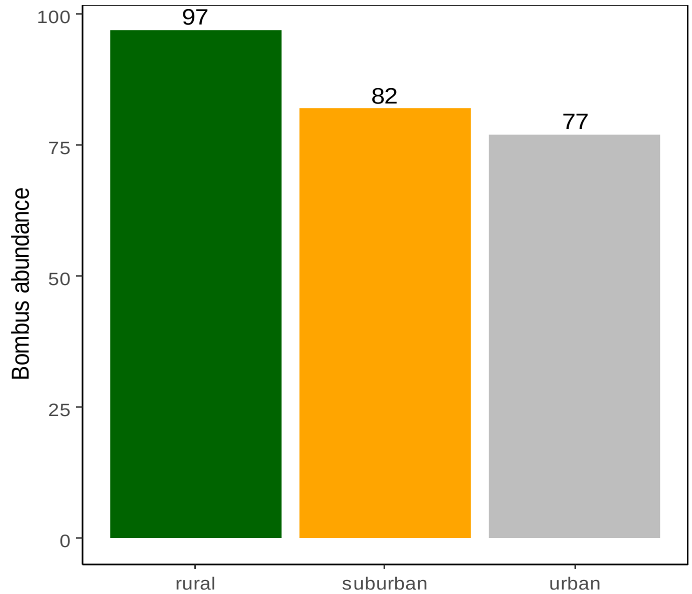

Figure 15: Bombus abundance by level of urbanization in Bergen, Norway (2022). Differentiated by color: rural in green, suburban in yellow and urban in grey.

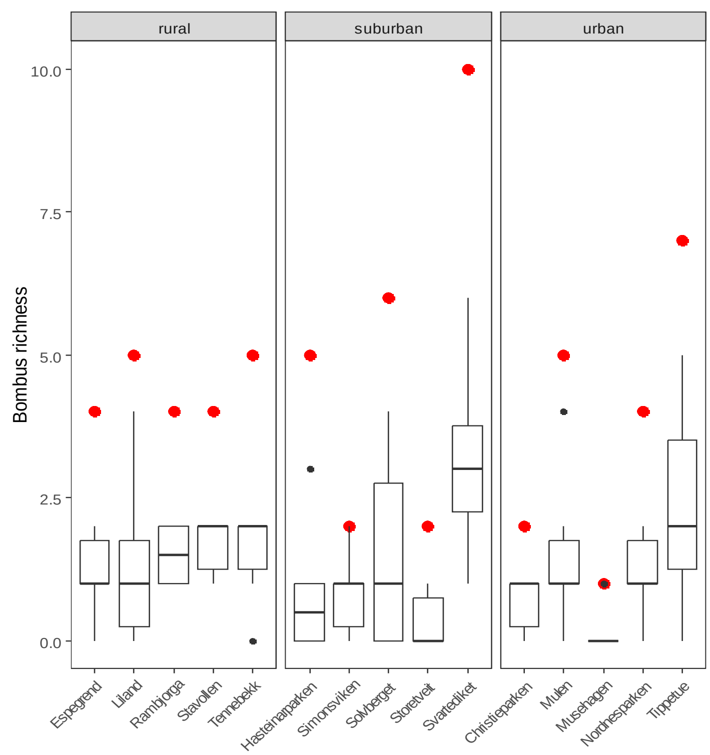

Figure 16. Richness of Bombus per. site, divided into rural, suburban and urban areas of Bergen, Norway (2022). Black dots show outliers and red dots show the total richness per. site.

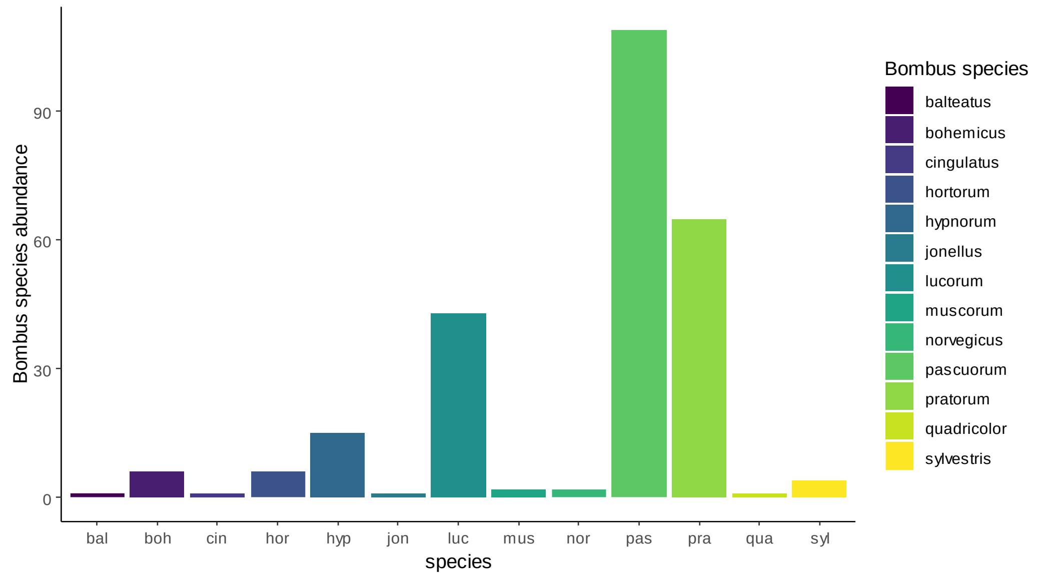

Figure. 17: Bombus abundance by species, in Bergen, Norway (2022).

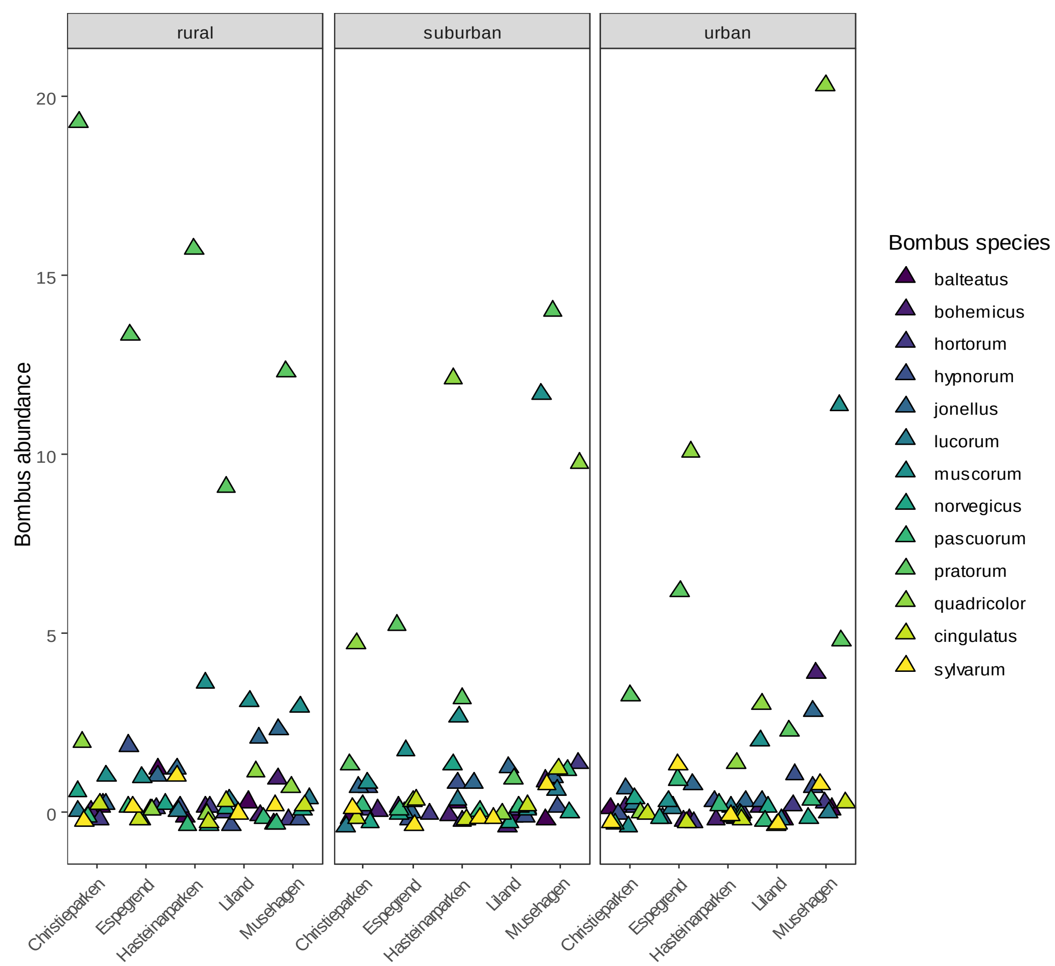

Figure 18: Bombus richness per site divided into rural, suburban and urban areas of Bergen, Norway (2022). Levels of urbanization are differentiated by color, from the left; rural in green, suburban in yellow and urban in grey.

Table 8: Bombus abundance and richness in suburban areas of Bergen, Norway (2022). Sorted from highest to lowest by richness. A total of *12 species were sampled in the suburban sites.*

Suburban sites	Species	Abundance	Richness
Hasteinarparken	B. pascuorum	1	5
Simonsviken	B. pascuorum	5	5
Solvberget	B. pascuorum	3	5
Storetveit	B. pascuorum	1	5
Svartediket	B. pascuorum	14	5
Hasteinarparken	B. hypnorum	1	4
Solvberget	B. hypnorum	1	4
Storetveit	B. hypnorum	1	4
Svartediket	B. hypnorum	1	4
Hasteinarparken	B. lucorum	1	4
Simonsviken	B. lucorum	2	4
Solvberget	B. lucorum	3	4
Svartediket	B. lucorum	12	4
Hasteinarparken	B. pratorum	5	3
Solvberget	B. pratorum	12	3
Svartediket	B. pratorum	10	3
Hasteinarparken	B. hortorum	1	2
Solvberget	B. hortorum	1	2
Svartediket	B. bohemicus	1	1
Svartediket	B. cingulatus	1	1
Svartediket	B. jonellus	1	1
Solvberget	B. muscorum	1	1
Svartediket	B. norvegicus	1	1
Svartediket	B. quadricolor	1	1
Svartediket	B. sylvestris	1	1

Table 9: Bombus abundance and richness in rural areas of Bergen, Norway (2022). Sorted from highest to lowest by richness. A total of *nine species were sampled in the rural sites.*

Rural sites	Species	Abundance	Richness
Espegrend	B. lucorum	1	5
Liland	B. lucorum	1	5
Rambjorga	B. lucorum	4	5
Stavollen	B. lucorum	3	5
Tennebekk	B. lucorum	3	5
Espegrend	B. pascuorum	19	5
Liland	B. pascuorum	13	5
Rambjorga	B. pascuorum	16	5
Stavollen	B. pascuorum	9	5
Tennebekk	B. pascuorum	12	5
Liland	B. hypnorum	1	4
Rambjorga	B. hypnorum	1	4
Stavollen	B. hypnorum	2	4
Tennebekk	B. hypnorum	2	4
Espegrend	B. pratorum	2	3
Stavollen	B. pratorum	1	3
Tennebekk	B. pratorum	1	3
Liland	B. balteatus	1	1
Tennebekk	B. bohemicus	1	1
Liland	B. hortorum	2	1
Espegrend	B. muscorum	1	1
Rambjorga	B. sylvestris	1	1

Table 10: Bombus abundance and richness in urban areas of Bergen, Norway (2022). Sorted from highest to lowest by richness. A total of eight species were sampled in the urban sites.

Urban sites	Species	Abundance	Richness
Christieparken	B. pascuorum	3	4
Mulen	B. pascuorum	6	4
Nordnesparken	B. pascuorum	2	4
Tippetue	B. pascuorum	5	4
Mulen	B. pratorum	10	4
Musehagen	B. pratorum	1	4
Nordnesparken	B. pratorum	3	4
Tippetue	B. pratorum	20	4
Christieparken	B. hypnorum	1	3
Mulen	B. hypnorum	1	3
Tippetue	B. hypnorum	3	3
Nordnesparken	B. hortorum	1	2
Tippetue	B. hortorum	1	2
Nordnesparken	B. lucorum	2	2
Tippetue	B. lucorum	11	2
Mulen	B. sylvestris	1	2
Tippetue	B. sylvestris	1	2
Tippetue	B. bohemicus	4	1
Mulen	B. norvegicus	1	1

Table 11: Abundance of Bombus spp. and where I found them, along with the number of sites each species was found in. «Abundance sum» shows the total abundance of individuals (regardless of species) found in the respective site throughout the season. Sorted by occurrence of each species by site.

Site	Area	Species	Abundance	Abundance sum	Occurrence per site
Christieparken	urban	*B. pascuorum*	3	4	14
Espegrend	rural	*B. pascuorum*	19	23	14
Hasteinarparken	suburban	*B. pascuorum*	1	9	14
Liland	rural	*B. pascuorum*	13	18	14
Mulen	urban	*B. pascuorum*	6	19	14
Nordnesparken	urban	*B. pascuorum*	2	8	14
Rambjorga	rural	*B. pascuorum*	16	22	14
Simonsviken	suburban	*B. pascuorum*	5	7	14
Solvberget	suburban	*B. pascuorum*	3	21	14
Stavollen	rural	*B. pascuorum*	9	15	14
Storetveit	suburban	*B. pascuorum*	1	2	14
Svartediket	suburban	*B. pascuorum*	14	43	14
Tennebekk	rural	*B. pascuorum*	12	19	14
Tippetue	urban	*B. pascuorum*	5	45	14
Espegrend	rural	*B. lucorum*	1	23	11
Hasteinarparken	suburban	*B. lucorum*	1	9	11
Liland	rural	*B. lucorum*	1	18	11
Nordnesparken	urban	*B. lucorum*	2	8	11
Rambjorga	rural	*B. lucorum*	4	22	11
Simonsviken	suburban	*B. lucorum*	2	7	11
Solvberget	suburban	*B. lucorum*	3	21	11
Stavollen	rural	*B. lucorum*	3	15	11
Svartediket	suburban	*B. lucorum*	12	43	11
Tennebekk	rural	*B. lucorum*	3	19	11
Tippetue	urban	*B. lucorum*	11	45	11
Christieparken	urban	*B. hypnorum*	1	4	10
Hasteinarparken	suburban	*B. hypnorum*	1	9	10
Liland	rural	*B. hypnorum*	1	18	10
Mulen	urban	*B. hypnorum*	1	19	10
Rambjorga	rural	*B. hypnorum*	1	22	10
Solvberget	suburban	*B. hypnorum*	1	21	10
Stavollen	rural	*B. hypnorum*	2	15	10
Storetveit	suburban	*B. hypnorum*	1	2	10
Svartediket	suburban	*B. hypnorum*	1	43	10
Tennebekk	rural	*B. hypnorum*	2	19	10
Tippetue	urban	*B. hypnorum*	3	45	10
Espegrend	rural	*B. pratorum*	2	23	10
Hasteinarparken	suburban	*B. pratorum*	5	9	10
Mulen	urban	*B. pratorum*	10	19	10

Musehagen	urban	*B. pratorum*	1	1	10
Nordnesparken	urban	*B. pratorum*	3	8	10
Solvberget	suburban	*B. pratorum*	12	21	10
Stavollen	rural	*B. pratorum*	1	15	10
Svartediket	suburban	*B. pratorum*	10	43	10
Tennebekk	rural	*B. pratorum*	1	19	10
Tippetue	urban	*B. pratorum*	20	45	10
Hasteinarparken	suburban	*B. hortorum*	1	9	5
Liland	rural	*B. hortorum*	2	18	5
Nordnesparken	urban	*B. hortorum*	1	8	5
Solvberget	suburban	*B. hortorum*	1	21	5
Tippetue	urban	*B. hortorum*	1	45	5
Mulen	urban	*B. sylvestris*	1	19	4
Rambjorga	rural	*B. sylvestris*	1	22	4
Svartediket	suburban	*B. sylvestris*	1	43	4
Tippetue	urban	*B. sylvestris*	1	45	4
Svartediket	suburban	*B. bohemicus*	1	43	3
Tennebekk	rural	*B. bohemicus*	1	19	3
Tippetue	urban	*B. bohemicus*	4	45	3
Espegrend	rural	*B. muscorum*	1	23	2
Solvberget	suburban	*B. muscorum*	1	21	2
Mulen	urban	*B. norvegicus*	1	19	2
Svartediket	suburban	*B. norvegicus*	1	43	2
Liland	rural	*B. balteatus*	1	18	1
Svartediket	suburban	*B. cingulatus*	1	43	1
Svartediket	suburban	*B. jonellus*	1	43	1
Svartediket	suburban	*B. quadricolor*	1	43	1

Table 12: PCA scores of sites sampled in Bergen, Norway (2022).

Site	PC1	PC2	PC3	PC4	PC5	PC6
Christieparken	0,838995	0,02036	-0,03361	-0,30573	0,67393	-0,08461
Espegrend	0,022753	0,59776	1,38841	0,35734	-0,66393	-1,17041
Hasteinarparken	0,029664	-0,9709	-0,18635	0,49151	0,02645	0,32693
Liland	0,413279	0,80832	0,03311	1,57356	0,32522	1,53717
Mulen	-0,254233	-0,57883	1,75734	-0,52639	1,11473	0,48546
Musehagen	0,844968	-1,05262	-0,31338	-0,69284	-0,41186	-0,01358
Nordnesparken	0,066508	-0,53795	-0,21972	0,43788	-1,09628	0,38989
Rambjorga	0,091346	1,16598	-0,26168	-0,35215	-0,08076	0,04038
Simonsviken	0,518732	0,43341	-0,36561	-0,35932	-0,95711	-0,19144
Solvberget	-0,584503	-0,75029	0,30415	0,95547	-0,59823	-0,68678
Stavollen	-0,004756	0,55613	-0,26051	-0,01676	0,31807	-0,53109
Storetveit	0,943983	-0,36733	-0,45324	-0,49515	0,55865	-0,02015
Svartediket	-1,294484	0,3979	0,08864	-1,30024	-0,75578	1,12145
Tennebekk	-0,14347	0,70667	-0,41063	-0,06409	0,72236	-0,79335
Tippetue	-1,488782	-0,42859	-1,06692	0,2969	0,82453	-0,40985

Table 13: PCA scores of Bombus species sampled in Bergen, Norway (2022).

Species	PC1	PC2	PC3	PC4	PC5	PC6
B. balteatus	0,04045	0,07911	0,003241	0,15401	0,03183	0,15045
B. bohemicus	-0,47907	0,01071	-0,273976	-0,06606	0,184109	-0,06103
B. cingulatus	-0,1267	0,03894	0,008675	-0,12726	-0,07397	0,10976
B. hortorum	-0,1294	-0,13767	-0,109261	0,45764	-0,03211	0,20128
B. hypnorum	-0,2964	0,0851	-0,190776	0,04958	0,446529	-0,01948
B. jonellus	-0,1267	0,03894	0,008675	-0,12726	-0,07397	0,10976
B. lucorum	-0,97751	0,3854	-0,443464	-0,02629	-0,265306	-0,02348
B. muscorum	-0,05498	-0,01493	0,165657	0,12849	-0,123532	-0,18177
B. norvegicus	-0,15158	-0,01771	0,180672	-0,17878	0,035132	0,15727
B. pascuorum	-0,50817	1,09428	0,372127	0,10513	0,058848	-0,01654
B. pratorum	-1,28383	-0,75489	0,305384	0,04498	0,009957	-0,03433
B. quadricolor	-0,1267	0,03894	0,008675	-0,12726	-0,07397	0,10976
B. sylvestris	-0,28835	0,05446	0,050637	-0,18419	0,107927	0,12111

Appendix C – *Bombus* composition and historical records

Table 14: My two periods of Bombus sampling in and around Bergen 2021 (two collections) and my 6 periods of sampling in 2022 (12 collections). Table sorted from high to low abundance of Bombus species 2022.

Species	2021	2022
B. pascuorum	6	109
B. pratorum	34	65
B. lucorum	6	43
B. hypnorum	5	15
B. hortorum	11	6
B. bohemicus	0	6
B. sylvestris	0	4
B. jonellus	2	1
B. wurflenii	3	0
B. magnus	2	0
B. muscorum	0	2
B. norvegicus	0	2
B. quadricolor	1	1
B. balteatus	0	1
B. cingulatus	0	1

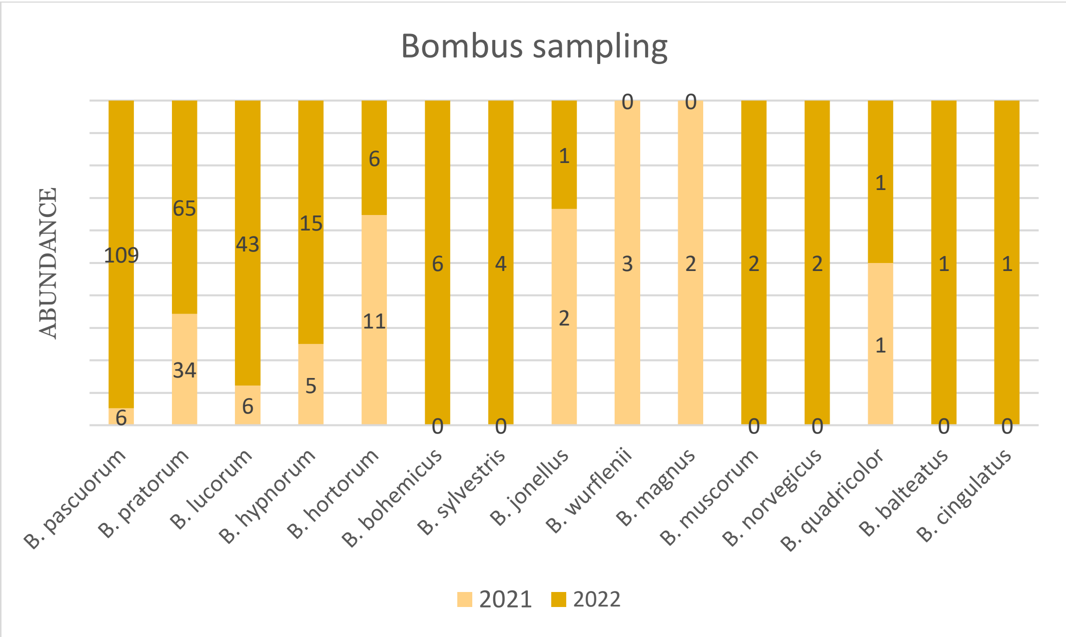

Figure 19: My two periods of Bombus sampling in and around Bergen 2021 (two collections) and my six periods of sampling in 2022 (12 collections). The figure is sorted from high to low abundance of Bombus species, from left to right (Artsdatabanken, 2021).

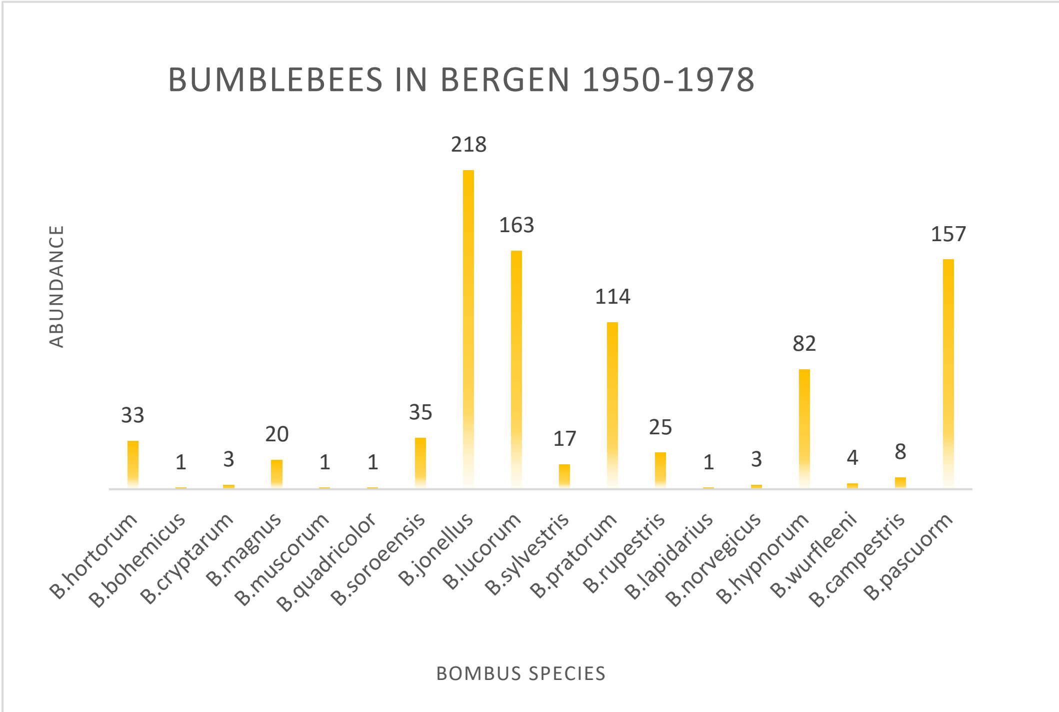

Figure 20: Astrid Løkens 18 years of Bombus sampling in all sites in and around Bergen (Artsdatabanken, 2021).

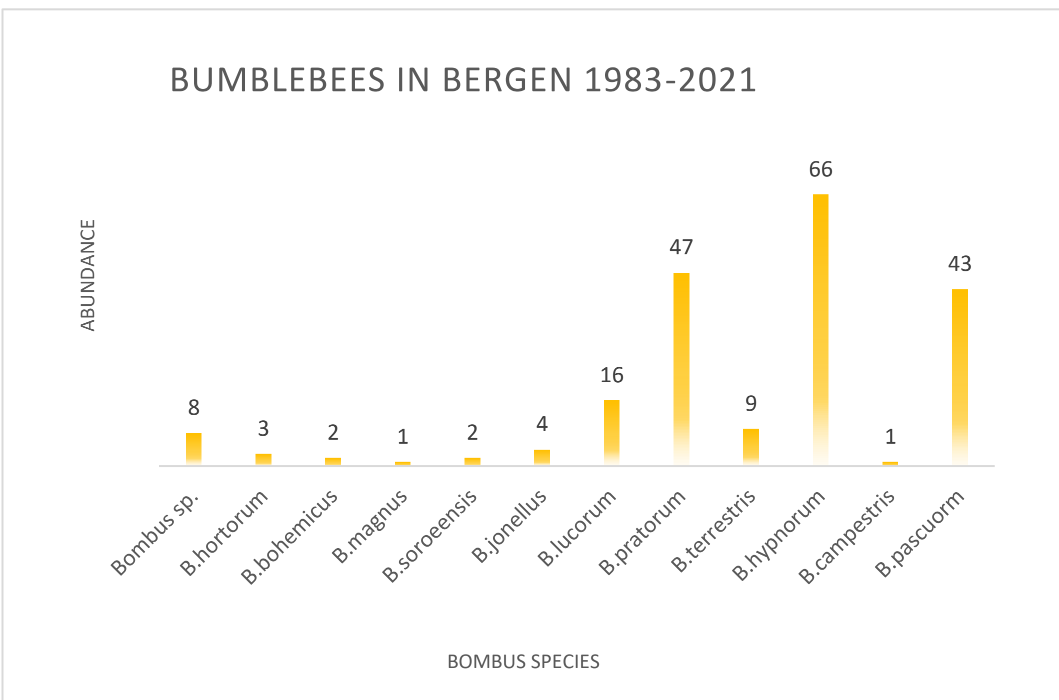

Figure 21: Abundance of Bombus in Bergen, Norway 1983-2021 (Artsdatabanken, 2021).

Table 15: Abundance of Bombus species sampled by Løken in sites not sampled by me, with > 10 individuals per species, in Bergen, Norway (2022). The table is sorted from highest to lowest number of occurrences per site. The yellow color marks cells with > zero individuals.

Common name	Latin name	Fan toft	Fles land	Kors nes	Milde	Paradis	Raa dalen	Saga nes	Steins vik	Stend	Occurrence per site
akerhumle	*pascuorum*	0	0	0	0	0	14	20	16	33	5
lys jordhumle	*lucorum*	27	11	49	0	0	0	0	0	0	4
markhumle	*pratorum*	0	0	0	13	0	0	0	0	0	2
trehumle	*hypnorum*	0	0	0	0	15	40	0	0	0	2
akergjokhumle	*campestris*	0	0	0	0	0	8	0	0	0	1
markgjokhumle	*sylvestris*	0	0	17	0	0	0	0	0	0	1
tyvhumle	*wurfleini*	0	0	0	0	0	4	0	0	0	1

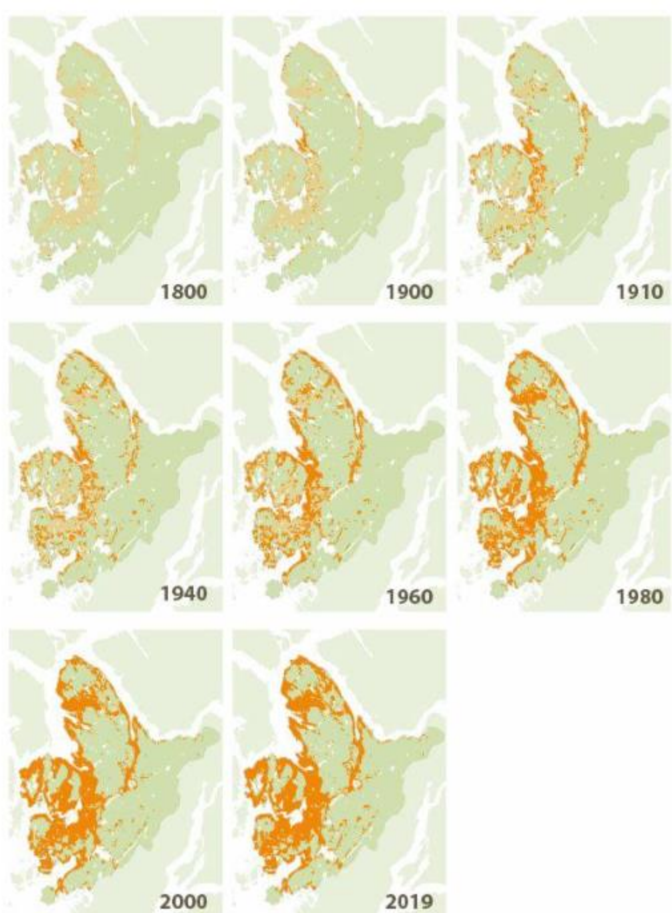

Figure 22: Historical map of Bergen city expansion from 1800 until 2019 (Bergen kommune, n.d.).

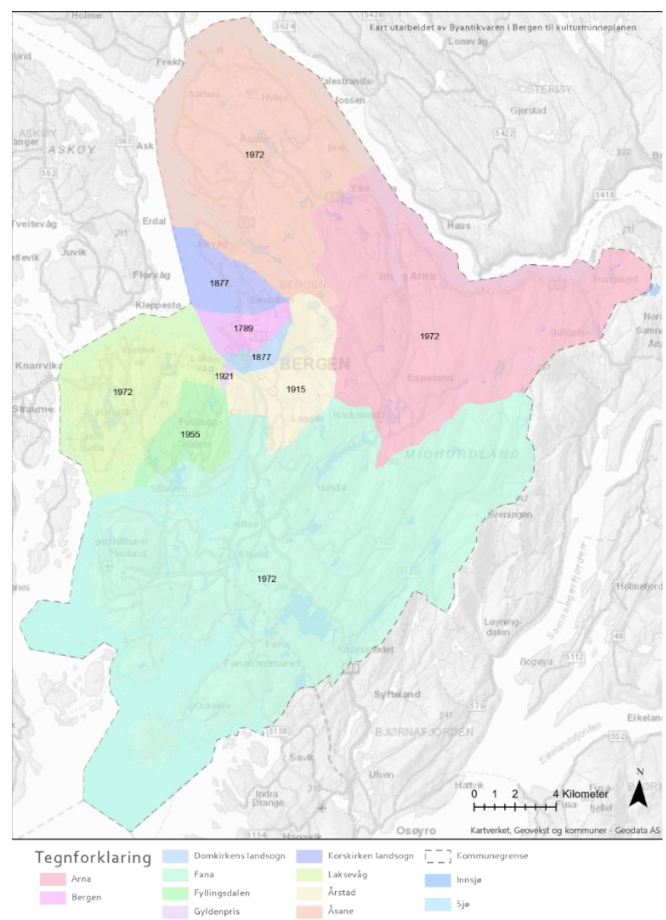

Figure 23: Historical map of Bergen city expansion from 1789 until 1972 (Bergenskart, 2023).

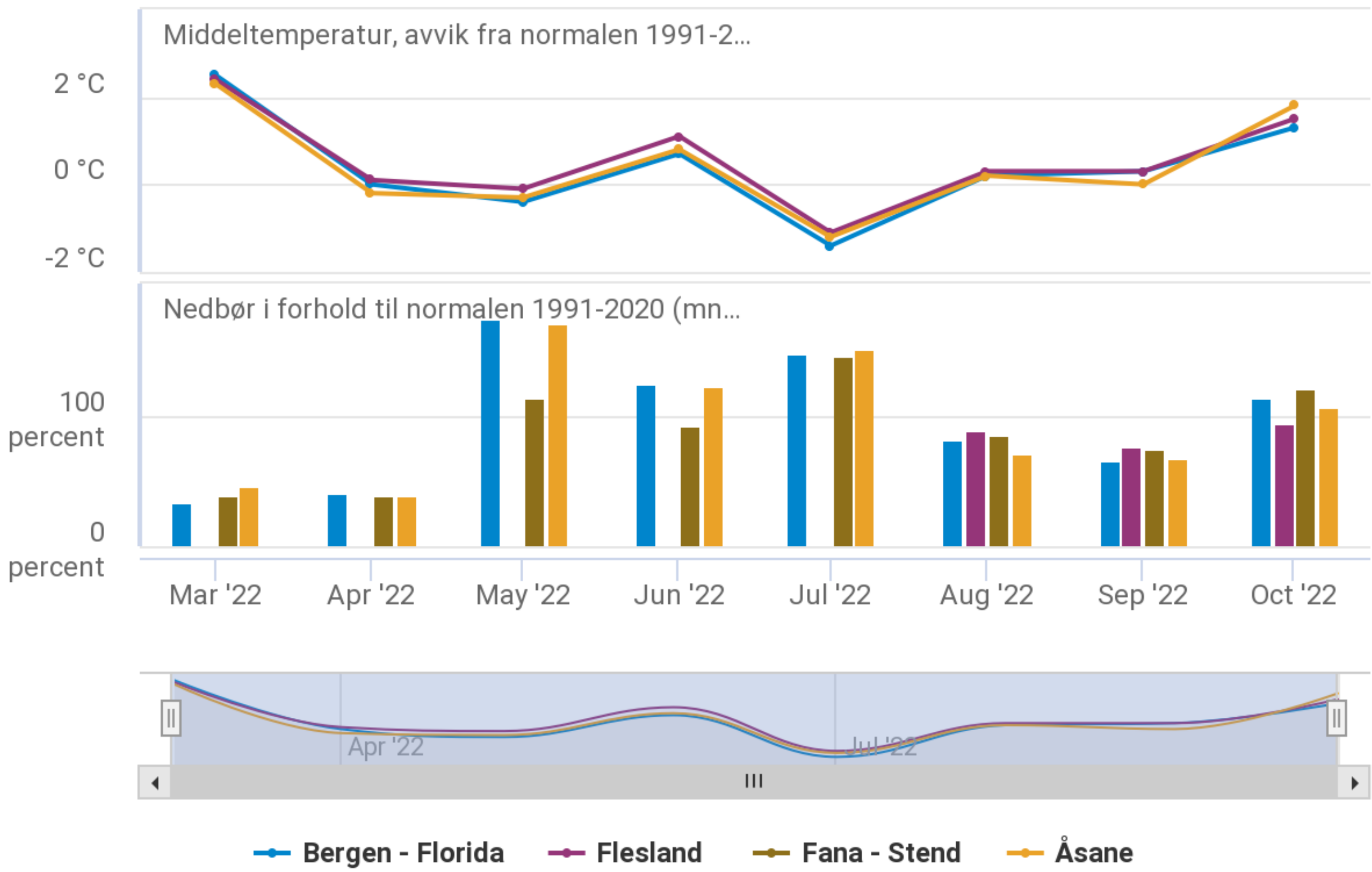

Figure 24: Historical weather data showing deviation from mean temperature and mean precipitation in Bergen, from 1991 until 2020 (Norsk klimaservicesenter, 2023).

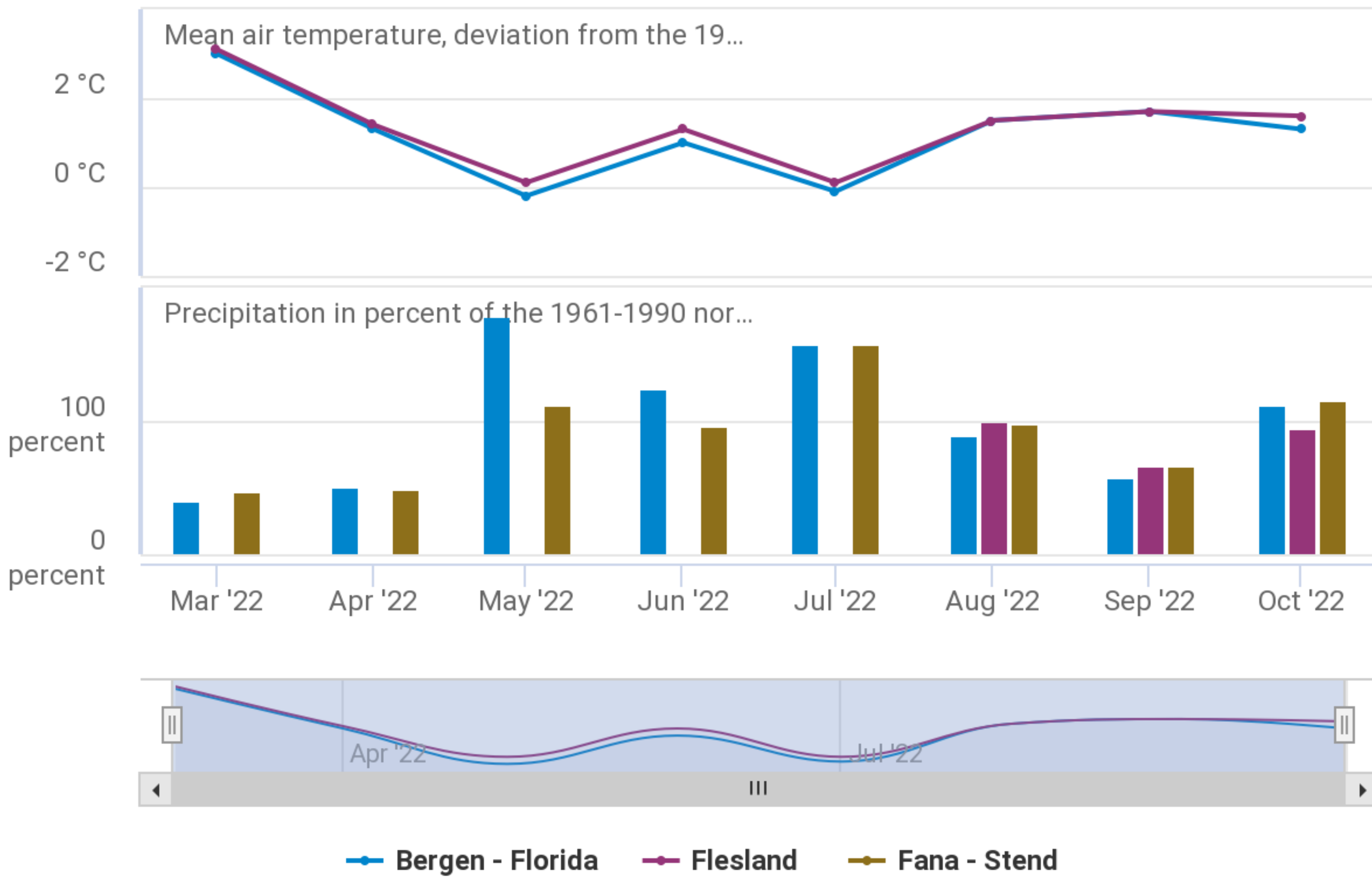

Figure 25: Historical weather data showing deviation from mean temperature and mean precipitation in Bergen, from 1960 until 1990 (Norsk klimaservicesenter, 2023).

Appendix D – Plant abundance and richness

*Table 16: The most common flowering plants during July (index score of 3 and 4) in Bergen, Norway (2022). Sorted by level of urbanization. *I. index is the individual status for the genus in a site.*

Area	Site	Latin name	Color	*I. index
rural	Stavollen	*Aegopodium sp.*	white	3
rural	Espegrend	*Aegopodium sp.*	white	3
rural	Liland	*Aegopodium sp.*	white	3
rural	Tennebekk	*Aegopodium sp.*	white	3
rural	Espegrend	*Allium sp.*	purple	3
rural	Liland	*Cirsium sp.*	purple	3
rural	Tennebekk	*Cirsium sp.*	purple	3
rural	Stavollen	*Conopodium sp.*	white	3
rural	Liland	*Digitalis sp.*	pink	3
rural	Liland	*Digitalis sp.*	pink	3
rural	Tennebekk	*Epilobium sp.*	white/ purple	3
rural	Stavollen	*Geranium sp.*	purple/ pink	3
rural	Tennebekk	*Geranium sp.*	purple/ pink	3
rural	Espegrend	*Geum sp.*	yellow	3
rural	Espegrend	*Hieracium sp.*	white	3
rural	Tennebekk	*Lychnis sp.*	pink	3
rural	Rambjørga	*Melampyrum sp.*	yellow	3
rural	Stavollen	*Potentilla sp.*	yellow	3
rural	Stavollen	*Ranunculus sp.*	yellow	3
rural	Liland	*Ranunculus sp.*	yellow	3
rural	Tennebekk	*Rubus sp.*	white	3
rural	Espegrend	*Sambucus sp.*	white	3
rural	Tennebekk	*Spergularia sp.*	purple	3
rural	Liland	*Stellaria sp.*	white	3
rural	Liland	*Trifolium sp.*	purple	3
rural	Tennebekk	*Trifolium sp.*	purple	3
rural	Rambjørga	*Trifolium sp.*	white	3
rural	Espegrend	*Trifolium sp.*	white	3
rural	Liland	*Trifolium sp.*	white	3
rural	Tennebekk	*Trifolium sp.*	white	3
rural	Rambjørga	*Valeriana sp.*	white/ purple	3
rural	Espegrend	*Valeriana sp.*	white/ purple	4
suburban	Sølvberget	*Epilobium sp.*	white/ purple	3
suburban	Storetveit	*Filipendula sp.*	white/ yellow	3
suburban	Håsteinarparken	*Geranium sp.*	purple/ pink	3
suburban	Håsteinarparken	*Geranium sp.*	purple/ pink	3
suburban	Svartediket	*Geum sp.*	yellow	4
suburban	Sølvberget	*Heracleum sp.*	white	3
suburban	Sølvberget	*Hieracium sp.*	yellow	3
suburban	Håsteinarparken	*Hosta sp.*	purple	3
suburban	Simonsviken	*Knautia sp.*	purple/ blue	3

suburban	Simonsviken	*Ligustrum sp.*	white	4
suburban	Simonsviken	*Lotus sp.*	yellow/orange	4
suburban	Sølvberget	*Lysimachia sp.*	yellow	3
suburban	Svartediket	*Potentilla sp.*	yellow	3
suburban	Svartediket	*Ranunculus sp.*	yellow	3
suburban	Simonsviken	*Ranunculus sp.*	yellow	3
suburban	Sølvberget	*Ranunculus sp.*	yellow	3
suburban	Sølvberget	*Rubus sp.*	white	4
suburban	Simonsviken	*Trifolium sp.*	purple	3
suburban	Storetveit	*Trifolium sp.*	white	3
suburban	Simonsviken	*Trifolium sp.*	white	3
suburban	Håsteinarparken	*Trifolium sp.*	white	3
suburban	Sølvberget	*Trifolium sp.*	white	4
suburban	Svartediket	*Valeriana sp.*	white/ purple	3
suburban	Storetveit	*Valeriana sp.*	white/ purple	3
urban	Christieparken	*Aegopodium sp.*	white	3
urban	Musehagen	*Aegopodium sp.*	white	4
urban	Christieparken	*Claytonia sp.*	white/ purple	3
urban	Nordnesparken	*Epilobium sp.*	white/ purple	3
urban	Musehagen	*Hieracium sp.*	white	4
urban	Nordnesparken	*Prunus sp.*	white	3
urban	Christieparken	*Ranunculus sp.*	yellow	3
urban	Tippetue	*Ranunculus sp.*	yellow	3
urban	Mulen	*Ranunculus sp.*	yellow	4
urban	Musehagen	*Ranunculus sp.*	yellow	3
urban	Mulen	*Rosa sp.*	pink	4
urban	Musehagen	*Sambucus sp.*	white	3
urban	Nordnesparken	*Syringa sp.*	purple	3
urban	Christieparken	*Trifolium sp.*	white	3
urban	Nordnesparken	*Trifolium sp.*	white	4
urban	Tippetue	*Valeriana sp.*	white/ purple	4
urban	Mulen	*Valeriana sp.*	white/ purple	3

*Table 17: The most common flowering plants during August (index score of 3 and 4) in Bergen, Norway (2022). Sorted by level of urbanization. *I. index is the individual status for the genus in a site.*

Area	Site	Latin name	Color	*I. index
rural	Espegrend	*Aegopodium sp.*	white	4
rural	Tennebekk	*Carduus sp.*	purple	3
rural	Espegrend	*Chamerion sp.*	purple	4
rural	Tennebekk	*Chamerion sp.*	purple	3
rural	Rambjørga	*Epilobium sp.*	white/ purple	3
rural	Tennebekk	*Hypericum sp.*	yellow	4
rural	Rambjørga	*Lysimachia sp.*	yellow	3
rural	Rambjørga	*Melampyrum sp.*	yellow	3
rural	Stavollen	*Potentilla sp.*	yellow	4
rural	Tennebekk	*Trifolium sp.*	purple	4
suburban	Storetveit	*Alchemilla sp.*	green/ yellow	3
suburban	Storetveit	*Apiaceae sp.*	white	3
suburban	Sølvberget	*Calluna sp.*	purple	4
suburban	Simonsviken	*Carduus sp.*	purple	3
suburban	Sølvberget	*Chamerion sp.*	purple	3
suburban	Svartediket	*Filipendula sp.*	white/ yellow	4
suburban	Storetveit	*Filipendula sp.*	white/ yellow	3
suburban	Håsteinarparken	*Geranium sp.*	purple/ pink	3
suburban	Svartediket	*Geum sp.*	yellow	4
suburban	Sølvberget	*Heracleum sp.*	white	4
suburban	Simonsviken	*Heracleum sp.*	white	3
suburban	Håsteinarparken	*Hosta sp.*	purple	4
suburban	Simonsviken	*Knautia sp.*	purple/ blue	3
suburban	Storetveit	*Scorzoneroides sp.*	yellow	4
suburban	Simonsviken	*Ligustrum sp.*	white	3
suburban	Simonsviken	*Lotus sp.*	yellow/orange	3
suburban	Svartediket	*Lysimachia sp.*	yellow	3
suburban	Håsteinarparken	*Sanguisorba sp.*	burgundy	3
suburban	Simonsviken	*Trifolium sp.*	purple	4
suburban	Storetveit	*Trifolium sp.*	white	3
urban	Musehagen	*Aegopodium sp.*	white	4
urban	Mulen	*Chamerion sp.*	purple	3
urban	Christieparken	*Claytonia sp.*	white/ purple	3
urban	Mulen	*Epilobium sp.*	white/ purple	3
urban	Musehagen	*Helianthus sp.*	yellow	3
urban	Nordnesparken	*Heracleum sp.*	white	3
urban	Christieparken	*Heracleum sp.*	white	3
urban	Musehagen	*Hieracium sp.*	yellow	3
urban	Musehagen	*Hosta sp.*	purple	3
urban	Nordnesparken	*Ligustrum sp.*	white	4
urban	Musehagen	*Pelargonium sp.*	pink/red	3
urban	Musehagen	*Rudbeckia sp.*	yellow	4
urban	Musehagen	*Sanvitalia sp.*	yellow	3

*Table 18: The most common flowering plants during September (index score of 3 and 4) in Bergen, Norway (2022). Sorted by level of urbanization. *I. index is the individual status for the genus in a site.*

Area	Site	Latin name	Color	*I. index
suburban	Storetveit	*Alchemilla sp.*	green/ yellow	4
suburban	Tennebekk	*Chamerion sp.*	purple	3
suburban	Håsteinarparken	*Hosta sp.*	purple	3
suburban	Storetveit	*Scorzoneroides sp.*	yellow	3
suburban	Håsteinarparken	*Sanguisorba sp.*	burgundy	3
suburban	Simonsviken	*Trifolium sp.*	purple	3
urban	Tippetue	*Alchemilla sp.*	green/ yellow	4
urban	Musehagen	*Antirrinum sp.*	white	3
urban	Mulen	*Chamerion sp.*	purple	3
urban	Musehagen	*Helianthus sp.*	yellow	3
urban	Christieparken	*Heracleum sp.*	white	3
urban	Musehagen	*Malva sylvestris sp.*	deep purple	3
urban	Musehagen	*Pelargonium sp.*	pink/red	3
urban	Musehagen	*Rudbeckia sp.*	yellow	4
urban	Musehagen	*Sanvitalia sp.*	yellow	4
urban	Musehagen	*Verbena sp.*	purple	3

*Table 19: All flowering plants registered July in Bergen, Norway (2022) with index score 1 – 4. Sorted by category. *I. index is the abundance of each species or genus in a site, while *S. index is the abundance of all species and/ or genus in a site. *Notes: Most/ all cut = mowing.*

Area	Site	Norwegian name	Latin name	Common traits	*I. index	*S. index	*Notes
rural	Espegrend	Skvallerkål	*Aegopodium podagraria*	Skjermplantefamilien. Large, slender, toothed leaves. Hallonlike, duplets near stalk, triplet end, tiny flowers	3	3	0
rural	Espegrend	Persisk løk	*Allium cristophii Trautv.*	Large purple starshaped flower	1	3	0
rural	Espegrend	Svartløk	*Allium nigrum*	Skjermplantefamilien, relatively large & white flowers w/ green bud inside, thick, hollow & smooth stalk	3	3	0
rural	Espegrend	Akeleie	*Aquilegia dumeticola Jord.*	Purple garden plant	1	3	0
rural	Espegrend	Knoppurtslekta	*Centaurea. Sp*	kurvplantefamilien. Light blue flowers	1	3	0
rural	Espegrend	Tistelslekta	*Cirsium sp.*	kurvplantefamilien. Tistelslekta	2	3	0
rural	Espegrend	Revebjelle	*Digitalis sp.*	Revebjelleslekta. Maskeblomstfamilien	0	3	0
rural	Espegrend	Mjølke	*Epilobium sp.*	Mjølkeslekta. Krattmjølke? Pale purple flower, thin, upright stalk and flowers	1	3	0
rural	Espegrend	Kratthumleblom	*Geum urbanum*	Rosefamilien. Messy hairbuds, red centre on yellow petals, 2-5 flowers	3	3	0
rural	Espegrend	Sveveslekta	*Hieracium sp.*	Skogsveve? Looks like føllblom, leaves prickly. Only branches on top, rounded cup	3	3	0
rural	Espegrend	Krypfredløs	*Lysimachia nummularia*	Nøkleblomfamilien. Looks like yellow "smørblomst/ waterlilly", crawling	1	3	0
rural	Espegrend	Engsoleie	*Ranunculus acris*	Soleieslekta. Yellow med. flowers, tall, thin stalk, green buds, rough leaves	1	3	0
rural	Espegrend	Bringebær	*Rubus idaeus*	Rosefamilien. White flower, 4 petals, leaves in pairs of three per branch	2	2	0
rural	Espegrend	Svarthyll	*Sambucus nigra*	Moskusurtfamilien, hyllslekta. Large, white epiphyte on tree, white flowers and long white buds on side	3	3	0
rural	Espegrend	Spirea	*Spiraea nipponica Maxim.*	Bush w/ white flowers	1	3	0
rural	Espegrend	Rødkløver	*Trifolium pratense*	Kløverslekta	1	3	0
rural	Espegrend	Hvitkløver	*Trifolium repens*	Kløverslekta	3	3	0
rural	Espegrend	Vendelrot	*Valeriana sambucifola*	Skjermplantefamilien. White and/ or pink, bisymetric leaves	4	3	0
rural	Espegrend	Vikkeslekta	*Vivia sp.*	Gjerdevikke? More than 4-8 pair of leaves	1	3	0
rural	Liland	Skvallerkål	*Aegopodium podagraria*	Skjermplantefamilien. Large, slender, toothed leaves. Hallonlike, duplets near stalk, triplet end, tiny flowers	3	4	0
rural	Liland	Tistelslekta	*Cirsium sp.*	kurvplantefamilien. Tistelslekta	3	4	0
rural	Liland	Revebjelle	*Digitalis sp.*	Revebjelleslekta. Maskeblomstfamilien	3	4	0
rural	Liland	Mjølke	*Epilobium sp.*	Mjølkeslekta. Krattmjølke? Pale purple flower, thin, upright stalk and flowers	1	4	0
rural	Liland	Mjødurt	*Filipendula ulmaria*	Mjødurtslekta. Yellow/ white, herb looking clusters	1	4	0
rural	Liland	Skogstorkenebb	*Geraniceae sylvaticum*	Storkenebbfamilien. 5 petals, dark lilac, bisymetrical leaves	1	4	0
rural	Liland	kurvplantefamilien	*Scorzoneroides sp.*	Kurvplantefamilien. Føllblom? Few branches in big cluster, ruccola leaves. Yellow petals, brown/ red stripes, white hairs on 2-7 thin cups	2	4	0
rural	Liland	Tiriltunge	*Lotus corniculatus*	Tiriltungeslekta. Thin, relatively short stalk w/ orange/ yellow flowers	1	4	0
rural	Liland	Blåkoll	*Prunella vulgaris*	Purple, small, leaves & flowers in levels	2	4	0
rural	Liland	Engsoleie	*Ranunculus acris*	Soleieslekta. Yellow med. flowers, tall, thin stalk, green buds, rough leaves	3	4	0
rural	Liland	Grasstjerneblom	*Stellaria graminea*	Small, white, thin stalk, very pretty, red styles	3	4	0
rural	Liland	Rødkløver	*Trifolium pratense*	Kløverslekta	3	4	0
rural	Liland	Hvitkløver	*Trifolium repens*	Kløverslekta	3	4	0
rural	Liland	Balderbrå	*Tripleurospermum inodorum*	Dandelion looking, small plant with long, thin leaves	1	4	0
rural	Liland	Vendelrot	*Valeriana sambucifola*	Skjermplantefamilien. white and/ or pink, bisymetric leaves	1	4	0
rural	Liland	Tveskjeggveronika	*Veronica chamaedrys*	Purple flowers, hairs bipedicular on stalk	1	4	0
rural	Liland	Vikkeslekta	*Vivia sp.*	Gjerdevikke? More than 4-8 pair of leaves	1	4	0
rural	Rambjørga	Skvallerkål	*Aegopodium podagraria*	Skjermplantefamilien. Large, slender, toothed leaves. Hallonlike, duplets near stalk, triplet end, tiny flowers	2	4	0
rural	Rambjørga	Engmarikåpe	*Alchemilla subcrenata*	Marikåpeslekta. Yellow greenish & bushlike plant, tiny green flowers	1	4	0
rural	Rambjørga	Storklokke	*Campanula latifolia*	Klokkefamilien, klokkeslekta. Big, white bellshaped flowers with deep cut	2	4	0
rural	Rambjørga	Blåklokke	*Campanula rotundifolia*	Klokkefamilien. Long, slender stalks	2	4	Most cut

rural	Rambjørga	Åkertistel	*Cirisium arvense*	kurvplantefamilien. Tistelslekta	1	4	0
rural	Rambjørga	Åkertistel	*Cirisium arvense*	kurvplantefamilien. Tistelslekta	1	4	0
rural	Rambjørga	Revebjelle	*Digitalis sp.*	Revebjelleslekta. Maskeblomstfamilien	1	4	0
rural	Rambjørga	Mjødurt	*Filipendula ulmaria*	Mjødurtslekta. Yellow/ white, herb looking	1	4	Most cut
rural	Rambjørga	Skogstorkenebb	*Geraniceae sylvaticum*	Storkenebbfamilien. 5 petals, dark lilac, bisymetrical leaves	1	4	0
rural	Rambjørga	Fagerfredløs	*Lysimachia punctata*	Fredløsslekta. Edges of crown leaves covered w/ hair; flowers abundant on stalk - two from each leaf base	1	4	Most cut
rural	Rambjørga	Småmarimjelle	*Melampyrum sylvaticum*	Maskeblomstfamilien. Yellow long flowers w/ long leaves. Thin stalk w/ egg- shaped leaves on short neck	3	4	Most cut
rural	Rambjørga	Forglemmegeislekta	*Myosotis sp.*	Rubladfamilien. Åkerforglemmegei? Small & light blue flowers with many buds on upper part of stalk	1	4	Most cut
rural	Rambjørga	Tepperot	*Potanilla erecta*	Rosefamilien. Small, cute, yellow flowers. Leaves in floors along stalk	2	4	0
rural	Rambjørga	Åkersvineblom	*Senecio sylvaticus*	Kurvplantefamilien. Svineblomslekta. Narrow cups, juicy & upright stalk, leaves deeply cut.	1	4	0
rural	Rambjørga	Rød jonsokblom	*Spergularia dioica*	Nelllikfamilien. Split petals, long hairy stalk, few branches, violet cups of 3-20 red/violet flowes	1	4	0
rural	Rambjørga	Skogsvinerot	*Stachys sylvatica*	Leppeblomstfamilien. Tall, purple, hairy, bad smell	1	4	0
rural	Rambjørga	Rødkløver	*Trifolium pratense*	Kløverslekta	1	4	0
rural	Rambjørga	Hvitkløver	*Trifolium repens*	Kløverslekta	3	4	0
rural	Rambjørga	Vendelrot	*Valeriana sambucifola*	Skjermplantefamilien. white and/ or pink, bisymetric leaves	3	4	Most cut
rural	Rambjørga	Legeveronika	*Veronica officinalis*	Small, purpur (blue/ pink)	0	4	0
rural	Rambjørga	Vikkeslekta	*Vivia sp.*	Gjerdevikke? More than 4-8 pair of leaves	2	4	0
rural	Stavollen	Skvallerkål	*Aegopodium podagraria*	Skjermplantefamilien. Large, slender, toothed leaves. Hallonlike, duplets near stalk, triplet end, tiny flowers	3	3	0
rural	Stavollen	Myrtistel	*Cirsium palustre*	kurvplantefamilien. Tistelslekta	1	3	0
rural	Stavollen	Jordnøtt	*Conopodium majus*	Venuskamslekta. Tiny white flowers, long narrow leaves	3	3	0
rural	Stavollen	Revebjelle	*Digitalis sp.*	Revebjelleslekta. Maskeblomstfamilien	0	3	0
rural	Stavollen	Mjølke	*Epilobium sp.*	Mjølkeslekta. Krattmjølke? Pale purple flower, thin, upright stalk and flowers	0	3	0
rural	Stavollen	Myrmaure	*Galium palustre*	Small white flowers, leaves in rosettes, lancet shaped leaves	2	3	0
rural	Stavollen	Skogstorknebb	*Geraniceae sylvaticum*	Storkenebbfamilien. 5 petals, dark lilac, bisymetrical leaves	3	3	0
rural	Stavollen	Småmarimjelle	*Melampyrum sylvaticum*	Maskeblomstfamilien. Yellow long flowers w/ long leaves. Thin stalk w/ egg- shaped leaves on short neck	1	3	0
rural	Stavollen	Tepperot	*Potanilla erecta*	Rosefamilien. Small, cute, yellow flowers. Leaves in floors along stalk	3	3	0
rural	Stavollen	Engsoleie	*Ranunculus acris*	Soleieslekta. Yellow med. flowers, tall, thin stalk, green buds, rough leaves	3	3	0
rural	Tennebekk	Skvallerkål	*Aegopodium podagraria*	Skjermplantefamilien. Large, slender, toothed leaves. Hallonlike, duplets near stalk, triplet end, tiny flowers	3	3	0
rural	Tennebekk	Engmarikåpe	*Alchemilla subcrenata*	Marikåpeslekta. Yellow greenish & bushlike plant, tiny green flowers	1	3	0
rural	Tennebekk	Tistelslekta	*Cirsium sp.*	kurvplantefamilien	3	3	0
rural	Tennebekk	Gyvel	*Cytisus scoparius*	Yellow, ochid looking flower on bush branch	1	3	0
rural	Tennebekk	Revebjelle	*Digitalis sp.*	Revebjelleslekta. Maskeblomstfamilien	2	3	0
rural	Tennebekk	Mjølke	*Epilobium sp.*	Mjølkeslekta. Krattmjølke? Pale purple flower, thin, upright stalk and flowers	3	3	0
rural	Tennebekk	Stankstorkenebb	*Geranium robertianum*	Storkenebbfamilien. Light purle, small flowers. Characteristic, rounded leaves, smells bad, red branch root	3	3	0
rural	Tennebekk	Sverdlilje	*Iris pseudacoris*	Large flower and long, slender leaves. Yellow orchid looking	0	3	0
rural	Tennebekk	Hanekam	*Lychnis flos-cuculi*	Nellik familien. Hanekamslekta. Pink/purple, 4-split & thin petals	3	3	0
rural	Tennebekk	Engsoleie	*Ranunculus acris*	Soleieslekta. Yellow med. flowers, tall, thin stalk, green buds, rough leaves	2	3	0
rural	Tennebekk	Bringebær	*Rubus idaeus*	Rosefamilien. White flower, 4 petals, leaves in pairs of three per branch	3	3	0
rural	Tennebekk	Rød jonsokblom	*Spergularia dioica*	Nelllikfamilien. Split petals, long hairy stalk, few branches, violet cups of 3-20 red/violet flowes	3	3	0
rural	Tennebekk	Rødkløver	*Trifolium pratense*	Kløverslekta	3	3	0
rural	Tennebekk	Hvitkløver	*Trifolium repens*	Kløverslekta	3	3	0
suburban	Håsteinarparken	Engmarikåpe	*Alchemilla subcrenata*	Marikåpeslekta. Yellow greenish & bushlike plant, tiny green flowers	1	2	0
suburban	Håsteinarparken	Akeleie Aquilegia	*Aquilegia pubescens*	Soleiefamilien. Yellow, orchidlooking	1	2	0
suburban	Håsteinarparken	Skogskjegg	*Aruncus dioicus*	Yellow/ white, herb looking	1	2	0
suburban	Håsteinarparken	Løytnantshjerte	*Dicentra spectabilis*	Characteristic pink or white, flowers heartshapes bulbs	1	2	0
suburban	Håsteinarparken	Revebjelle	*Digitalis sp.*	Revebjelleslekta. Maskeblomstfamilien	1	2	0

suburban	Håsteinarparken	Mjølke	*Epilobium sp.*	Mjølkeslekta. Krattmjølke? Pale purple flower, thin, upright stalk and flowers	1	2	0
suburban	Håsteinarparken	Skogstorkenebb	*Geraniceae sylvaticum*	5 petals, dark lilac, bisymetrical leaves	1	2	0
suburban	Håsteinarparken	Rosestorkenebb	*Geranium macrorrhizum*	Storkenebbfamilien. Looks like "skogstorkenebb" but has clusters and white flowers	3	2	0
suburban	Håsteinarparken	Storkenebbslekta	*Geranium sp.*	Storkenebbfamilien. X oxonianum Yeo? Looks almost identical to skogstorkenebb, but larger	3	2	0
suburban	Håsteinarparken	Doggbladlilje	*Hosta sieboldiana*	Light purple lilly with large green/ blue leaves.	3	2	0
suburban	Håsteinarparken	Hortensiaslekta	*Hydrangea sp.*	Woody epiphyte w/ large and flat white/ light pink flowers on top of small purple flowers	1	2	0
suburban	Håsteinarparken	Leppeblomstfamilien	*Lamiaceae sp.*	Koreamynte? Small orchid looking, hairy, smells like lemon balm	2	2	0
suburban	Håsteinarparken	Påskelilje	*Narcissus pseudonarcissus L.*	0	1	2	0
suburban	Håsteinarparken	Engsoleie	*Ranunculus acris*	Soleieslekta. Yellow med. flowers, tall, thin stalk, green buds, rough leaves	2	2	0
suburban	Håsteinarparken	Rabarbra	*Rheum rhaponticum L.*	White, tall, thick green stalk and small green buds with small white flowers	1	2	0
suburban	Håsteinarparken	Roseslekta	*Rosa sp.*	R. rubiginosa. Bright pink & large flower. Leaves large, round on top of double triplets. Slim base. Dark spiked stalk.	1	2	0
suburban	Håsteinarparken	Blodtopp	*Sanguisorba officinalis*	Rosefamilien. Very tall and slender, dark pink & bushlike flowers on top	1	2	0
suburban	Håsteinarparken	Spireaslekta	*Spirea sp.*	Small, fluffy pink flowers on top, rough leaves w/ one large on top and two duplets	1	2	0
suburban	Håsteinarparken	Hvitkløver	*Trifolium repens*	Kløverslekta	3	2	0
suburban	Simonsviken	Skvallerkål	*Aegopodium podagraria*	Skjermplantefamilien. Large, slender, toothed leaves. Hallonlike, duplets near stalk, triplet end, tiny flowers	2	4	0
suburban	Simonsviken	Blåklokke	*Campanula rotundifolia*	Klokkefam. Slender stalks, long & slender leaves upright	2	4	0
suburban	Simonsviken	Geitrams	*Chamerion angustifolium*	Geitramsslekta. Tall, pink to blue. Arrowshaped towards top	1	4	0
suburban	Simonsviken	kurvplantefamilien	*Cirsium sp.*	kurvplanteslekta	2	4	0
suburban	Simonsviken	Engnellik	*Dianthus deltoides*	Nellikfam. Petals sawtoothed. Purple crown, slender leaves/stalk, white flowerspots	1	4	0
suburban	Simonsviken	Mjølke	*Epilobium sp.*	Mjølkeslekta. Krattmjølke? Pale purple flower, thin, upright stalk and flowers	2	4	0
suburban	Simonsviken	Moskusurtfamilien	*Knautia sp.*	Rødknapp? Large violet button on top, thistel looking	3	4	0
suburban	Simonsviken	Prestekrage	*L.vulgae*	Large white petals on slender stalk w/ lacet shaped leaves	4	4	0
suburban	Simonsviken	Haremat	*Lapsana communis*	Tall, yellow, dandelionlooking, eggshaped & pointy leaves w/ quite toothed edges	2	4	0
suburban	Simonsviken	kurvplantefamilien	*Scorzoneroides sp.*	Kystgrisøre? Looks like Føllblom and Dandelion. Not Sveve or Føllblom	2	4	0
suburban	Simonsviken	Tiriltunge	*Lotus corniculatus*	Thin, relatively short stalk w/ orange/ yellow flowers	4	4	0
suburban	Simonsviken	Krypfredløs	*Lysimachia nummularia*	Nøkleblomfamilien. Looks like yellow "smørblomst/ waterlilly", crawling	1	4	0
suburban	Simonsviken	Åkerforglemmegei	*Myosotis avensis*	Rubladfamilien. Small & light blue flowers with many buds on upper part of stalk	1	4	0
suburban	Simonsviken	Engsoleie	*Ranunculus acris*	Soleieslekta. Yellow med. flowers, tall, thin stalk, green buds, rough leaves	3	4	0
suburban	Simonsviken	Engsmelle	*Silene vulgaris*	Nelllikfamilien. Characteristic & purple bulblike cup	1	4	0
suburban	Simonsviken	Rød jonsokblom	*Spergularia dioica*	Nelllikfamilien. Split petals, long hairy stalk, few branches, violet cups of 3-20 red/violet flowes	1	4	0
suburban	Simonsviken	Rødkløver	*Trifolium pratense*	Kløverslekta	3	4	0
suburban	Simonsviken	Hvitkløver	*Trifolium repens*	Kløverslekta	3	4	0
suburban	Simonsviken	Engtjæreblom	*Viscaria vulgaris*	Nellik fam. Tjæreblomslekta. Petals spread. Sticky below leafbase, long slender leaves	1	4	0
suburban	Storetveit	Skjermplantefamilien	*Apiaceae sp.*	Skvallerkål? White/grey flowers, brown seeds	0	3	Most cut
suburban	Storetveit	Jordnøtt	*Conopodium majus*	Tiny white flowers, Long narrow leaves	1	3	Most cut
suburban	Storetveit	Mjødurt	*Filipendula ulmaria*	Mjødurtslekta. Yellow/ white, herb looking clusters	3	3	Most cut
suburban	Storetveit	kurvplantefamilien	*Scorzoneroides sp.*	Kurvplantefamilien. Føllblom? Few branches in big cluster, ruccola leaves. Yellow petals, brown/ red stripes, white hairs on 2-7 thin cups	1	3	Most cut
suburban	Storetveit	Engforglemmegei	*Myosotis scorpioides*	Rubladfamilien. Small & light blue flowers with many buds on upper part of stalk	1	3	Most cut
suburban	Storetveit	Engsoleie	*Ranunculus acris*	Soleieslekta. Yellow med. flowers, tall, thin stalk, green buds, rough leaves	1	3	Most cut
suburban	Storetveit	Rød jonsokblom	*Spergularia dioica*	Nelllikfamilien. Split petals, long hairy stalk, few branches, violet cups of 3-20 red/violet flowes	0	3	0
suburban	Storetveit	Rødkløver	*Trifolium pratense*	Kløverslekta	1	3	Most cut
suburban	Storetveit	Hvitkløver	*Trifolium repens*	Kløverslekta	3	3	Most cut
suburban	Storetveit	Vendelrot	*Valeriana sambucifola*	Skjermplantefamilien. white and/ or pink, bisymetric leaves	3	3	Most cut
suburban	Svartediket	Mjølke	*Epilobium sp.*	Mjølkeslekta. Krattmjølke? Pale purple flower, thin, upright stalk and flowers	2	3	All cut
suburban	Svartediket	Skogstorknebb	*Geranium sylvaticum*	Storkenebbfamilien. 5 petals, dark lilac, bisymetrical leaves	1	3	0

suburban	Svartediket	Kratthumleblom	*Geum urbanum*	Rosefamilien. Messy hairbuds, red centre on yellow petals, 2-5 flowers	4	3	All cut
suburban	Svartediket	Tepperot	*Potanilla erecta*	Rosefamilien. Small, cute, yellow flowers. Leaves in floors along stalk	3	3	All cut
suburban	Svartediket	Engsoleie	*Ranunculus acris*	Soleieslekta. Yellow med. flowers, tall, thin stalk, green buds, rough leaves	3	3	All cut
suburban	Svartediket	Vendelrot	*Valeriana sambucifola*	Skjermplantefamilien, white and/ or pink, bisymetric leaves	3	3	All cut
suburban	Sølvberget	Roseklokkebusk	*Caprifoliaceae agg.*	Large, red and lily looking flowers with sturdy leaves	2	3	0
suburban	Sølvberget	Revebjelle	*Digitalis sp.*	Maskeblomstfamilien	2	3	0
suburban	Sølvberget	Mjølke	*Epilobium sp.*	Mjølkeslekta. Krattmjølke? Pale purple flower, thin, upright stalk and flowers	3	3	0
suburban	Sølvberget	Storkenebbfamilien	*Geraniceae sp.*	Skogstorkenebb?	2	3	0
suburban	Sølvberget	Kystbjønnkjeks	*Heracleum sphondylium*	Skjermplantefamilien, Bjønnkjeksslekta. White flowers on screen. Thick and tall stalk, characteristic sawed leaves	3	3	0
suburban	Sølvberget	Sveveslekta	*Hieracium sp.*	Skogsveve? Looks like føllblom, leaves prickly. Only branches on top, rounded cup	3	3	0
suburban	Sølvberget	Vivendel	*Lonicera periclymenum*	Kaprifolfamilien, leddvedslekta. Reddish on outside, yellow inside. Bushlike. Oval, limegreen leaves	2	3	0
suburban	Sølvberget	Gjerdevikke	*Lupinus sepium*	More than 4-8 pair of leaves	2	3	0
suburban	Sølvberget	Krypfredløs	*Lysimachia nummularia*	Looks like yellow "smørblomst/ waterlilly", crawling	3	3	0
suburban	Sølvberget	Nøkleblomfamilien	*Lysimachia sp.*	Fredløsslekta. Fagerfredløs? Yellow flowers w/ 5 petals. 4 leaves per. leafcluster.	3	3	0
suburban	Sølvberget	Gul valmuesøster	*Meconopsis cambrica*	Valmuefamilien, valmueslekta. Both yellow and orange here	2	3	0
suburban	Sølvberget	Hagepelargonia	*Pelargonium zonale*	Hybrid garden flower, comes in many colors, thick and clover like leaves	2	3	0
suburban	Sølvberget	Tepperot	*Potanilla erecta*	Rosefamilien. Small, cute, yellow flowers. Leaves in floors along stalk	2	3	0
suburban	Sølvberget	Engsoleie	*Ranunculus acris*	Soleieslekta. Yellow med. flowers, tall, thin stalk, green buds, rough leaves	3	3	0
suburban	Sølvberget	Rosefamilien	*Rosa sp.*	Rynkerose? Deep pink, yellow r. organ, oval thick and shiny leaves w/ toothed edges. Gets thick fruit	2	3	0
suburban	Sølvberget	Bringebær	*Rubus idaeus*	Rosefamilien. White flower, 4 petals, leaves in pairs of three per branch	4	3	0
suburban	Sølvberget	Skyggesildre	*Saxifraga umbrosa*	Tiny w/ small, white flowers, purple and yellow spots. Round, narrow petals.	2	3	0
suburban	Sølvberget	Hvitkløver	*Trifolium repens*	Kløverslekta	4	3	0
suburban	Sølvberget	Korsved	*Viburnum opulus*	Large, yellowish white cluster on branches	2	3	0
urban	Christieparken	Skvallerkål	*Aegopodium podagraria*	Skjermplantefamilien. Large, slender, toothed leaves. Hallonlike, duplets near stalk, triplet end, tiny flow	3	2	Most cut
urban	Christieparken	Sibirportulakk	*Claytonia sibirica L.*	Portulakkfamilien. Small round leaves, like waterlily	3	2	Most cut
urban	Christieparken	Kardeborreslekta	*Dipsacus sp.*	Purple neck, blue petals and pink centre	1	2	All cut
urban	Christieparken	Mjølke	*Epilobium sp.*	Mjølkeslekta. Krattmjølke? Pale purple flower, thin, upright stalk and flowers	1	2	All cut
urban	Christieparken	Kystgrisøre	*Hypocaeris radicata*	Grey/purple stripe on petals, hairs on middle nerve, green/ blue stalk.	2	2	Most cut
urban	Christieparken	Gul valmuesøster	*Meconopsis cambrica*	Valmuefamilien, valmueslekta. Yellow	1	2	All cut
urban	Christieparken	Blåkoll	*Prunella vulgaris*	Purple, small, leaves & flowers in levels	1	2	All cut
urban	Christieparken	Engsoleie	*Ranunculus acris*	Soleieslekta. Yellow med. flowers, tall, thin stalk, green buds, rough leaves	3	2	Most cut
urban	Christieparken	Hvitkløver	*Trifolium repens*	Kløverslekta	3	2	Most cut
urban	Mulen	Bergmjølke	*Epilobium collinum*	Mjølkeslekta. Pink flowers. Opposite, whole and toothed leaves	2	3	0
urban	Mulen	Gul valmuesøster	*Meconopsis cambrica*	Valmuefamilien, valmueslekta. Yellow	1	3	0
urban	Mulen	Tepperot	*Potanilla erecta*	Rosefamilien. Small, cute, yellow flowers. Leaves in floors along stalk	1	3	0
urban	Mulen	Engsoleie	*Ranunculus acris*	Soleieslekta. Yellow med. flowers, tall, thin stalk, green buds, rough leaves	4	3	0
urban	Mulen	Steinnype	*Rosa canina*	Nyperose, gets slender fruit	4	3	0
urban	Mulen	Åkersvineblom	*Senecio sylvaticus*	Kurvplantefamilien. Svineblomslekta. Narrow cups, juicy & upright stalk, leaves deeply cut.	0	3	0
urban	Mulen	Rødkløver	*Trifolium pratense*	Kløverslekta	1	3	0
urban	Mulen	Hvitkløver	*Trifolium repens*	Kløverslekta	2	3	0
urban	Mulen	Vendelrot	*Valeriana sambucifola*	Skjermplantefamilien. white and/ or pink, bisymetric leaves	3	3	0
urban	Mulen	Vikkeslekta	*Vivia sp.*	Gjerdevikke? More than 4-8 pair of leaves	2	3	0
urban	Musehagen	Skvallerkål	*Aegopodium podagraria*	Skjermplantefamilien. Large, slender, toothed leaves. Hallonlike, duplets near stalk, triplet end, tiny flowers	4	3	0
urban	Musehagen	Sibirportulakk	*Claytonia sibirica L.*	Portulakkfamilien. Small round leaves, like waterlily	1	3	0
urban	Musehagen	kurvplantefamilien	*Cyanus sp.*	Kornblomslekta. Big purple/blue flower. Long narrow leaves	1	3	0
urban	Musehagen	Revebjelle	*Digitalis sp.*	Revebjelleslekta. Maskeblomstfamilien	2	3	0

urban	Musehagen	Mjølke	*Epilobium sp.*	Mjølkeslekta. Krattmjølke? Pale purple flower, thin, upright stalk and flowers	1	3	0
urban	Musehagen	Honningrose	*Helenae hybrida*	White climbing rose	2	3	0
urban	Musehagen	Skogsvever	*Hieracium murorum agg.*	Tall with yellow flowers. Hairy leaves, rough stalk	4	3	0
urban	Musehagen	Doggbladlilje	*Hosta sieboldiana*	Light purple lilly with large green/ blue leaves.	2	3	0
urban	Musehagen	Gul valmuesøster	*Meconopsis cambrica*	Valmuefamilien, valmueslekta. Both yellow and orange here	1	3	0
urban	Musehagen	Åkerforglemmegei	*Myosotis avensis*	Rubladfamilien. Small & light blue flowers with many buds on upper part of stalk	1	3	0
urban	Musehagen	Blåkoll	*Prunella vulgaris*	Purple, small, leaves & flowers in levels	1	3	0
urban	Musehagen	Engsoleie	*Ranunculus acris*	Soleieslekta. Yellow med. flowers, tall, thin stalk, green buds, rough leaves	3	3	0
urban	Musehagen	Svarthyll	*Sambucus nigra*	Small white and yellow flowers, large woody bush	3	3	0
urban	Musehagen	Blodtopp	*Sanguisorba officinalis*	Rosefamilien. Tall, slender stalk w/ deep pink and cylindrical bush on top.	1	3	0
urban	Musehagen	Japanspirea	*Spiraea japonica*	Spireaslekta. Small purple/pink flowers. Red stalk	2	3	0
urban	Musehagen	Hvitkløver	*Trifolium repens*	Kløverslekta	1	3	0
urban	Nordnesparken	Skvallerkål	*Aegopodium podagraria*	Skjermplantefamilien. Large, slender, toothed leaves. Hallonlike, duplets near stalk, triplet end, tiny flowers	2	2	0
urban	Nordnesparken	Marikåpeslekta	*Alchemilla sp.*	Engmarikåpe? Marikåpeslekta. Yellow greenish & bushlike plant, tiny green flowers	2	2	0
urban	Nordnesparken	Storklokke	*Campanula latifolia*	Klokkefamilien, klokkeslekta. Big, white bellshaped flowers with deep cut	1	2	0
urban	Nordnesparken	Blåklokke	*Campanula rotundifolia*	Klokkefamilien	2	2	0
urban	Nordnesparken	Roseklokkebusk	*Caprifoliaceae agg.*	Kaprifolfamilien, klokkebuskslekta. Large, red and lily looking flowers with sturdy leaves	2	2	0
urban	Nordnesparken	Mjølke	*Epilobium sp.*	Mjølkeslekta. Krattmjølke? Pale purple flower, thin, upright stalk and flowers	3	2	0
urban	Nordnesparken	Stankstorkenebb	*Geranium robertianum*	Storkenebbfamilien. Light purle, small flowers. Characteristic, rounded leaves, smells bad, red branch root	2	2	0
urban	Nordnesparken	Kratthumleblom	*Geum urbanum*	Rosefamilien. Messy hairbuds, red centre on yellow petals, 2-5 flowers	2	2	0
urban	Nordnesparken	Sveveslekta	*Hieracium sp.*	Skogsveve? Looks like føllblom, leaves prickly. Only branches on top, rounded cup	2	2	0
urban	Nordnesparken	Haremat	*Lapsana communis*	Kurvplantefamilien. Tall, yellow, dandelionlooking, eggshaped & pointy leaves w/ quite tothed edges	2	2	0
urban	Nordnesparken	Hegg	*Prunus padus*	White, upright flowers on tree. Leaves wrinkly and matt	3	2	0
urban	Nordnesparken	Engsoleie	*Ranunculus acris*	Soleieslekta. Yellow med. flowers, tall, thin stalk, green buds, rough leaves	2	2	0
urban	Nordnesparken	Bringebær	*Rubus idaeus*	Rosefamilien. White flower, 4 petals, leaves in pairs of three per branch	2	2	0
urban	Nordnesparken	Grasstjerneblom	*Stellaria graminea*	Thin and tall, small and pretty flowers, few leaves - bipendicular and far apart	2	2	0
urban	Nordnesparken	Snøbær	*Symphoricarpos a. laevigatus*	White, big berries	2	2	0
urban	Nordnesparken	Syrin	*Syringa sp.*	Purple elliptical petals, 4 bisymmetrical petals, bush/ treelike. Thing and relatively long crown	3	2	0
urban	Nordnesparken	Løvetann	*Taraxacum officinale agg.*	Kurvplantefamilien, løvetannslekta	2	2	0
urban	Nordnesparken	Hvitkløver	*Trifolium repens*	Kløverslekta	4	2	0
urban	Nordnesparken	Vendelrot	*Valeriana sambucifola*	Skjermplantefamilien. white and/ or pink, bisymetric leaves	2	2	0
urban	Tippetue	Skvallerkål	*Aegopodium podagraria*	Skjermplantefamilien. Large, slender, toothed leaves. Hallonlike, duplets near stalk, triplet end, tiny flowers	2	3	0
urban	Tippetue	Mjølke	*Epilobium sp.*	Mjølkeslekta. Krattmjølke? Pale purple flower, thin, upright stalk and flowers	2	3	0
urban	Tippetue	Mjødurt	*Filipendula ulmaria*	Mjødurtslekta. Yellow/ white, herb looking	2	3	0
urban	Tippetue	Skogstorkenebb	*Geraniceae sylvaticum*	Storkenebbfamilien. 5 petals, dark lilac, bisymetrical leaves	2	3	0
urban	Tippetue	Humleblomslekta	*Geum sp.*	Rosefamilien. Kratthumle? Yellow flower, thick stalk, upright flowers in cl. of 3-5	1	3	0
urban	Tippetue	Engsoleie	*Ranunculus acris*	Soleieslekta. Yellow med. flowers, tall, thin stalk, green buds, rough leaves	3	3	0
urban	Tippetue	Rosefamilien	*Rosa sp.*	Rynkerose? Deep pink, yellow r. organ, oval thick and shiny leaves w/ toothed edges. Gets thick fruit	1	3	0
urban	Tippetue	Skogsvinerot	*Stachys sylvatica*	Leppeblomstfamilien. Tall, purple, hairy, bad smell	1	3	0
urban	Tippetue	Vendelrot	*Valeriana sambucifola*	Skjermplantefamilien. white and/ or pink, bisymetric leaves	4	3	0

*Table 20: All flowering plants during August Bergen in Norway (2022). with index score 1 – 4. Sorted by category. *I. index is the abundance of each species or genus in a site, while *S. index is the abundance of all species or genus in a site. *Notes: All/ half cut = mowing.*

Area	Site	Norwegian name	Latin name	Common traits	*I. index	*S. index	*Notes
rural	Espegrend	Blåkoll	*Prunella vulgaris*	Purple, small, leaves & flowers in levels	1	2	0
rural	Espegrend	Geitrams	*Chamerion angustifolium*	Geitramsslekta. Tall, pink to blue. Arrowshaped towards top	4	2	0
rural	Espegrend	Hvitkløver	*Trifolium repens*	Kløverslekta	1	2	0
rural	Espegrend	Kurvplantefamilien	*Sveve sp.*	kurvplantefamilien. Yellow, y-shaped cup, looks like føllblom but no red on petals	1	2	0
rural	Espegrend	Kurvplantefamilien	*Scorzoneroides sp.*	kurvplanteslekta. Føllblom? Branches in big cluster, ruccola leaves, few branches. Yellow petals, brown/ red stripes, white hairs on cup, 2-7 narrow cups	2	2	0
rural	Espegrend	Krypfredløs	*Lysimachia nummularia*	Looks like yellow "smørblomst/ waterlilly", crawling	1	2	0
rural	Espegrend	Liguster	*Ligustrum sp.*	Oljetrefamilien. Bush w/ white flowers	1	2	0
rural	Espegrend	Mjølkeslekta	*Epilobium sp.*	Krattmjølke? Pale purple flower, thin, upright stalk and flowers	1	2	0
rural	Espegrend	Mureslekta	*Potentilla sp.*	Rosefamilien. Small yellow, sharp leaves and petals, bush	1	2	0
rural	Espegrend	Myrtistel	*Cirsium palustre*	kurvplantefamilien. Tistelslekta	2	2	0
rural	Espegrend	Nyremarikåpe	*Alchemilla murbeckiana*	Marikåpeslekta. 5-9 cm wide leaves, 5-7 leaf patches, 15-19 small tips, wide leaf base opening, bald surface	1	2	0
rural	Espegrend	Rødkløver	*Trifolium pratense*	Kløverslekta	1	2	0
rural	Espegrend	Skogsalat	*Mycelis muralis*	kurvplantefamilien. Tall, small yellow flowers with narrow cup, centered on top, arrow shaped leaves	1	2	0
rural	Espegrend	Skvallerkål	*Aegopodium podagraria*	Skjermplantefamilien. Large, slender, toothed leaves. Hallonlike groundleaves (duplets near stalk, triplet on end), tiny flowers	4	2	0
rural	Espegrend	Spireaslekta	*Spirea sp.*	Small, fluffy pink flowers on top, slender leaves w/ wide base	1	2	0
rural	Espegrend	Stankstorkenebb	*Geranium sp.*	Storkenebbfamilien. Small hairs on stalk and cup, long neck, red and thin stalk	1	2	0
rural	Espegrend	Storklokke	*Campanula latifolia*	Klokkefamilien, klokkeslekta. Big, white bellshaped flowers with deep cuts	0	2	0
rural	Espegrend	Storklokke	*Campanula latifolia*	Klokkefamilien, klokkeslekta. Big, white bellshaped flowers with deep cuts.	0	2	0
rural	Espegrend	Svarthyll	*Sambucus nigra*	Moskusurtfamilien, hyllslekta. Large, white epiphyte on tree, white flowers and long white buds on the side	1	2	0
rural	Espegrend	Sveveslekta	*Hieracium sp.*	Skogsveve? Looks like føllblom, leaves prickly. Only branches on top, rounded cup	1	2	0
rural	Espegrend	Sveveslekta	*Hieracium sp.*	Engsveve? Slender, long leaves at ground, soft hairs, no branches, cup w/ white and dark hairs. Grey/ red stalk w/ long cover leaves and short hairs	1	2	0
rural	Espegrend	Sveveslekta	*Hieracium sp.*	kurvplantefamilien. Tall, large yellow flowers, few branches, cylindrical and hairy cup. Leaves large, dark on top, dandelion like, light green and hairy	1	2	0
rural	Espegrend	Vendelrot	*Valeriana sambucifola*	Skjermplantefamilien. Flower white and/ or pink, bisymetric leaves	1	2	0
rural	Espegrend	Vikkeslekta	*Vivia sp.*	Gjerdevikke? More than 4-8 pair of leaves	1	2	0
rural	Espegrend	Åkersennep?	*Sinapis arvensis*	Yellow, small, spread petals, cabbage-like leaves	0	2	0
rural	Espegrend	Åkersvineblom	*Senecio sylvaticus*	Kurvplantefamilien. Svineblomslekta. Narrow cups, thick & upright stalk, leaves deeply cut	1	2	0
rural	Liland	Balderbrå	*Tripleurospermum inodorum*	Dandelion and "dill" looking	1	3	0
rural	Liland	Engsoleie	*Ranunculus acris*	Soleieslekta. Yellow medium sized flowers, tall, thin stalk, green buds, rough leaves	1	3	0
rural	Liland	Geitrams	*Chamerion angustifolium*	Geitramsslekta. Tall, pink to blue. Arrowshaped towards top	1	3	0
rural	Liland	Hvitkløver	*Trifolium repens*	Kløverslekta	1	3	0
rural	Liland	Knoppurtslekta	*Centaurea. Sp*	kurvplantefamilien. Light blue flowers	2	3	0
rural	Liland	Kurvplantefamilien	*Scorzoneroides sp.*	Lodneføllblom? Tall, few branches, ruccola leaves with hair, crowpetals w/ red stripes	1	3	0
rural	Liland	Kurvplante familien	*Cirsium sp.*	Veitistel? 4 medium sized clusters on top, dandelion like leaves and stalk w/ spikes	1	3	0
rural	Liland	Kurvplantefamilien	*Cirsium sp.*	Tistelslekta. Myrtistel? 4-5- clusters in top and pr. Branch, small, long and spiky leaves	2	3	0
rural	Liland	Kurvplante familien	*Scorzoneroides sp.*	kurvplanteslekta. Føllblom? Branches in big cluster, ruccola leaves, few branches. Yellow petals, brown/ red stripes, white hairs on cup, 2-7 narrow cups	2	3	0
rural	Liland	Krusetistel?	*Carduus crispus*	3-5 small clusters per. branch, few branches in top, almost bare stalk, lancet shaped and rounded leaves	0	3	0
rural	Liland	Marikåpeslekta	*Alchemilla sp.*	Engmarikåpe? Rosefamilien. Open leaves, 15-19 evenly large leaf-teeth, evenly hairs, smooth stalk from flowerstand, flowers in clusters	1	3	0

rural	Liland	Mjødurt	Filipendula ulmaria	Mjødurtslekta. Yellow/ white, herb looking clusters	1	3	0
rural	Liland	Mjølkeslekta	*Epilobium sp.*	Krattmjølke? Pale purple flower, thin, upright stalk and flowers, both thick and thin red stalks	1	3	0
rural	Liland	Mjølkeslekta	*Epilobium sp.*	Amerikamjølke? Green, both thick and thin stalks.	2	3	0
rural	Liland	Revebjelle	*Digitalis sp.*	Maskeblomstfamilien. Revebjelleslekta.	1	3	0
rural	Liland	Rødkløver	*Trifolium pratense*	Kløverslekta	2	3	0
rural	Liland	Sellerislekta	*Apium snaue. Sp*	Small, hvite flower, small rounded leaves on stalk, long slender leaves on top	1	3	0
rural	Liland	Skogstorknebb	*Geraniceae sylvaticum*	Storkenebbfamilien. 5 petals, dark lilac, bisymetrical leaves	2	3	0
rural	Liland	Stankstorkenebb	*Geranium sp.*	Storkenebbfamilien. Small hairs on stalk and cup, long neck, red and thin stalk	1	3	0
rural	Liland	Steinnype	*Rosa canina*	Nyperose, gets slender fruit	4	3	0
rural	Liland	Stivdylle	*Sonchus asper*	Yellow, dandelion looking, thick stalk, spiky leaves that embrace and twirls around the stalk. Bulbous cup	1	3	0
rural	Liland	Sumphaukeskjegg	*Crepis paludosa*	Haukeskjeggslekta. Looks like stivdylle but smaller and a bit diff. leaves. Small sharp toothed leaves	1	3	0
rural	Liland	Tepperot	*Potanilla erecta*	Rosefamilien. Small, cute, yellow flowers. Leaves in floors along stalk	1	3	0
rural	Liland	Tiriltunge	*Lotus corniculatus*	Thin, relatively short stalk w/ orange/ yellow flowers	1	3	0
rural	Liland	Tistelslekta	*Cirsium sp.*	kurvplantefamilien. Tistelslekta	0	3	0
rural	Liland	Tusenfryd	*Bellis perennis*	Gullrisslekta. Small, white flowers on thin and short stalk, hairy leaves, thin base on leaves, then very wide towards edge	1	3	0
rural	Liland	Vikkeslekta	*Vivia sp.*	Gjerdevikke? More than 4-8 pair of leaves	1	3	0
rural	Rambjørga	Bergmjølke	*Epilobium collinum*	Mjølkeslekta. Pink flowers. Opposite, whole and toothed leaves.	3	2	Half cut
rural	Rambjørga	Blåklokke	*Campanula rotundifolia*	Klokkefamilien. Long, slender stalks	2	2	Half cut
rural	Rambjørga	Engsoleie	*Ranunculus acris*	Soleieslekta. Yellow medium sized flowers, tall, thin stalk, green buds, rough leaves	0	2	All cut
rural	Rambjørga	Firkantperikum	*Hypericum maculatum*	Perikumfamilien. Yellow flowers, squared stalk, 4 leaves in rosetta	2	2	0
rural	Rambjørga	Fredløs sp.	*Lysimachia punctata*	Fredløsslekta. Fagerfredløs? Edges of crown leaves covered w/ hairs, flowers abundant on stalk - two from each leaf base	3	2	Half cut
rural	Rambjørga	Fredløs sp.	*Lysimachia sp.*	Fredløsslekta. Fagerfredløs? Edges of crown leaves covered w/ hairs, flowers abundant on stalk - two from each leaf base	3	2	0
rural	Rambjørga	Fuglevikke	*Vicia cracca*	Vikkeslekta. Violet, clusters.	1	2	Half cut
rural	Rambjørga	Geitrams	*Chamerion angustifolium*	Geitramsslekta. Tall, pink to blue. Arrowshaped towards top	1	2	All cut
rural	Rambjørga	Hanekamslekta	*Lychnis sp.*	Tall and slim, violet flowers w/ deep cut long petals	0	2	0
rural	Rambjørga	Haukeskjeggslekta	*Crepis sp.*	Looks like løvetann, tall and slender, hairy	1	2	All cut
rural	Rambjørga	Hvitbladtistel	*Circium heterophyllum*	kurvplantefamilien. Tistelslekta. Long spiky leaves, white underneath	1	2	All cut
rural	Rambjørga	Hvitkløver	*Trifolium repens*	Kløverslekta	2	2	0
rural	Rambjørga	Kardeborreslekta	*Dipsacus*	Blåknapp? Purple neck, blue petals and pink centre	1	2	All cut
rural	Rambjørga	Klasespirea	*Spiraea billardii*	Small, fluffy pink flowers on top, slender leaves with narrow base	1	2	All cut
rural	Rambjørga	Kystbjønnkjeks	*Heracleum spondylium*	Skjermplantefamilien, Bjønnkjeksslekta. Flowers white/ pink, flat/ non-conic hat. Big flowers. Thick, tall stalk. Sawtoothed leaves	1	2	All cut
rural	Rambjørga	Mjødurt	*Filipendula ulmaria*	Mjødurtslekta. Yellow/ white, herb looking	1	2	All cut
rural	Rambjørga	Mjølkeslekta	*Epilobium sp.*	Krattmjølke? Pale purple flower, thin, upright stalk and flowers, green, many teeth on leaves	2	2	All cut
rural	Rambjørga	Revebjelle	*Digitalis sp.*	Maskeblomstfamilien. Revebjelleslekta.	1	2	All cut
rural	Rambjørga	Rødkløver	*Trifolium pratense*	Kløverslekta	1	2	0
rural	Rambjørga	Skvallerkål	*Aegopodium podagraria*	Skjermplantefamilien. Large, slender, toothed leaves. Hallonlike groundleaves (duplets near stalk, triplet on end), tiny flowers	1	2	Half cut
rural	Rambjørga	Stivdylle	*Sonchus asper*	Yellow, dandelion looking, thick stalk, spiky leaves that embrace and twirls around the stalk. Bulbous cup	1	2	Half cut
rural	Rambjørga	Stormarimjelle	*Melampyrum pratense*	Maskeblomstfamilien. Yellow long flowers w/ short leaves. Thin stalk w/ lancet shaped leaves on long neck	3	2	Half cut
rural	Rambjørga	Sumphaukeskjegg	*Crepis paludosa*	Haukeskjeggslekta. Looks like stivdylle but smaller and a bit diff. leaves. Small sharp toothed leaves	1	2	All cut
rural	Rambjørga	Sveveslekta	*Hieracium sp.*	kurvplantefamilien. Skogsveve? Yellow	1	2	Half cut
rural	Rambjørga	Sveveslekta	*Hieracium sp.*	kurvplantefamilien. Yellow	1	2	All cut
rural	Rambjørga	Tepperot	*Potanilla erecta*	Rosefamilien. Small, cute, yellow flowers. Leaves in floors along stalk	2	2	All cut
rural	Rambjørga	Vendelrot	*Valeriana sambucifola*	Skjermplantefamilien. Flower white and/ or pink, bisymetric leaves	1	2	All cut
rural	Rambjørga	Vikkeslekta	*Vivia sp.*	Skogvikke? More than 4-8 pair of leaves	1	2	Half cut
rural	Rambjørga	Åkersvineblom	*Senecio sylvaticus*	Kurvplantefamilien. Svineblomslekta. Narrow cups, thick & upright stalk, leaves deeply cut	0	2	0
rural	Rambjørga	Åkertistel	*Cirisium arvense*	0	1	2	Half cut

rural	Stavollen	Engsoleie	*Ranunculus acris*	Soleieslekta. Yellow medium sized flowers, tall, thin stalk, green buds, rough leaves	1	1	0
rural	Stavollen	Geitrams	*Cham. angustifolium*	Geitramsslekta. Tall, pink to blue. Arrowshaped towards top	1	1	0
rural	Stavollen	Kystbjønnkjeks	*Heracleum spondylium*	Skjermplantefamilien, Bjønnkjeksslekta. Flowers white/ pink, flat/ non-conic hat. Big flowers. Thick, tall stalk. Sawtoothed leaves	2	1	0
rural	Stavollen	Mjødurt	*Filipendula ulmaria*	Mjødurtslekta. Yellow/ white, herb looking clusters	1	1	0
rural	Stavollen	Myrtistel	*Cirsium palustre*	kurvplantefamilien. Tistelslekta	0	1	0
rural	Stavollen	Revebjelle	*Digitalis sp.*	Maskeblomstfamilien. Revebjelleslekta.	0	1	0
rural	Stavollen	Skvallerkål	*Aegopodium podagraria*	Skjermplantefamilien. Large, slender, toothed leaves. Hallonlike groundleaves (duplets near stalk, triplet on end), tiny flowers	1	1	0
rural	Stavollen	Tepperot	*Potanilla erecta*	Rosefamilien. Small, cute, yellow flowers. Leaves in floors along stalk	4	1	0
rural	Stavollen	Åkersennep?	*Sinapis arvensis*	Yellow, small, spread petals, cabbage-like leaves	0	1	0
rural	Stavollen	Åkersvineblom	*Senecio sylvaticus*	Kurvplantefamilien. Svineblomslekta. Narrow cups, thick & upright stalk, leaves deeply cut	1	1	0
rural	Tennebekk	Brunrot	*Scrophularia nodosa*	Brunrotslekta. Orchid looking, violet lip, brown (young)/ green stalk, tall bush	2	3	0
rural	Tennebekk	Engsoleie	*Ranunculus acris*	Soleieslekta. Yellow medium sized flowers, tall, thin stalk, green buds, rough leaves	1	3	0
rural	Tennebekk	Firkantperikum	*Hypericum maculatum*	Perikumfamilien. Yellow flowers, squared stalk, 4 leaves in rosetta	4	3	0
rural	Tennebekk	Fredløs sp.	*Lysimachia sp.*	Fredløsslekta	1	3	0
rural	Tennebekk	Geitrams	*Chamerion angustifolium*	Geitramsslekta. Tall, pink to blue. Arrowshaped towards top	3	3	0
rural	Tennebekk	Humleblomslekta	*Geum sp.*	Yellow flower, thick stalk, upright flowers in cl. of 3-5	1	3	0
rural	Tennebekk	Hvitkløver	*Trifolium repens*	Kløverslekta	2	3	0
rural	Tennebekk	kurvplantefamilien	*Senecio sp.*	Svineblomslekta. Dikesvineblom?	1	3	0
rural	Tennebekk	kurvplantefamilien	*Senecio sp.*	Svineblomslekta. Yellow with green, saladish leaves	1	3	0
rural	Tennebekk	kurvplantefamilien	*Scorzoneroides sp.*	Føllblom? Branches in big cluster, ruccola leaves, few branches. Yellow petals, brown/ red stripes, white hairs on cup, 2-7 narrow cups	1	3	0
rural	Tennebekk	kurvplantefamilien	*Hypochaeris sp.*	Griseøreslekta. Yellow, long slender, few branches, narrow leaves	1	3	0
rural	Tennebekk	Krusetistel	*Carduus crispus*	3-5 small clusters per. branch, few branches in top, almost bare stalk, lancet shaped and rounded leaves	3	3	0
rural	Tennebekk	Kystbjønnkjeks	*Heracleum spondylium*	Skjermplantefamilien, Bjønnkjeksslekta. Flowers white/ pink, flat/ non-conic hat. Big flowers. Thick, tall stalk. Sawtoothed leaves	2	3	0
rural	Tennebekk	Marikåpeslekta	*Alchemilla sp.*	Engmarikåpe? Rosefamilien. Open leaves, 15-19 evenly large leaf-teeth, evenly hairs, smooth stalk from flowerstand, flowers in clusters	0	3	0
rural	Tennebekk	Mjølkeslekta	*Epilobium sp.*	Thin, medium height, green	1	3	0
rural	Tennebekk	Mjølkeslekta	*Epilobium sp.*	Thin and thick, tall, red stalk and leaves	2	3	0
rural	Tennebekk	Revebjelle	*Digitalis sp.*	Maskeblomstfamilien. Revebjelleslekta.	1	3	0
rural	Tennebekk	Rødkløver	*Trifolium pratense*	Kløverslekta	4	3	0
rural	Tennebekk	Røsslyng	*Calluna vulgaris*	0	1	3	0
rural	Tennebekk	Skvallerkål	*Aegopodium podagraria*	Skjermplantefamilien. Large, slender, toothed leaves. Hallonlike groundleaves (duplets near stalk, triplet on end), tiny flowers	1	3	0
rural	Tennebekk	Stankstorkenebb	*Geranium robertianum*	Storkenebbfamilien. Light purle, small flowers. Characteristic, rounded leaves, smells baad, red around branch root	1	3	0
rural	Tennebekk	Tepperot	*Potanilla erecta*	Rosefamilien. Small, cute, yellow flowers. Leaves in floors along stalk	2	3	0
suburban	Håsteinarparken	Akeleie Aquilegia	*Aquilegia pubescens*	Soleiefamilien. Yellow, orchidlooking	1	2	0
suburban	Håsteinarparken	Blodtopp	*Sanguisorba officinalis*	Rosefamilien. Very tall and slender, dark pink & bushlike flowers on top	3	2	0
suburban	Håsteinarparken	Doggbladlilje	*Hosta sieboldiana*	Light purple lilly with large green/ blue leaves.	4	2	0
suburban	Håsteinarparken	Firkantperikum	*Hypericum maculatum*	Perikumfamilien. Yellow flowers, squared stalk, 4 leaves in rosetta	1	2	0
suburban	Håsteinarparken	Gul valmuesøster	*Meconopsis cambrica*	Valmuefamilien, valmueslekta. Looks like poppy, both yellow and orange here	1	2	0
suburban	Håsteinarparken	Hortensia	*Hydrangea macrophylla*	Woody epiphyte w/ large and flat white/ light pink flowers on top of small purple flowers	2	2	0
suburban	Håsteinarparken	Leppeblomstfamilien	*Lamiaceae sp.*	Koreamynte? Small ochid looking, hairy, smells like lemon balm	2	2	0
suburban	Håsteinarparken	Mjølkeslekta	*Epilobium sp.*	Krattmjølke? Pale purple flower, thin, upright stalk, and flowers, red stalk	1	2	0
suburban	Håsteinarparken	Mjølkeslekta	*Epilobium sp.*	Green, some branches, small leaves on top, larger towards base	1	2	0
suburban	Håsteinarparken	Revebjelleslekta	*Digitalis sp.*	Maskeblomstfamilien. Revebjelleslekta. White and pink.	1	2	0
suburban	Håsteinarparken	Roseslekta	*Rosa sp.*	R. rubiginosa? Leaves large, round on top of double triplets. Smaller tow base. Dark spikes on stalk. Bright pink & large flower. Get slender fruit	1	2	0

suburban	Håsteinarparken	Spirea	*Spirea sp.*	Tall, pink flower	0	2	0
suburban	Håsteinarparken	Spireaslekta	*Spirea sp.*	Small, fluffy pink flowers on top, rough leaves w/ one large on top and two duplets	2	2	0
suburban	Håsteinarparken	Stankstorkenebb	*Geranium robertianum*	Storkenebbfamilien. Light purle, small flowers. Characteristic, rounded leaves, smells baad, red around branch root	1	2	0
suburban	Håsteinarparken	Storkenebbslekta	*Geranium sp.*	Storkenebbfamilien. X oxonianum Yeo? Looks almost identical to skogstorkenebb, but larger	3	2	0
suburban	Simonsviken	Arve	*Cerastium fontanum*	Small white flowers, thin and short	1	3	0
suburban	Simonsviken	Blåklokke	*Campanula rotundifolia*	Klokkefamilien. Long, slender stalks	2	3	0
suburban	Simonsviken	Engnellik	*Dianthus deltoides*	Nellikfam. Petals sawtoothed. Purple crown, slender leaves/stalk, white flowerspots	1	3	0
suburban	Simonsviken	Engsoleie	*Ranunculus acris*	Soleieslekta. Yellow medium sized flowers, tall, thin stalk, green buds, rough leaves	1	3	0
suburban	Simonsviken	Geitrams	*Chamerion angustifolium*	Geitramsslekta. Tall, pink to blue. Arrowshaped towards top	2	3	0
suburban	Simonsviken	Hvitkløver	*Trifolium repens*	Kløverslekta	2	3	0
suburban	Simonsviken	Knoppurtslekta	*Centaurea. Sp*	kurvplantefamilien.	2	3	0
suburban	Simonsviken	kurvplantefamilien	*Scorzoneroides sp.*	Kystgrisøre? Looks like Føllblom and Dandelion. Not Sveve or føllblom	1	3	0
suburban	Simonsviken	Krusetistel	*Carduus crispus*	kurvplantefamilien. Tistelslekta. Small buds in clusters of 3-5, soft leaves with soft spikes, whitehaired under leaves.	3	3	0
suburban	Simonsviken	Kystbjønnkjeks	*Heracleum spondylium*	Skjermplantefamilien, Bjønnkjeksslekta. Flowers white/ pink, flat/ non-conic hat. Big flowers. Thick, tall stalk. Sawtoothed leaves	3	3	0
suburban	Simonsviken	Marikåpeslekta	*Alchemilla sp.*	Engmarikåpe? Rosefamilien. Open leaves, 15-19 evenly large leaf-teeth, evenly hairs, smooth stalk from flowerstand, flowers in clusters	1	3	0
suburban	Simonsviken	Mjølkeslekta	*Epilobium sp.*	Amerikamjølke? Light violet flowers, leaves dark green, turns inward on tip	2	3	0
suburban	Simonsviken	Mjølkeslekta	*Epilobium sp.*	Krattmjølke? Pale purple flower, thin, upright stalk and flowers	1	3	0
suburban	Simonsviken	Prestekrage	*L.vulgae*	Large white petals on slender stalk w/ lacet shaped leaves	3	3	0
suburban	Simonsviken	Rød jonsokblom	*Spergularia dioica*	Nellikfamilien. Split petals, long hairy stalk, few branches, violet cups of 3-20 red/violet flowes	1	3	0
suburban	Simonsviken	Rødkløver	*Trifolium pratense*	Kløverslekta	4	3	0
suburban	Simonsviken	Rødnapp	*Knautia arvensis*	Moskusurtfam. Large violet button on top	3	3	0
suburban	Simonsviken	Røsslyng	*Calluna vulgaris*	0	1	3	0
suburban	Simonsviken	Salatsveve sp.	*Seksjon Prenanthoidea*	Sveveslekta. Tall dandelion looking, yellow flowers, rounded lancet leaves, hairlike structures on cup, branches starts from base of stalk leaves	1	3	0
suburban	Simonsviken	Storarve	*Cerastium arvense*	Small white flowers, thin and tall	1	3	0
suburban	Simonsviken	Tepperot	*Potanilla erecta*	Rosefamilien. Small, cute, yellow flowers. Leaves in floors along stalk	1	3	0
suburban	Simonsviken	Tiriltunge	*Lotus corniculatus*	Thin, relatively short stalk w/ orange/ yellow flowers	3	3	0
suburban	Simonsviken	Vendelrot	*Valeriana sambucifola*	Skjermplantefamilien. Flower white and/ or pink, bisymetric leaves	1	3	0
suburban	Simonsviken	Åkerforglemmegei	*Myosotis avensis*	Rubladfam. Small, blue flowers with many buds on upper part of stalk	1	3	0
suburban	Storetveit	Engsoleie	*Ranunculus acris*	Soleieslekta. Yellow medium sized flowers, tall, thin stalk, green buds, rough leaves	1	2	Half cut
suburban	Storetveit	Hanekamslekta	*Lychnis sp.*	Tall and slim, violet flowers w/ deep cut long petals	0	2	Half cut
suburban	Storetveit	Humleblomslekta	*Geum sp.*	Yellow flower, thick stalk, upright flowers in cl. of 3-5	1	2	Half cut
suburban	Storetveit	Hvitkløver	*Trifolium repens*	Kløverslekta	3	2	Half cut
suburban	Storetveit	Kurvplantefamilien	*Scorzoneroides sp.*	Kurvplantefamilien. Føllblom? Branches in big cluster, ruccola leaves, few branches. Yellow petals, brown/ red stripes, white hairs on cup, 2-7 narrow cups	4	2	Half cut
suburban	Storetveit	Kratthumleblom	*Geum urbanum*	Rosefamilien. Messy hairbuds, red centre on yellow petals, 2-5 flowers	1	2	Half cut
suburban	Storetveit	Marikåpeslekta	*Alchemilla sp.*	Engmarikåpe? Rosefamilien. Open leaves, 15-19 evenly large leaf-teeth, evenly hairs, smooth stalk from flowerstand, flowers in clusters	3	2	Half cut
suburban	Storetveit	Mjødurt	*Filipendula ulmaria*	Mjødurtslekta. Yellow/ white, herb looking	3	2	Half cut
suburban	Storetveit	Mjølkeslekta	*Epilobium sp.*	No hairs on stalk, many leaves on one of them. Red stalk	1	2	Half cut
suburban	Storetveit	Rød jonsokblom	*Spergularia dioica*	Nellikfamilien. Split petals, long hairy stalk, few branches, violet cups of 3-20 red/violet flowes	0	2	Half cut
suburban	Storetveit	Rødkløver	*Trifolium pratense*	Kløverslekta	1	2	Half cut
suburban	Storetveit	Skjermplantefamilien	*Apiaceae sp.*	Skvallerkål? White/grey flowers, brown seeds, no slit	3	2	Half cut
suburban	Svartediket	Engsoleie	*Ranunculus acris*	Soleieslekta. Yellow medium sized flowers, tall, thin stalk, green buds, rough leaves	1	2	All cut
suburban	Svartediket	Fredløs sp.	*Lysimachia p.*	Fredløsslekta. Fagerfredløs? Edges of crown leaves covered w/ hairs, flowers abundant on stalk - two from each leaf base	3	2	All cut
suburban	Svartediket	Kratthumleblom	*Geum urbanum*	Rosefamilien. Messy hairbuds, red centre on yellow petals, 2-5 flowers	4	2	All cut
suburban	Svartediket	Kystbjønnkjeks	*Heracleum spondylium*	Skjermplantefamilien, Bjønnkjeksslekta. Flowers white/ pink, flat/ non-conic hat. Big flowers. Thick, tall stalk. Sawtoothed leaves	2	2	All cut
suburban	Svartediket	Marikåpeslekta	*Alchemilla sp.*	Engmarikåpe? Rosefamilien. Open leaves, 15-19 evenly large leaf-teeth, evenly hairs, smooth stalk from flowerstand, flowers in cl.	1	2	All cut

suburban	Svartediket	Mjødurt	*Filipendula ulmaria*	Mjødurtslekta. Yellow/ white, herb looking	4	2	All cut
suburban	Svartediket	Mjølkeslekta	*Epilobium sp.*	Krattmjølke? Pale purple flower, thin, upright stalk and flowers	2	2	0
suburban	Svartediket	Mjølkeslekta	*Epilobium sp.*	Greinmjølke? Very thick, red, squared stalk. Very tall.	2	2	All cut
suburban	Svartediket	Mjølkeslekta	*Epilobium sp.*	Amerikamjølke? Many branches/seeds/ leaves, thin and red stalk	2	2	All cut
suburban	Svartediket	Tepperot	*Potanilla erecta*	Rosefamilien. Small, cute, yellow flowers. Leaves in floors along stalk	2	2	0
suburban	Svartediket	Vendelrot	*Valeriana sambucifola*	Skjermplantefamilien. Flower white and/ or pink, bisymetric leaves	2	2	All cut
suburban	Sølvberget	Firkantperikulum	*Hypericum maculatum*	Yellow flower on long, upright, thin stalk w/ 4 edges	1	3	0
suburban	Sølvberget	Fredløs sp.	*Lysimachia sp.*	Nøkleblomfamilien, fredløsslekta. Yellow flowers w/ 5 petals. 4 leaves per. leafcluster	2	3	0
suburban	Sølvberget	Geitrams	*Chamerion angustifolium*	Geitramsslekta. Tall, pink to blue. Arrowshaped towards top	3	3	0
suburban	Sølvberget	Gul valmuesøster	*Meconopsis cambrica*	Valmuefamilien, valmueslekta. Looks like poppy, both yellow and orange here	1	3	0
suburban	Sølvberget	kurvplantefamilien	*Scorzoneroides sp.*	Føllblom? Branches in big cluster, ruccola leaves, few branches. Yellow petals, brown/ red stripes, white hairs on cup, 2-7 narrow cups	1	3	0
suburban	Sølvberget	Krypfredløs	*Lysimachia nummularia*	Looks like yellow "smørblomst/ waterlilly", crawling	2	3	0
suburban	Sølvberget	Kvassdå	*Galeopsis tetrahits*	Leppeblomstfamilien. Looks like svinerot, small and orchid looking pale purple flowers, hairy branch	1	3	0
suburban	Sølvberget	Kystbjønnkjeks	*Heracleum sphondylium*	Skjermplantefamilien, Bjønnkjeksslekta. Flowers white/ pink, flat/ non-conic hat. Big flowers. Thick, tall stalk. Sawtoothed leaves	4	3	0
suburban	Sølvberget	Marikåpeslekta	*Alchemilla sp.*	Rounded, a bit open	1	3	0
suburban	Sølvberget	Marikåpeslekta	*Alchemilla sp.*	Pointy, a bit closed	1	3	0
suburban	Sølvberget	Mjølkeslekta	*Epilobium sp.*	Tall, green, light pink flowers, 3 brances in top, many seeds in top	1	3	0
suburban	Sølvberget	Mjølkeslekta	*Epilobium sp.*	Pale purple and upright flower, thick, red and upright stalk	2	3	0
suburban	Sølvberget	Revebjelle	*Digitalis sp.*	Maskeblomstfamilien. Revebjelleslekta.	1	3	0
suburban	Sølvberget	Rubladfamilien	*Myosotis sp.*	Forglemmegei? Small, blue flowers with many buds on upper part of stalk	1	3	0
suburban	Sølvberget	Røsslyng	*Calluna vulgaris*	0	4	3	0
suburban	Sølvberget	Sildrespir	*Astilbe arendsii*	Spirslekta. Tall, bushlike top w/ dark pink lfowers, large leaf with duplets at base	1	3	0
suburban	Sølvberget	Skogsalat	*Mycelis muralis*	kurvplantefamilien. Tall, small yellow flowers with narrow cup, centered on top, arrow shaped leaves	2	3	0
suburban	Sølvberget	Skogsbjørnebær	*Rubus nessensis*	Rosefamilien	1	3	0
suburban	Sølvberget	Spirea	*Spirea sp.*	Spireaslekta. Small, fluffy pink flowers on top, rough leaves w/ one large on top and two duplets	1	3	0
suburban	Sølvberget	Stormarimjelle	*Melampyrum pratense*	Maskeblomstfamilien. Yellow long flowers w/ short leaves. Thin stalk w/ lancet shaped leaves on long neck	1	3	0
suburban	Sølvberget	Tepperot	*Potanilla erecta*	Rosefamilien. Small, cute, yellow flowers. Leaves in floors along stalk	1	3	0
suburban	Sølvberget	Tistelslekta	*Cirsium sp.*	kurvplantefamilien. Tistelslekta	0	3	0
suburban	Sølvberget	Vivendel	*Lonicera periclymenum*	Kaprifolfamilien, leddvedslekta. Bushlike. Flower red outside, yellow inside. Oval, limegreen leaves	1	3	0
urban	Christieparken	Blåkoll	*Prunella vulgaris*	Purple, small, leaves & flowers in levels	1	1	All cut
urban	Christieparken	Engsoleie	*Ranunculus acris*	Soleieslekta. Yellow medium sized flowers, tall, thin stalk, green buds, rough leaves	1	2	All cut
urban	Christieparken	Hvitkløver	*Trifolium repens*	Kløverslekta	0	1	All cut
urban	Christieparken	kurvplantefamilien	*Scorzoneroides sp.*	Føllblom? Branches in big cluster, ruccola leaves, few branches. Yellow petals, brown/ red stripes, white hairs on cup, 2-7 narrow cups	2	1	All cut
urban	Christieparken	kurvplantefamilien	*Scorzoneroides sp.*	Føllblom? Leaves hairy on both sides	0	1	All cut
urban	Christieparken	Kystbjønnkjeks	*Heracleum spondylium*	Skjermplantefamilien, Bjønnkjeksslekta. Flowers white/ pink, flat/ non-conic hat. Big flowers. Thick, tall stalk. Sawtoothed leaves	3	1	All cut
urban	Christieparken	Kystgrisøre	*Hypocaeris radicata*	Grey/purple stripe on petals, hairs on middle nerve, green/ blue stalk, large and thick leaves	1	1	All cut
urban	Christieparken	Marikåpeslekta	*Alchemilla sp.*	Engmarikåpe? Rosefamilien. Open leaves, 15-19 evenly large leaf-teeth, evenly hairs, smooth stalk from flowerstand, flowers in clusters	1	1	All cut
urban	Christieparken	Mjølkeslekta	*Epilobium sp.*	Krattmjølke? Pale purple flower, thin, upright stalk and flowers	1	1	All cut
urban	Christieparken	Sibirportulakk	*Claytonia sibirica L.*	Portulakkfamilien. Small round leaves, like waterlily	3	1	All cut
urban	Mulen	Bergmjølke	*Epilobium collinum*	Mjølkeslekta. Pink flowers. Opposite, whole and toothed leaves.	2	2	0
urban	Mulen	Blekspirea	*Spiraea rubella*	Pink flowers, very conical shape. Two toothed leaf teeth.	1	2	0
urban	Mulen	Engsoleie	*Ranunculus acris*	Soleieslekta. Yellow medium sized flowers, tall, thin stalk, green buds, rough leaves	2	2	0
urban	Mulen	Fredløs sp.	*Lysimachia sp.*	Fredløsslekta. Fagerfredløs? Edges of crown leaves covered w/ hairs, flowers abundant on stalk - two from each leaf base	2	2	0
urban	Mulen	Geitrams	*Chamerion angustifolium*	Geitramsslekta. Tall, pink to blue. Arrowshaped towards top	3	2	0

urban	Mulen	Haremat	*Lapsana communis*	Harematslekta. Tall, yellow, dandelionlooking, eggshaped & pointy leaves w/ quite tothed edges	1	2	0
urban	Mulen	Kratthumleblom	*Geum urbanum*	Rosefamilien. Messy hairbuds, red centre on yellow petals, 2-5 flowers	1	2	0
urban	Mulen	Kystbjønnkjeks	*Heracleum spondylium*	Skjermplantefamilien, Bjønnkjeksslekta. Flowers white/ pink, flat/ non-conic hat. Big flowers. Thick, tall stalk. Sawtoothed leaves	1	2	0
urban	Mulen	Marikåpeslekta	*Alchemilla sp.*	Engmarikåpe? Yellow greenish & bushlike plant with tiny green flowers	1	2	0
urban	Mulen	Marikåpeslekta	*Alchemilla sp.*	Stjernemarikåpe? 9 (- 11) leaf-parts w/ 13-23 uneavenly sized buds. 8-15 cm wide rosett? this one is not	1	2	0
urban	Mulen	Marikåpeslekta	*Alchemilla sp.*	Glattmarikåpe?	1	2	0
urban	Mulen	Marikåpeslekta	*Alchemilla sp.*	Granmarikåpe? 7 leaf parts, 11 teeth (does not match any w/ same shape), rounded leaf, wide opening w/ convex curve. Leaf 3-10 cm.	1	2	0
urban	Mulen	Mjølkeslekta	*Epilobium sp.*	Krattmjølke el. amerika? Pale purple flower, thin, upright stalk and flowers. But neck on seeds. Crown leaves 7.5 mm	3	2	0
urban	Mulen	Rødkløver	*Trifolium pratense*	Kløverslekta	1	2	0
urban	Mulen	Spireaslekta	*Spirea sp.*	Small, fluffy pink flowers on top, rough leaves w/ one large on top and two duplets	1	2	0
urban	Mulen	Stankstorkenebb	*Geranium robertianum*	Storkenebbfamilien. Light purle, small flowers. Characteristic, rounded leaves, smells baad, red around branch root	1	2	0
urban	Mulen	Tepperot	*Potanilla erecta*	Rosefamilien. Small, cute, yellow flowers. Leaves in floors along stalk	2	2	0
urban	Mulen	Vendelrot	*Valeriana sambucifola*	Skjermplantefamilien. Flower white and/ or pink, bisymetric leaves	1	2	0
urban	Mulen	Vikkeslekta	*Vivia sp.*	Gjerdevikke? More than 4-8 pair of leaves	2	2	0
urban	Mulen	Åkersvineblom	*Senecio sylvaticus*	Kurvplantefamilien. Svineblomslekta. Narrow cups, thick & upright stalk, leaves deeply cut	0	2	0
urban	Musehagen	Akeleie Aquilegia	*Aquilegia pubescens*	Soleiefamilien. Yellow, orchidlooking	0	3	0
urban	Musehagen	Blodtopp	*Sanguisorba officinalis*	Rosefamilien. Tall, slender stalk w/ deep pink and cylindrical bush on top	1	3	0
urban	Musehagen	Doggbladlilje	*Hosta sieboldiana*	Light purple lilly with large green/ blue leaves.	3	3	0
urban	Musehagen	Engsoleie	*Ranunculus acris*	Soleieslekta. Yellow medium sized flowers, tall, thin stalk, green buds, rough leaves	1	3	0
urban	Musehagen	Gul valmuesøster	*Meconopsis cambrica*	Valmuefamilien, valmueslekta. Looks like poppy, both yellow and orange here	2	3	0
urban	Musehagen	Japanspirea	*Spiraea japonica*	Spireaslekta. Small purple/pink flowers. Red stalk	2	3	0
urban	Musehagen	Kamilleblom	*Matricaria recutita*	Looks like daisy, white flower w/ yellow styles	1	3	0
urban	Musehagen	Krypsolknapp	*Sanvitalia*	Yellow, small-sized flower. Short stalk, green rep. organ	3	3	0
urban	Musehagen	Kystbjønnkjeks	*Heracleum spondylium*	Skjermplantefamilien, Bjønnkjeksslekta. Flowers white/ pink, flat/ non-conic hat. Big flowers. Thick, tall stalk. Sawtoothed leaves	1	3	0
urban	Musehagen	Løvemunn	*Anthirrinum sp.*	Maskeblomstfamilien. Yellow, orchid looking	1	3	0
urban	Musehagen	Mjølkeslekta	*Epilobium sp.*	Krattmjølke? Pale purple flower, thin, upright stalk and flowers	1	3	0
urban	Musehagen	Mjølkeslekta	*Epilobium sp.*	Amerikamjølke? Green plant, white/ purple flower, short	2	3	0
urban	Musehagen	Nøkleblomfamilien	*Nøkleblom sp.*	Marianøkleblom? Purple, flat flower w/ yellow concave centre	2	3	0
urban	Musehagen	Nøkleblomfamilien	*Nøkleblom sp.*	Nøkleblomslekta. Light purple, slender, several flowers on stalk.	1	3	0
urban	Musehagen	Oregano	*Origanum vulgare L.*	Green, short, purple flowers like vendelrot, stalk w/ leaves like periculum	1	3	0
urban	Musehagen	Pelargonium	*Pelargonium zonale*	Hybrid garden flower, comes in many colors, thick and clover like leaves	3	3	0
urban	Musehagen	Sibirportulakk	*Claytonia sibirica L.*	Portulakkfamilien. Small round leaves, like waterlily	2	3	0
urban	Musehagen	Skogsalat	*Mycelis muralis*	kurvplantefamilien. Tall, small yellow flowers with narrow cup, centered on top, arrow shaped leaves	2	3	0
urban	Musehagen	Skvallerkål	*Aegopodium podagraria*	Skjermplantefamilien. Large, slender, toothed leaves. Hallonlike groundleaves (duplets near stalk, triplet on end), tiny flowers	4	3	0
urban	Musehagen	Solhatt	*Rudbeckia*	Yellow, mid-sized flower. Oval leaves with flat ends on petals, Dark brown rep.organ	4	3	0
urban	Musehagen	Solsikke	*Helianthus annuus*	Yellow, large-sized flower	3	3	0
urban	Musehagen	Storhjelm	*Aconitum napellus*	White or lilac small, cone shaped helmets in floors along tall stalks.	2	3	0
urban	Musehagen	Sveveslekta	*Hieracium sp.*	Skogsveve? Tall with yellow flowers. Hairy leaves, rough stalk	3	3	0
urban	Nordnesparken	Engmarikåpe	*Alchemilla subcrenata*	Small yellow/greenish with tiny green flowers. Boring bushlike	2	1	0
urban	Nordnesparken	Engsoleie	*Ranunculus acris*	Soleieslekta. Yellow medium sized flowers, tall, thin stalk, green buds, rough leaves	1	1	0
urban	Nordnesparken	Engsoleie	*Ranunculus acris*	Soleieslekta. Yellow medium sized flowers, tall, thin stalk, green buds, rough leaves	1	1	0
urban	Nordnesparken	Geitrams	*Chamerion angustifolium*	Geitramsslekta. Tall, pink to blue. Arrowshaped towards top	1	1	0
urban	Nordnesparken	Gravbergknapp	*Phedimus spurius*	White & pink, large, succulent large leaves	1	1	0
urban	Nordnesparken	Hvitbergknapp	*Sebum album*	White, small, succulent small leaves	1	1	0
urban	Nordnesparken	Hvitkløver	*Trifolium repens*	Kløverslekta	1	1	0
urban	Nordnesparken	Japanspirea	*Spiraea japonica*	Spireaslekta. Small purple/pink flowers. Red stalk	2	1	0
urban	Nordnesparken	Kratthumleblom	*Geum urbanum*	Rosefamilien. Messy hairbuds, red centre on yellow petals, 2-5 flowers	1	1	0

urban	Nordnesparken	Kystbjønnkjeks	*Heracleum sphondylium*	Skjermplantefamilien, Bjønnkjeksslekta. Flowers white/ pink, flat/ non-conic hat. Big flowers. Thick, tall stalk. Sawtoothed leaves	3	1	0
urban	Nordnesparken	Liguster	*Ligustrum vulgare*	Syrinslekta. White, small trumpetlike flowers on bush. Long, slender leaves, black berries in cluster	4	1	0
urban	Nordnesparken	Mjølkeslekta	*Epilobium sp.*	Krattmjølke? Pale purple flower, thin, upright stalk and flowers	1	1	0
urban	Nordnesparken	Roseklokkebusk	*Caprifoliaceae agg.*	Kaprifolfamilien, klokkebuskslekta. Large, red and lily looking flowers with sturdy leaves	1	1	0
urban	Nordnesparken	Roseklokkebusk	*Caprifoliaceae agg.*	Kaprifolfamilien, klokkebuskslekta. Large, red and lily looking flowers with sturdy leaves	2	1	0
urban	Nordnesparken	Skjermsveve	*Hieracium sp.*	Sveveslekta.Tall & slender, wide spikes on lancet shaped leaves	0	1	0
urban	Nordnesparken	Smalkjempe	*Plantaginaceae lanceolata*	Brown, furry top. Tall and slender leaves	1	1	0
urban	Nordnesparken	Snøbær	*Symphoricarpos albus laevigatus*	Bush w/ small pink & white flowers	1	1	0
urban	Nordnesparken	Stankstorkenebb	*Geranium robertianum*	Storkenebbfamilien. Light purle, small flowers. Characteristic, rounded leaves, smells baad, red around branch root	1	1	0
urban	Nordnesparken	Stivdylle	*Sonchus asper*	Yellow, dandelion looking, thick stalk, spiky leaves that embrace and twirls around the stalk. Bulbous cup	1	1	0
urban	Nordnesparken	Vivendel	*Lonicera periclymenum*	Kaprifolfamilien, leddvedslekta. Bushlike. Flower red outside, yellow inside. Oval, limegreen leaves	2	1	0
urban	Tippetue	Geitrams	*Chamerion angustifolium*	Geitramsslekta. Tall, pink to blue. Arrowshaped towards top	1	1	0
urban	Tippetue	Humleblomslekta	*Geum sp.*	Yellow flower, thick stalk, upright flowers in cl. of 3-5	1	1	0
urban	Tippetue	Kystbjørnekjeks	*Heracleum sphondylium*	Skjermplantefamilien, Bjønnkjeksslekta. Flowers white/ pink, flat/ non-conic hat. Big flowers. Thick, tall stalk. Sawtoothed leaves	0	1	0
urban	Tippetue	Marikåpeslekta	*Alchemilla sp.*	Engmarikåpe? Rosefamilien. Open leaves, 15-19 evenly large leaf-teeth, evenly hairs, smooth stalk from flowerstand, flowers in clusters	1	1	0
urban	Tippetue	Marikåpeslekta	*Alchemilla sp.*	Stjernemarikåpe? 9 (- 11) leaf-parts w/ 13-23 uneavenly sized buds. 8-15 cm wide rosett? this one is not	1	1	0
urban	Tippetue	Marikåpeslekta	*Alchemilla sp.*	Granmarikåpe? 7 leaf parts, 11 teeth (does not match any w/ same shape), rounded leaf, wide opening w/ convex curve. Leaf 3-10 cm	1	1	0
urban	Tippetue	Mjødurt	*Filipendula ulmaria*	Mjødurtslekta. Yellow/ white, herb looking	1	1	0
urban	Tippetue	Mjølkeslekta	*Epilobium sp.*	Krattmjølke? Pale purple flower, thin, upright stalk and flowers	1	1	0
urban	Tippetue	Mjølkeslekta	*Epilobium sp.*	Purple flowers, less than 15 teeth but leaves 4-6 cm. Pointy leaves	1	1	0
urban	Tippetue	Mjølkeslekta	*Epilobium sp.*	Amerikamjølke? Dark purple flowers. Large, many seeds/ leaves/ branches	1	1	0
urban	Tippetue	Mongolspringfrø	*Impatiens parviflora*	Tall, yellow & small orchid looking flowers with large leaves and seed capsules like mjølke.	1	1	0
urban	Tippetue	Vendelrot	*Valeriana sambucifola*	Skjermplantefamilien. Flower white and/ or pink, bisymetric leaves	1	1	0

*Table 21: All flowering plants during September in Bergen, Norway (2022) with index score 1 - 4. Sorted by category. *I. index is the abundance of each species in a site, while *S. index is the abundance of all species and/ or genus in a site.*

Area	Site	Norwegian name	Latin name	Common traits	*I. index	*S. index
rural	Espegrend	No records	0	0	0	0
rural	Liland	No records	0	0	0	0
rural	Rambjørga	No records	0	0	0	0
rural	Stavollen	No records	0	0	0	0
rural	Tennebekk	Geitrams	*Chamerion angustifolium*	Geitramsslekta. Tall, pink to blue. Arrowshaped towards top	3	2
suburban	Håsteinarparken	Doggbladlilje	*Hosta sieboldiana*	Light purple lilly with large green/ blue leaves.	3	2
suburban	Håsteinarparken	Blodtopp	*Sanguisorba officinalis*	Rosefamilien. Very tall and slender, dark pink & bushlike flowers on top	3	2
suburban	Simonsviken	Rødkløver	*Trifolium pratense*	Kløverslekta	3	3
suburban	Storetveit	Marikåpe	*Alchemilla sp.*	Engmarikåpe? Rosefamilien	4	2
suburban	Storetveit	kurvplantefamilien	*Scorzoneroides sp.*	Føllblom? Leaves hairy on both sides	3	2
suburban	Svartediket	Marikåpe	*Alchemilla sp.*	Engmarikåpe? Rosefamilien	4	1
suburban	Sølvberget	No records	0	0	0	0
urban	Christieparken	Kystbjønnkjeks	*Heracleum spondylium*	Skjermplantefamilien. Flowers white/ pink, flat/ non-conic hat. Big flowers - mostly the front petal, deep cut	3	1
urban	Mulen	Geitrams	*Chamerion angustifolium*	Geitramsslekta. Weed, pretty, tall, pink to blue. Arrowshaped towards top	3	2
urban	Musehagen	Solhatt	*Rudbeckia*	Yellow, mid-sized flower. Oval leaves with flat ends on petals, Dark brown rep.organ	4	3
urban	Musehagen	Solsikke	*Helianthus annuus*	Yellow, large-sized flower	3	3
urban	Musehagen	Krypsolknapp	*Sanvitalia*	Yellow, small-sized flower. Short stalk, green rep. organ	4	3
urban	Musehagen	Pelargonium	*Pelargonium zonale*	Dark pink, short, typical garden flower (also comes in dark purple, yellow etc.)	3	3
urban	Musehagen	Kjempeverbena	*Verbena bonariensis*	Purple tiny flowers, mid-tall, slender, long green/blues spiky toothed leaves	3	3
urban	Musehagen	Løvemunn	*Antirrinum majus*	Pink flowers, yellow flowers, orchid looking	3	3
urban	Musehagen	Mauretansk kattost	*Malva sylvestris mauritania*	Purple, tall. Fan-like flower with heart shaped petals, very visible nervateur. Maple-like leaves. Rough stalk	3	3
urban	Nordnesparken	No records	0	0	0	0
urban	Tippetue	Marikåpe	*Alchemilla sp.*	Engmarikåpe? Rosefamilien	4	1