Impacts of Residential Infilling on Private Gardens in the Helsinki Metropolitan Area[1]

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Residential areas in Finland are largely comprised of low-rise housing areas with detached and semi-detached houses. At present, there are over 68,000 detached and semi-detached houses with associated gardens and yards in the Helsinki Metropolitan Area (Table 1). Private gardens can have multiple roles in urban areas as they are special and valuable environments for people and wildlife.[2] They are unique and heterogeneous environments, where the management choices of individual

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[2] C. Smith, D. Dawson, J. Archer, M. Davies, M. Frith, E. Hughes and P. Massini, 'From green to grey; observed changes in garden vegetation structure in London, 1998-2008', London Wildlife Trust, Greenspace Information for Greater London and Greater London Authority (London, 2011), <https://www.rbkc.gov.uk/pdf/Garden%20Research%20Full%20report.pdf > (accessed July 2015)**;** see also reviews: M.A. Goddard, A.J. Dougill and T.G. Benton, 'Scaling up from gardens: Biodiversity conservation in urban environments', *Trends in Ecology and Evolution*, 25 (2010), 90-98 and R.W.F Cameron, T. Blanuša, J.E. Taylor, A. Salisbury, A.J. Halstead, B. Henricot and K. Thompson, 'The domestic garden – Its contribution to urban green infrastructure', *Urban Forestry & Urban Greening*, 11 (2012), 129-137.

gardeners are important, particularly when considering the possibilities of these habitats to maintain and enhance urban biodiversity and to provide ecosystem services for urban inhabitants.[3]

Table 1. The number of residential buildings in the Helsinki Metropolitan Area, which includes the cities of Helsinki, Espoo, Vantaa and Kauniainen (31.12.2013).

	Detached and semi-detached houses	Row and terraced houses	Blocks of flats
Helsinki	20072	4244	10262
Espoo	26371	3735	2735
Vantaa	21120	2869	2326
Kauniainen	1076	146	99
Helsinki Metropolitan Area	68639	10994	15422

Source: Statistics Finland, Helsingin seudun aluesarjat, 'Rakennukset käyttötarkoituksen ja rakentamisvuoden mukaan 31.12.2013', <http://www.aluesarjat.fi/> (Accessed July 2015).

Prior to this study, there was no information available on the extent and distribution of domestic gardens in residential areas of the Helsinki Metropolitan Area. As the cities in the area have not been monitoring the state of private green areas, such as domestic gardens, there are no detailed registers or statistics of these green areas. In addition, there is a considerable lack of ecological research done on private garden environments in Finland.

However, increasing attention is being paid to the urban garden environments in many European cities and research done in the United Kingdom in particular highlights the potential of such habitats in supporting urban and wider region wildlife.[4] Although subject to high levels of management activities, gardens may provide beneficial resources for urban fauna: a diversity of vegetation covers and structures as well as additional water elements, such as ponds, that could function as habitats for aquatic and other water-dependent species.[5] The abundance of trees and shrubs in gardens can be essential for insect and bird species diversity.[6] Gardens provide breeding

[3] Goddard et al., 'Scaling up from gardens'; J. Tratalos, A.F. Richard, P.H. Warren, R.G. Davies and K.J. Gaston, 'Urban form, biodiversity potential and ecosystem services', *Landscape and Urban Planning*, 83 (2007), 308-317.

[4] Goddard et al., 'Scaling up from gardens'; Smith et al., 'From green to grey'; D.E. Chamberlain, M.P. Toms, R. Cleary-McHarg and A.N. Banks, 'House sparrow (*Passer domesticus*) habitat use in urbanized landscapes', *Journal of Ornithology*, 148 (2007), 453–462; J.-A. Carrier and T.J.C. Beebee, 'Recent, substantial, and unexplained declines of the common toad Bufo bufo in lowland England', *Biological Conservation*, 111 (2003), 395–399; R.L. Bland, J. Tully and J.J.D. Greenwood, 'Birds breeding in British gardens: an underestimated population?', *Bird Study*, 51:2 (2004), 97-106.

[5] A. Loram, P. Warren, K. Thompson and K.J. Gaston, 'Urban domestic gardens: The effects of human interventions on garden composition', *Environmental Management*, 48 (2011), 808–824; A. Loram, K. Thompson, P.H. Warren and K.J. Gaston, 'Urban domestic gardens (XII): The richness and composition of the flora in five UK cities', *Journal of Vegetation Science*, 19 (2008), 321-330.

[6] Y. Paker, Y. Yom-Tov, T. Alon-Mozes and A. Barnea, 'The effect of plant species richness and urban garden structure on bird species richness, diversity and community structure', *Landscape and Urban Planning*, 122 (2014),

environments for birds and habitats for several other species, including frogs, hedgehogs, rabbits, foxes, bats and grey squirrels.[7] Furthermore, urban domestic gardens are important nesting and feeding habitats for bumblebees,[8] which are thereby favoured as useful pollinators. Gardens thus have a significant role in maintaining biodiversity in urban environments.[9] Urban gardeners may also use active management methods such as wildlife gardening to enhance local biodiversity.[10] Urban gardens, including allotment gardens and private domestic gardens, can also provide a variety of ecosystem services for the benefit of urban inhabitants,[11] as summarised in Table 2.

Table 2. Potential ecosystem services provided by domestic gardens.

Provisioning services	Cultural services	Regulating services	Supporting services
Food	Aesthetic values	Regulation of microclimate	Habitat for fauna and flora
Ornamental resources	Inspiration	Erosion regulation	Pollination
Fire wood	Nature education	Noise reduction	Seed dispersal
	Recreation	Pest regulation	Water cycling
	Social relations	Air pollution mitigation	Soil formation

Source: Modified from J. Colding, J. Lundberg and C. Folke, 'Incorporating green-area user groups in urban ecosystem management', *Ambio* 35 (2006), 237-244.

Although there have been very few ecological surveys done in Finland on private gardens,[12] in one rare study the garden floras of 41 private gardens in the city of Helsinki were inventoried.[13] The main finding of this study was similar to that of studies done in Britain: while many of the garden

186-195; R.M. Smith, P.H. Warren, K. Thompson and K.J. Gaston, 'Urban domestic gardens (VI): Environmental correlates of invertebrate species richness', *Biodiversity and Conservation*, 15 (2006), 2415-2438; R.M. Smith, K.J. Gaston, P.H. Warren and K. Thompson, 'Urban domestic gardens (VIII): Environmental correlates of invertebrate abundance', *Biodiversity and Conservation*, 15 (2006), 2515-2545.

[7] Carrier and Beebee, 'Recent, substantial, and unexplained declines'; P.J. Baker and S. Harris, 'Urban mammals: what does the future hold? An analysis of the factors affecting patterns of use of residential gardens in Great Britain, *Mammal Review*, 37:4 (2007), 297-315.

[8] J.L. Osborne, A.P. Martin, C.R. Shortall, A.D. Todd, D. Goulson, M.E. Knight, R.J. Hale and R.A. Sanderson, 'Quantifying and comparing bumblebee nest densities in gardens and countryside habitats', *Journal of Applied Ecology*, 45 (2008), 784-792.

[9] e.g., Goddard et al., 'Scaling up from gardens'; G. Galluzzi, P. Eyzaguirre and V. Negri, 'Home gardens: neglected hotspots of agro-biodiversity and cultural diversity', *Biodiversity and Conservation*, 19 (2010), 3635-3654.

[10] Loram et al., 'Urban domestic gardens'; Z.G. Davies, R.A. Fuller, A. Loram, K.N. Irvine, V. Sims and K.J. Gaston,'A national scale inventory of resource provision for biodiversity within domestic gardens', *Biological Conservation*, 142 (2009), 761-771.

[11] J.H. Breuste and M. Artmann, 'Allotment gardens contribute to urban ecosystem services: Case study Salzburg, Austria', *Journal of Urban Planning and Development*, A5014005 (2014); J. Colding, J. Lundberg and C. Folke, 'Incorporating green-area user groups in urban ecosystem management', *Ambio* 35 (2006), 237-244.

[12] But see e.g., N. Nieminen, 'Lilacs, phloxes and irises –The ornamental garden flora in Puu-Käpylä", *M.Sc. thesis, Faculty of Agriculture and Forestry, University of Helsinki* (Helsinki, 2010) (in Finnish with short summary in English), a historical perspective to ornamental flora.

[13] P. Piirainen, 'Kasvikartoituksen satoa', in L. Eerikäinen et al. (eds), *Vihreä kylä – monta tarinaa. Kanta-Helsingin omakotiyhdistyksen historiikki 1987-2007* (Helsinki, 2007), pp. 254-262.

plants may be introduced species, the gardens show high levels of floristic diversity.[14] Furthermore, private gardens in Helsinki and Vantaa provide habitats for strictly protected species such as flying squirrels and certain types of bat.[15]

Although private gardens may be rich in species,[16] they cannot replace natural habitats. However, they can complement such habitats and provide resources (for example, foraging, overwintering and nesting sites) that benefit urban fauna.[17] In particular, species with good dispersal abilities or high mobility, such as birds and flying insects, are most likely users of garden environments. On the other hand, private gardens can also have unwanted impacts on biodiversity, as they may act as sources of harmful invasive species.[18]

In this chapter[19] we focus on the environmental impacts of infilling on private gardens in low-density residential areas of the Helsinki Metropolitan Area. Sustainable development goals of cities in Finland and elsewhere necessitate the densification of city structures, usually through infilling, which may threaten the existence of urban green spaces, such as gardens. To carry out this study we investigated in depth two areas: one from the city of Vantaa, within the centrally located city district of Ylästö, the second from the city of Helsinki, taking the suburban district of Paloheinä. A number of specific research questions were addressed: firstly, what kinds of changes have taken place in gardens and yards as a consequence of infill processes in the case study areas? Secondly, how did the infilling development differ between the two study areas and why? Thirdly, what kind of ecological impacts did the infill process have on private gardens? However before answering these questions we need to look at the wider urban context.

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[14] Loram et al. 'Urban domestic gardens (XII)'**;** K. Thompson, K.C. Austin, R.M. Smith, P.H. Warren, P.G. Angold and K.J. Gaston, 'Urban domestic gardens (I): Putting small-scale plant diversity in context', *Journal of Vegetation Science*, 14 (2003), 71-78.

[15] E. Lammi and P. Routasuo, 'Helsingin luoteisosan liito-oravakartoitus 2014' ('Flying squirrel survey in Northwestern Helsinki 2014'), *Helsingin kaupungin ympäristökeskuksen julkaisuja 13/2014* (Helsinki, 2014) [in Finnish with a summary in English]; Y. Siivonen, 'Vantaan kaupungin lepakkokartoitus 2001-2002', <http://www.vantaa.fi/instancedata/prime_product_julkaisu/vantaa/embeds/vantaawwwstructure/64969_Vantaan_kaupungin_lepakkokartoitus_2001.pdf> (Vantaa, 2002).

[16] See e.g. Thompson et al., 'Urban domestic gardens (I)'.

[17] Cameron et al., 'The domestic garden'; I.H. Henning and J. Ghazoul, 'Pollinating animals in the urban environment', *Urban Ecosystems*, 15 (2012), 149–166; Goddard et al., 'Scaling up from gardens'.

[18] A. Marco, T. Dutoit, M. Deschamps-Cottin, J.-M. Mauffrey, M. Vennetier and V. Bertaudière-Montes, 'Gardens in urbanizing rural areas reveal an unexpected floral diversity related to housing density', *C.R. Biologies*, 331 (2008), 452-465; M. Seppälä, 'Espoon haitallisten vieraskasvilajien kartoitus 2011', *Espoon Ympäristökeskuksen monistesarja 3/2011*, (Espoo, 2011); Ministry of Agriculture and Forestry, 'Alien species in Finland', <http://www.mmm.fi/en/index/frontpage/natural_resources/invasive_alien_species.html> (accessed July 2015)
: e.g. hogweeds, japanese rose and spanish slug have been declared *particularly harmful invasive alien species* in Finland.

[19] Research for this chapter was carried out as part of a two year project directed by Prof. Peter Clark "Green Space Issues and the Metropolitan City 1990-2012" funded by the Helsinki Metropolitan Region Urban Research Programme.

Urban growth challenges in the Helsinki Metropolitan Area

Helsinki Metropolitan Area (HMA) is a growing region with slightly over one million inhabitants, accounting for one fifth of Finland's population. Besides Helsinki, the HMA includes the cities of Vantaa, Espoo, and Kauniainen. In addition, the HMA forms the heart of the larger Helsinki Region, which consists of 14 municipalities with over 1.4 million inhabitants.[20] According to Helsinki Region's Programme for land use, housing and transport, 12,000 – 13,000 new dwellings will be constructed in the Helsinki Region annually.[21] A growing population in the Helsinki Region is generating great pressures on city planning and housing production. One of the principal challenges in the HMA, besides responding to the housing demand, is the consolidation or compacting of the city structure.[22] While Helsinki has a dispersed urban structure when measured in terms of residential density,[23] it also has lots of green areas, such as urban forests and parks situated in and around residential areas.

National policy for consolidating the urban structure includes infilling practices, where complementary housing is planned within or close to existing housing areas.[24] Over the past decades, and in particular since the 1990s the planning guidelines of cities of Helsinki and Vantaa have promoted urban densification.[25] According to this planning policy a more compact city structure is beneficial by offering opportunities to optimize the use of previously developed land and infrastructure, promote public transportation, revitalize older residential areas,[26] and at the same time to provide more homes for new inhabitants. In low-density housing areas, the objectives of infill development also include the protection of local services, thereby maintaining or improving

[20] HelsinginSeutu, 'Helsingin seutu tiivistetysti' ('Helsinki Region in brief'), <http://www.helsinginseutu.fi/hki/HS/Helsingin+Seutu/Kaupunkitieto+ja+tilastot> (Accessed July 2015).

[21] MAL Neuvottelukunta, 'Helsingin seudun maankäytön, asumisen ja liikenteen toteutusohjelma 2017' ('Helsinki Region's implementation plan for land use, housing and transportation') (Helsinki, 2008), pp. 9-10, <http://www.hel2.fi/Helsinginseutu/Pks/raportit/MAL_2017_180108.pdf > (Accessed July 2015).

[22] MAL Neuvottelukunta, 'Helsingin seudun maankäytön', p. 9.

[23] M. Kasanko, J.I. Barredo, C. Lavalle, N. McCormick, L. Demicheli, V. Sagris and A. Brezger, 'Are European cities becoming dispersed? A comparative analysis of 15 European urban areas', *Landscape and Urban Planning*, 77 (2006), 111–130.

[24] Ministry of the Environment, 'Valtakunnalliset alueidenkäyttötavoitteet'. <http://www.ymparisto.fi/fi-FI/Elinymparisto_ja_kaavoitus/Maankayton_suunnittelujarjestelma/Valtakunnalliset_alueidenkayttotavoitteet> (Accessed July 2015).

[25] e.g., City of Vantaa, 'Vantaan Yleiskaava, Selostus 14.9.1992', *Vantaan kaupunki, Yleiskaavoitus. Julkaisu A19:92*, p.16; City of Helsinki, 'Helsingin yleiskaava 1992: Selostus', *Kaupunginkanslian julkaisusarja A 31/1992*, p.23.

[26] e.g. K. Rauhala, 'Näkemyksiä ja kokemuksia eheyttävästä rakentamisesta', *LYYLI –Reporttisarja 4, Liikenneministeriö* (Helsinki, 1999), pp. 51-55; City of Vantaa,'Vantaan Yleiskaava, Selostus 14.9.1992', p.17; T. Henriksson and J. Jääskeläinen, 'Yhdyskuntarakenteen eheyttäminen Vantaalla', *Vantaan kaupunki, Kaupunkisuunnittelu, Yleiskaavoitus C13:2006 Kaupsu 7/2006. YK0005*, pp. 11-17; City of Helsinki, 'Laadukkaan asumisen Helsinki - Maankäytön ja asumisen ohjelma 2008-2017', *Helsingin kaupungin talous- ja suunnittelukeskuksen julkaisuja 2/2008*, p. 15.

the quality of these areas for the residents. Although the aims of the consolidation policy are positive in many ways, there is a danger that existing green spaces, including private gardens, may suffer. Thus it is typical in the HMA to consolidate existing residential areas by sub-dividing existing large, single-house lots to enable the construction of additional homes, thereby increasing plot density ratios (that is, the proportion of building to space, including green space).

Infilling practices in low-density housing areas in Helsinki and Vantaa

At the beginning of 2015 Helsinki housed 620,000 and Vantaa 210,000 residents.[27] The current master plan of Vantaa has made provision for a population of 240,000 inhabitants by 2030.[28] According to the latest population forecast (the fastest growth option) the population of Helsinki will reach 860,000 in 2050, meaning an increase of 265,000 people. This would require the construction of over 190,000 new housing units over the next 40 years.[29] According to these scenarios, Helsinki will need to construct approximately 5,000 new dwellings annually and Vantaa 2,000 per year. To achieve these housing targets, the cities will need to implement both the construction of new housing areas and the considerable densification of existing housing districts.[30]

Living in a suburban type of residential environment with detached, semi-detached and row houses is highly valued in Finland. Both Helsinki and Vantaa cities aim to provide residents with these favourite forms of housing. Especially in Helsinki, the existing housing stock consists mainly of small apartments and there is a considerable lack of spacious family-dwellings.[31] In order to increase the number of detached, semi-detached and row houses the cities have, as well as developing new housing areas, also promoted the infilling of existing low density housing areas. Infilling can take place for instance through expanding the residential area by zoning new housing plots, or allowing existing owners to subdivide large plots with unused *permitted building volume*

[27] City of Helsinki Urban Facts, 'Helsingin väkiluku' ('Inhabitants of Helsinki'), <http://www.hel.fi/www/uutiset/fi/tietokeskus/helsingin-vakiluku-vuodenvaihteessa-2014-2015> (Accessed July 2015)

[28] City of Vantaa, 'Vantaan yleiskaava – Yleiskaavan selostus, joka koskee 17.12.2007 päivättyä yleiskaavakarttaa', *Vantaan kaupunki, Kaupunkisuunnittelu A7:2007* (Vantaa, 2007), p. 21.

[29] Helsinki City Planning Department, 'Helsinki city plan. How the city plan is drawn up and how you can participate?', *Strategic Urban Planning Division Reports 1:2012*,< http://www.hel2.fi/ksv/julkaisut/yos_2012-1_en.pdf> (Accessed July 2015).

[30] M. Siivola, 'Täydennysrakentamistyöryhmän loppuraportti 9.2.2011', *Helsingin kaupunki, Talous- ja suunnittelukeskus, Kehittämisosaston raportteja 2011* (Helsinki, 2011), pp. 3,5.

[31] City of Helsinki Urban Facts, *Statistical Yearbook of Helsinki 2011* (Helsinki, 2011), p. 28. <http://www.hel2.fi/tietokeskus/julkaisut/pdf/12_04_05_Statistical_Yearbook_Askelo.pdf > (Accessed July 2015)

(see footnote)**,**[32] or allowing more permitted building volume to the individual plot's owner, or to the whole residential area. [33]

In practice, the infill process is guided by *the local master plan and the local detailed plans* (see footnote)[34] of the city. In Helsinki during the 1970s certain areas of detached houses saw already more compact, denser development due to planning policy. The detailed plans allowed the construction of row houses and terraced houses in these areas. The same decade Vantaa likewise set a goal for achieving higher housing density rates in existing detached housing areas. One justification for the infill development at this time was the need to increase the number of households in these areas to ensure sufficient demand for new municipal infrastructure such as water and sewage networks. A well-functioning infrastructure was an important precondition for the growth of these areas.[35] In the 1990s, the master plan of Helsinki identified the residential areas that could be compacted more and those where the original architectural and aesthetic values should be preserved. [36] The current master plans of Helsinki and Vantaa likewise recognize that certain housing areas have their special historical, cultural and landscape values and direct intensive infill developments elsewhere.[37]

In general, the infill development of low-density housing areas is a gradual process, occurring mainly by plot subdivisions. The detailed plan and its regulations provide the basis for any plot subdivision. The detailed plan records among other things the permitted building volume and possibly the building area of the plot. The subdivision possibilities depend on the amount of unused permitted building volume, the location of the existing dwelling, and the general landscape features of the site (for instance the type of the soil).[38] As the proposal for plot division usually comes from the plot owner, the extent and the timing of this development may be uncertain from the city's point

[32] *Permitted building volume (building right)* tells how much you can build to the plot (permitted building volume = plot density rate x plot area).

[33] H. Kukkonen, O. Lehtovuori, V. Lehmuspuisto and M. Nuutinen, 'Omatonttinen pientalo kasvukeskuksissa – Tilannekatsaus'. *Teknillinen korkeakoulu, Yhdyskunta- ja kaupunkisuunnittelun laitos, Arkkitehtiosaston julkaisuja 2000/62* (Helsinki, 2000), pp.18,58; E. Tuominen, R. Manninen, A. Tani and O. Veltheim, 'Lähtökohtia pientaloasumisen kehittämiseen Helsingissä', *Helsingin kaupunkisuunnitteluviraston yleissuunnitteluosaston selvityksiä* (Helsinki, 2008), p. 18; City of Vantaa, *Elämänmakuista asumista Vantaalla: Vantaan asunto-ohjelma 2009-2017* (Vantaa, 2009), p. 19.

[34] Finnish cities have *master plans* (they cover usually the whole city area) / *local master plans* (they cover parts of the city) and *detailed plans*. The (local) master plan guides the drawing up of detailed plans, which are used for regulating the more detailed functions and locations of townscape (for instance, the size and type of buildings).

[35] S. Hirvonen, 'Ruraali urbaani – Vantaan kaupunkisuunnittelun historia', *Vantaan kaupunkisuunnittelu C18:2005* (Vantaa, 2005), p.89.

[36] City of Helsinki, 'Helsingin yleiskaava 1992: Selostus', map 2.

[37] City of Helsinki, 'Helsingin Yleiskaava 2002 – Ehdotus, Selostus', *Helsingin kaupunkisuunnitteluviraston julkaisuja 2002:17* (Helsinki, 2003), p.179; City of Vantaa, 'Vantaan yleiskaava – Yleiskaavan selostus, joka koskee 17.12.2007 päivättyä yleiskaavakarttaa', *Kaupunkisuunnittelu A7:2007* (Vantaa, 2007), p.57.

[38] Orvo Valtonen, City Survey Department of Vantaa, personal communication, 25 October, 2012.

of view. Recently, it has been estimated that up to 20,000 new detached houses could be built on the private lands with unused permitted building volume in the Helsinki Metropolitan Area.[39] The municipalities can encourage the development of empty residential plots, for instance, by raising the real estate tax on these sites. The current allowable tax range is 1.0-3.0 per cent: in Helsinki the rate is 2.3 per cent and in Vantaa 3.0 per cent. [40]

Comparison of the infilling development of the two research areas through garden and yard area mapping

As already noted, two residential districts were selected as case study areas in order to measure private garden and yard sizes and the changes in them resulting from infilling. Furthermore, the environmental impacts of infilling processes were estimated. The first area from Vantaa, the district of Ylästö (Fig. 1), was chosen because its detached house areas with their gardens have the potential to function as an important green corridor area connecting extensive green areas in the city including a nature conservation area. In addition, important sources were available from the City Survey Department of Vantaa including aerial photographs (ortophotos) and cadastral boundary maps for this area in digital form from 1998. The second case study area, the Helsinki district of Paloheinä (Fig. 1), was built after the Second World War and was originally designed with large plots with possibilities for horticulture and gardening. Here, infill development has been very intensive and many garden areas have been built upon.

Ylästö is located in the southern part of the city of Vantaa and follows the border of the city of Helsinki (Fig. 1). The housing stock of the district consists mainly of detached and semi-detached houses. Because the official district area of Ylästö is large (8.7 sq. km), a smaller sub-district within it – hereafter called Ylästö4A – was chosen for more detailed analysis (Fig. 1). This area is covered mainly by the local detailed plan called Ylästö4A, which has total acreage of 147 ha. Within Ylästö4A, the zoned residential area covers approximately 46 ha. This is only about 32 per cent of the total zoning area, because extensive green areas (including forests and fields) are also included

[39] J. Saarinen, 'Yksityiset panttaavat tontteja', *Helsingin Sanomat*, 26 February 2011

[40] K. Silfverberg, 'Isoille pihoille tuhansien lasku', *Helsingin Sanomat*, 28 November 2012; Verohallinto, 'Kiinteistöveroprosentit kunnittain vuonna 2015'. Available at: https://www.vero.fi/fi-FI/Henkiloasiakkaat/Kiinteistovero/Kiinteistoveroprosentit%289216%29 (Accessed July 2015), in Finnish *rakentamattoman tontin kiinteistövero* (cf. general real estate tax, *yleinen kiinteistövero*, in Helsinki 0,8 % and in Vantaa 1,0 %).

in this detailed plan. By comparison, the residential area of Paloheinä is located in northern Helsinki (Fig. 1) and covers a surface area of 170 ha. There were 5,905 inhabitants at the start of 2015.[41]

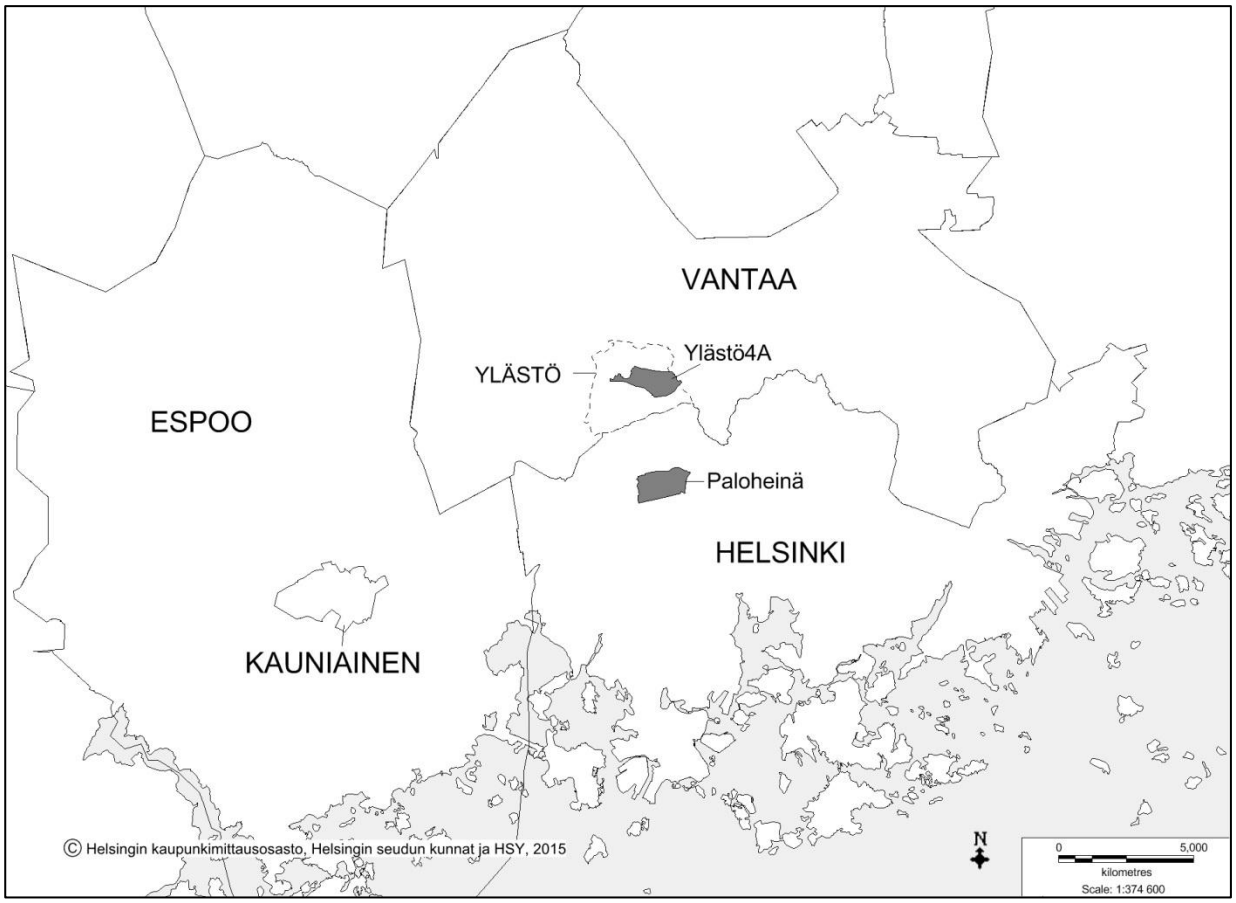

Figure 1. The location of the case study areas Ylästö4A and Paloheinä in the Helsinki Metropolitan Area. Ylästö district is situated in the southern part of the city of Vantaa. A smaller sub-district, the case study area Ylästö4A, is situated within this area (Base map data from http://kartta.hel.fi/avoindata/, Creative Commons Attribution 4.0 International Public License, http://creativecommons.org/licenses/by/4.0/legalcode.fi).

Since there was no existing detailed register containing data on garden and yard sizes in the residential areas of the HMA, we used aerial photographs (Figs. 2 and 3). The garden and yard areas of Ylästö4A were mapped from aerial photographs taken in 1998 and 2009 and for Paloheinä from an aerial photograph taken in 2009 (no other aerial photographs were available) by manual digitizing using MapInfo Professional 10.0. In the mapping, the base of the analysis was an aerial

[41] Helsingin seudun aluesarjat, 'Helsingin väestö sukupuolen, iän ja äidinkielen (ruotsinkieliset) mukaan 1.1.2015', <http://www.aluesarjat.fi/> (Accessed July 2015).

photograph and a cadastral boundary map showing plot boundaries. The plot boundary maps and the aerial photographs of Ylästö4A were provided by the City Survey Department of Vantaa and for Paloheinä by SeutuCD'10 database.[42] The coverage of garden and yard areas was measured from the residential plots with detached, semi-detached, row and terraced houses. Garden and yard land (hereafter called garden land) refers to the vegetated land within the boundary of an existing property.

There was a limit to the details visible in aerial photographs, and in particular the resolution of the aerial image of Ylästö from the year 1998 was not very good, which caused some problems defining the boundaries of garden land. For example, sometimes small built structures and paved surfaces could not be identified and were misrecorded as garden land. In certain areas shadows were problematic as they obscured the gardens.

Mapping results: Ylästö and Paloheinä

First Ylästö. The garden land development in the Ylästö4A (Fig. 2) area was affected in two ways between 1998 and 2009. On one hand, new gardens were created as a result of housing development, and, on the other hand, garden and yard areas were lost through infill development on existing garden lands. In 1998, Ylästö4A had 115 residential plots and the total amount of garden land within these plots was 18.0 hectares. As a result of housing development and plot divisions, by 2009 there were in total 274 plots with 21.5 hectares of garden land within them (see Table 3). In 1998 total garden and yard areas represented approximately 72 per cent of the total area used for the housing, and in 2009 50 per cent (Table 3). New gardens were created in this area from former field or forest areas, although they were in general smaller in size than the older gardens existing in 1998 (Table 3). In addition, new infrastructure, such as roads, needed for housing development reduced the size of garden and yard areas in some locations.

[42] SeutuCD'10 provided by Helsinki Region Environmental Services Authority (HSY)

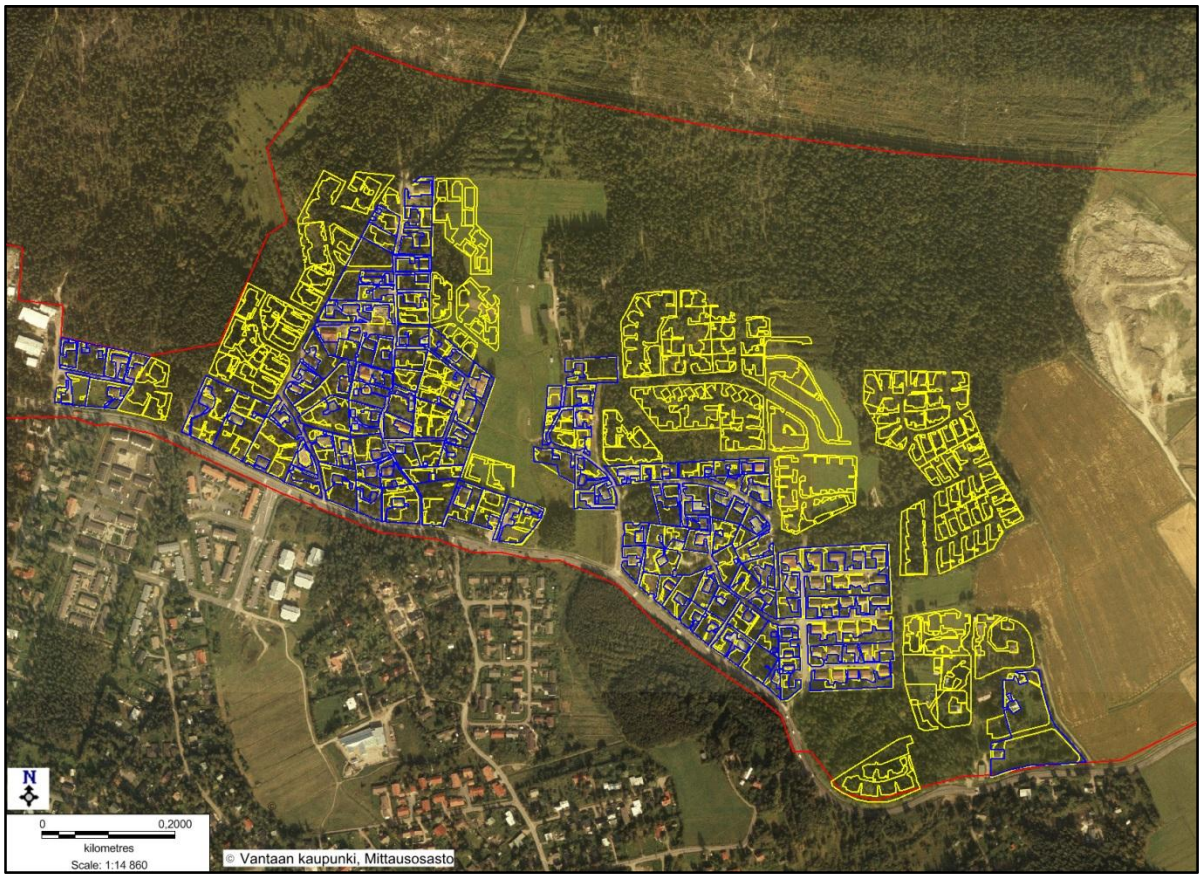

Figure 2. Garden and yard areas of YlästöA4 case area (red boundary line) measured from 389 plots in total: 115 plots in 1998 (in blue) and 274 plots in 2009 (in yellow). The aerial photograph shown here is from 1998 (Source: City Survey Department, City of Vantaa).

Table 3. Results from the garden and yard area mapping in Ylästö4A and Paloheinä areas.

CASE STUDY AREA	1998	2009
YLÄSTÖ4A		
Total land area (ha)	147	147
Area zoned for housing (ha)	44.0	46.3
Area used for housing (estimate, ha)	25.0	43.0
Garden and yard area (ha)	18.0	21.5
Gardens and yards from the total land area (%)	12	15
Gardens and yards from the area used for housing (%)	72	50
Number of plots	115	274
Average area of garden and yard per plot (sq. m)	1565	785
Range of the garden and yard areas in plots (sq. m)	290-10810	34-5383
PALOHEINÄ		
Total land area (ha)		170.4
Garden and yard area (ha)		45.9
Gardens and yards from the total land area (%)		27
Park area (ha)		33.4
Parks from the total land area (%)		20
Number of plots		831
Average area of garden and yard per plot (sq. m)		552
Range of the garden and yard areas in the plots (sq. m)		61-2599

The number of plots increased also through subdivisions (Fig. 2). After 1998 there were 37 plot divisions in Ylästö4A area. Single plots were divided into two to five smaller parts, resulting in 56 new plots by the year 2009 (Table 4). In total, approximately 3.4 hectares of old garden land was lost as a result of these plot divisions. Overall, there was a 39 per cent reduction from the situation in 1998, equivalent to seven football fields. When the existing plots were divided, the remaining gardens and newly created garden land areas were naturally smaller in size and the habitats within them more fragmented.

Table 4. Plot subdivisions in Ylästö4A area between 1998-2009.

	1998	2009	Change
Number of plots	37	93	+ 56
Total garden and yard area (ha)	8.64	5.28	- 3.36
Size range of the garden and yard areas in the plots (sq. m)	760 – 10810	34 – 5383	

Turning now to Paloheinä, the cover of garden land in the case study area was measured from 831 plots (Fig. 3). The total area of garden land was 45.9 hectares, which is approximately 27 per cent of the total area of Paloheinä. Gardens and yards comprise an important part of the green space of Paloheinä, as they cover a larger area than the parks (Table 3). The garden land in the plots ranged from 61 – 2 599 sq. m in area. The mean garden area was 552 sq. m.

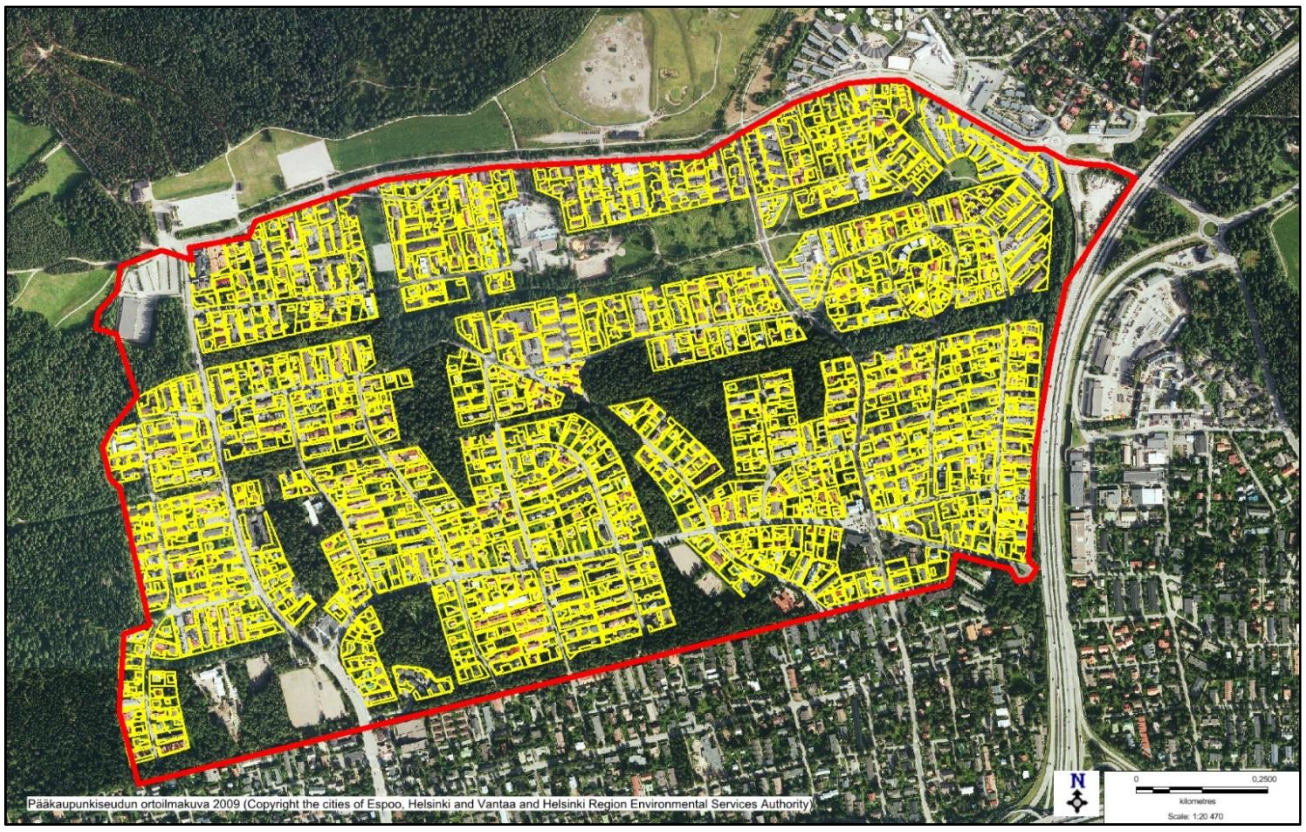

Figure 3. Garden and yard area of Paloheinä (red boundary line) was measured from 831 plots (in yellow).[43]

Comparing the infill development of Ylästö and Paloheinä

From the 1970s both Ylästö and Paloheinä were seen as suitable sites for infill development by their growing host cities. However, the compaction processes in the two areas have been quite different. The main reasons for this include differences in the areas' housing and planning histories, and particularly in the detailed planning regulations with regard to the housing types allowed.

[43] Base map from SeutuCD'10, ©The City Survey Division of Helsinki City.

Ylästö residential area has grown gradually from a small village to a modern housing area. It consists today mainly of detached and semi-detached dwellings in a variety of styles. Paloheinä represents an example of a special but in Finland common type of detached house area, a so-called *veteran's housing area*. Paloheinä was constructed relatively quickly after the Second World War for accommodating war veterans and Finnish immigrants who had lost their homes during the war. Usually, the same kind of building type was used in the whole area, creating a very harmonious and distinctive townscape.[44] In 1947, the land area of Paloheinä was purchased from the city of Helsinki by the state. A total of 541 plots were established in the Paloheinä area, and construction of houses started quickly. The plots were spacious, typically ranging between 1000-2000 sq. m. In addition, there were 40 larger sites with the acreage of 3000-9000 sq. m, and people living on them had to farm the land for commercial purposes.[45] The houses of Paloheinä were originally so-called *type-planned houses* (in Finnish *rintamamiestaloja*). In general, these wooden detached houses were relatively small, usually one and a half storeys high with a saddle roof.[46] In sum, the Paloheinä gardens were spacious and were planned for small-scale food production.[47]

In contrast, Ylästö, has a long housing history as it has been inhabited since the 15th century. The ancient historic road from Turku to Viipuri (*King's road*, or now locally called *Ylästöntie*) passes through the area. Traditionally, Ylästö has a rural character with old village-like areas and small farms still existing with many cultural and historic values. Housing development in the area has been gradual and mosaic-like as the residents have been selling their lands at different times.[48]

In both case study areas, the detailed planning process from the 1970s involved local residents. In Paloheinä, before the detailed plan was drawn up in 1972, residents' opinions about the most suitable housing types for the infill development were canvassed by city officials. In the final survey, the majority of residents (77 per cent) preferred detached houses, semi-detached houses and row houses rather than blocks of flats. This helped influence the detailed plan. Consequently, city

[44] e.g., S. Sädevirta, R. Salastie and M. Karisto, 'Korsutieltä Näätäkujalle. Helsingin jälleenrakennuskauden pientaloalueita, Osa 1', *Helsingin kaupunkisuunnitteluviraston asemakaavaosaston selvityksiä 2003:11* (Helsinki, 2003).

[45] O. Haimi, *Rintamamiehet rakentajina Helsingissä. Vuoden 1945 maanhankintalain toteutuminen Helsingin kaupungissa*, (Kerava, 2010), p.79.

[46] Sädevirta et al., 'Korsutieltä Näätäkujalle', p.11.

[47] e.g., M. Karisto, 'Elisabeth Kochin mallipihat omakotirakentajille' in Sädevirta et al., 'Korsutieltä Näätäkujalle', p. 18.

[48] *Vantaa alueittain 2010*, Vantaan kaupunki, Keskushallinnon tietopalveluyksikkö, B 10: 2011 (Vantaa, 2011), p.111.

planners opted for small-scale housing production for the infill development. In Ylästö, the planning process involved not only residents but a range of city officials and departments.[49]

In Paloheinä, the local detailed plan, covering the whole residential area, came into force in 1972. In this plan, the plot density rate (e_t), which signifies the permitted building volume relative to the surface area of the plot, was raised from 0.2 to 0.3. The detailed plan allowed the construction of row houses and terraced houses in the area. Of particular significance was the planning notation (1/400), which allowed a building to be constructed for every 400 sq. m plot area.[50] This was different from the general decision made in Vantaa in the 1970s to take 800 sq. m as the minimum plot size.[51] After the Paloheinä's detailed plan came into force, sales of the plots accelerated. Many of the original type-planned houses were replaced with row houses, resulting in the loss of the previous gardens.[52] Since 1972 there have been over 250 plot divisions: usually the plot was divided into two or sometimes into three separate parts.[53] In general, the plot division rate has been greater in Paloheinä (about 6.4 subdivisions per year) than in Ylästö (about 3.4 subdivisions per year).

The drawing up of the detailed plan for Ylästö (Ylästö 4A) started in 1992. It was based on the local master plan which came into force in 1976 and on the housing production plan approved by the Vantaa city council in 1989. In the local master plan of Ylästö the objective was to enable more efficient land use in the area, and to acquire a sufficient density of residents to justify various public services. The detailed plan of Ylästö4A stated several additional goals, including aims to preserve the original detached house identity of the area and to maintain the green corridors between nature areas. As a result, the area efficiency level remained slightly lower than official targets stated by the local master plan. The plot density rate (e_t) of the Ylästö4A area is generally only 0.15-0.25.[54] However, in order to achieve the population growth targets, there was a considerable need to expand the existing housing area.

In the Ylästö4A detailed plan every house should have a defined yard area. In addition, the housing block areas often have a planning notation concerning the planting of trees and shrubs. Houses

[49] City of Vantaa, 'Ylästö 4A nro 400600, Asemakaavan selostus', *Asemakaavaosaston julkaisuja A6/1998* (Vantaa, 1998).
[50] City of Helsinki, City Planning Department, 'Paloheinä, Osa 35', p.6.
[51] Kukkonen et al, 'Omatonttinen pientalo kasvukeskuksissa'.
[52] Haimi, *Rintamamiehet rakentajina Helsingissä*, p. 91.
[53] Counted from the Cadastral boundary map of Helsinki GIS Service 2011.
[54] City of Vantaa, 'Ylästö 4A nro 400600', pp. 6-7,9.

could be linked together with small warehouses, but the overall detached house identity of the area was to be maintained.[55]

From the preceding analysis, it seems that there were different objectives concerning the townscape in the two areas. In Paloheinä infilling was considered such a priority that a dramatic change of the original character of the area was allowed with extensive row house construction, whereas in Ylästö the identity of the area was preserved. In Paloheinä, the detailed plan did not include any regulations for the protection of the cultural and historic traditions of the area, and in consequence intensive infilling and densification took place (Fig. 4).

Figure 4. An example of infilling in Paloheinä: a new row house (on the left) was built next to the old type-planned house (on the right) (photo: Anna Ojala).

In Ylästö there was more non-built land available, so the majority of the development pressure could be directed away from the established housing area. Although the detailed plan was a

[55] City of Vantaa, 'Ylästö 4A nro 400600', p.7, Appendix 20c.

compromise between different goals, the planners recognized the importance of the preservation of green corridors between the nature areas and the creation of a sufficient buffer zone adjacent to the nature conservation area. Nonetheless, infill development caused a general loss of garden habitats, both when garden lands were built upon in the older parts of the housing area and because the gardens associated with new houses were smaller in size.

Ecological and environmental consequences of the infilling process

Although infilling is seen as beneficial for urban sustainability, intensive densification can have harmful environmental and ecological impacts, especially when city green areas, such as parks and gardens, and the associated ecosystem services they provide, are lost due to new development.[56] The decrease in the proportion of vegetated land and the simultaneous increase of paved surfaces, such as paths, patios and parking lots in residential areas[57] can cause more local flooding incidents.[58] The increase of paved (so-called "non-evapotranspiring") surfaces can also affect the local microclimate,[59] although more research is needed to quantify the extent to which gardens contribute to air cooling in urban areas.

Infill development results in decreased abundance and diversity of vegetation, which in turn leads to a loss of wildlife habitats. Larger gardens tend to have more variety in the types of microhabitats that they provide for wildlife (such as mature trees, shrubs and other vegetation) than smaller gardens. At the level of housing areas, it seems likely that residential blocks with large gardens will have greater habitat and vegetation diversity[60] - and hence also greater overall species diversity - than similarly large residential blocks with smaller gardens. The abundance and cover of trees has been shown to be an important habitat element for the insect and bird species richness in gardens.[61]

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[56] V. Yli-Pelkonen, 'Kaupunkirakenteen tiivistyminen ja ekosysteemipalvelut', in S. Aho, A. Alku and V. Yli-Pelkonen, 'Näkökulmia kaupunkirakenteen tiivistymiseen Helsingin seudulla', *Aalto-yliopiston julkaisusarja CROSSOVER 7/2011*, < http://lib.tkk.fi/CROSSOVER/2011/isbn9789526043623.pdf> (Accessed July 2015); S. Pauleit, R. Ennos and Y. Golding,'Modeling the environmental impacts of urban land-use and land cover change – a study in Merseyside, UK', *Landscape and Urban Planning,* 71 (2005), 295–310.

[57] Smith et al., 'From green to grey', pp. 15-17; T. Perry and R. Nawaz, 'An investigation into the extent and impacts of hard surfacing of domestic gardens in an area of Leeds, United Kingdom', *Landscape and Urban Planning,* 86 (2008), 1–13.

[58] See e.g., Perry and Nawaz, 'An investigation into the extent and impacts of hard surfacing of domestic gardens in an area of Leeds'; V. Whitford, A.R. Ennos and J.F. Handley, 2001:' "City form and natural process" – indicators for the ecological performance of urban areas and their application to Merseyside, UK', *Landscape and Urban Planning,* 57 (2001), 91–103.

[59] Pauleit et al., 'Modeling the environmental impacts of urban land-use and land cover change'.

[60] Smith et al., 'From green to grey', pp.15,21; Loram et al. 'Urban domestic gardens (XII)'; R.M. Smith, K.J. Gaston, P.H. Warren and K. Thompson, 'Urban domestic gardens (V): relationships between landcover composition, housing and landscape', *Landscape Ecology,* 20 (2005), 235–253.

[61] Smith et al., 'Urban domestic gardens (VI)'; G.D. Daniels and J.B. Kirkpatrick, 'Does variation in garden characteristics influence the conservation of birds in suburbia?', *Biological Conservation,* 133 (2006), 326-335.

For example, goat willow (*Salix caprea*) and bird cherry (*Prunus padus*) are promoted as very beneficial trees for early pollinators such as bumble bees and butterflies: they are also important in private garden environments.[62] In smaller gardens, the planting of fruit trees or shrubs, such as lilacs and roses,[63] is good option: they are also useful for many species, as they provide foraging sites and cover.[64] Urban gardens can have high levels of floristic diversity[65] and thus offer a continuous supply of nectar and pollen, which pollinators and other species can utilize during the growing season. [66]

Conclusions

This chapter has sought to present data on the extent of private domestic gardens in the Helsinki Metropolitan Area, Finland, and pilot methods for quantifying the effect of infill development on garden lands in residential areas. The mapping results showed that private gardens constitute an important part of the housing area in the two case study districts. The study also indicated that there is a need for baseline information on the extent and distribution of private gardens, which could be used for monitoring long-term changes in urban green areas. We also saw that planning and housing histories are very important when considering the infill development of housing areas.

As local authorities exercise only limited control over private gardens, management choices of individual owners of gardens play an important role, particularly with regard to the possibility of these environments supporting urban biodiversity and especially native species diversity.[67] To enhance the potential of garden land for urban biodiversity, it is essential to engage the garden owners themselves.[68] There is a need for more research on the biodiversity benefits of private gardens and the research should also cover the possible negative impacts of gardens, in particular, in providing habitat and dispersal opportunities for harmful invasive species. In addition, more information is needed on the role of the gardens as green corridors between nature areas. At the same time, the value of these private green areas in providing ecosystem services for residents should be acknowledged in city planning policies.

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[62] R. Cajander, *Luontopiha –Ympäristöystävällinen piha ja puutarha*, (Hämeenlinna, 2010), pp. 34,42.

[63] Other species than japanese rose *Rosa rugosa* (harmful invasive species).

[64] Cajander, *Luontopiha*, p.61; K. Mikkola, J. Murtosaari and K. Nissinen, *Perhosten lumo –suomalainen perhostieto*, (Helsinki, 2005), p.175.

[65] Loram et al., 'Urban domestic gardens (XII)';Thompson et al., 'Urban domestic gardens (I)'.

[66] Henning and Ghazoul, 'Pollinating animals in the urban environment'; M. Fussel and S.A. Corbet, 'Flower usage by bumble-bees: a basis for forage plant management', *Journal of Applied Ecology*, 29 (1992), 451–465.

[67] Y.M. van Heezik, K.J.M. Dickinson and C. Freeman, 'Closing the gap: communicating to change gardening practices in support of native biodiversity in urban private gardens', *Ecology and Society*,17:1 (2012), 34.

[68] Goddard et al., 'Scaling up from gardens'; Smith et al, 'From green to grey', p. 24.

An important goal for future research is to increase awareness of the environmental and ecological values of urban private gardens – both as individual habitat patches and as a part of the wider green area network.[69] There is also a role for urban planning in promoting the maintenance of diverse private gardens. In Finnish city plans nature values are mainly denoted as 'to be preserved', but changing this to 'to be enhanced' would encourage both city practitioners and local residents to promote urban biodiversity. Furthermore, it would be beneficial to encourage residents to share their local ecological knowledge for environmental and planning purposes. Clearly closer collaboration between urban planners, ecologists, resident associations and individual gardeners is desirable and necessary.

[69] J. Colding, '"Ecological land-use complementation" for building resilience in urban ecosystems', *Landscape and Urban Planning* 81 (2007), 46-55 ; Goddard et al., 'Scaling up from gardens'; Smith et al. ,'From green to grey', p. 24.