Ecosystem Services Provision by Allotment Gardens in Manchester and Poznan

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Contents

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1 Abstract

Ecosystem services are defined as services provided by the natural environment that benefit people, such as food and fuel provision and recreation but also climate regulation, flood protection and air and water purification (Defra 2007). The importance of ecosystem services was demonstrated in the Millenium Ecosystem Assessment which was a scientific appraisal of the condition and trends in the ecosystems of the world, including an appraisal of conservation actions. Many ecosystem services are considered to be degrading, such as pollination for agriculture, so it is important to assess the ecosystem services provided by current land use types and then move strategically to conserve and improve them. Urban areas, in particular, present unique challenges for the conservation of ecosystems. Allotment gardens are an important greenspace feature of the urban landscape in Europe which offer several possibilities for conservation of ecosystems.

This study quantitatively assesses the ecosystem services provided by allotment gardens in Manchester, UK, and Poznan, Poland. There are large differences in the amount of land allocated to allotments, with Poznan having 8 times as high a proportional land surface cover as Manchester. There are also striking differences in the land use characteristics in the two cities with a preference for vegetable growing in Manchester, and for ornamental gardens in Poznan. The consequences of these basic differences are discussed in terms of the ecosystem services that are provided by the two different land use types, and they are also compared to public parks. In addition, a study of the spontaneous vascular flora present in the paths and verges of allotments provides insights into their ecological quality.

2 Introduction

Allotment gardens are an important feature of European cities, providing urban residents with the opportunity to grow their own food and socialise in a pleasant environment. Their form, function and historical aspects vary considerably from nation to nation. In Poland, allotments were named 'worker's gardens' in communist times and plot sizes are large, with swiss-style chalets on the majority. In the UK, allotment tenancy reached its peak during wartime in the 1940s thanks to the 'Dig for Victory' campaign, and plot sizes are relatively small with a shed and greenhouse being common. This study will look at some of these differences between Polish and British allotments in more detail (Figure 2.1).

Figure2.1 – Allotment plot in 'Budowliani' Poznan (left) and 'Green Lane' Manchester (right) clearly showing the differences in vegetation types and structure.

More specifically the study will investigate ecosystem service provision by allotment gardens. Ecosystem services are the benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational, and cultural benefits; and supporting services, such as nutrient cycling, that maintain the conditions for life on Earth (MA 2005). Ecosystem services are increasingly being recognised for their importance in government policy and practice. Added importance is gained from the fact that urban areas have their own inherent, localised problems such as pollution and urban heat islands, so urban green space is often touted as a panacea that can be placed where it is needed most.

The aim of the study is to quantify ecosystem service provision by allotment gardens in Poznan and Manchester and compare, both between countries, and to another urban land use type - parks. In addition, the study benefits from an investigation into the spontaneous floral diversity of allotment gardens.

3 Study areas

Manchester is a large city situated in north-west England. The Manchester city district, which includes the centre of the Greater Manchester conurbation, has a population of over 514,000 (UK statistics, 2014). The Greater Manchester conurbation contains a further 9 districts giving a total population for the area of 2.7 million. The city population of Poznan is around 550,000, with 1.3 million people in the metropolitan area. Poznan is located in the west of Poland (Figure 3.1).

Figure 3.1 – Locations of Manchester and Poznan within Europe

	Manchester	Poznan
Number of allotments	40	83
District area (ha)	11 564	26 153
Allotments area (ha)	49.1	848.5
Allotment area proportion	0.4%	3.2%
Mean allotment area (ha)	1.2	10.2

Table 3.1 – Main characteristics of the two study sites

Table 3.1 shows that the two cities differ considerably, with 17 times as much land area given over to allotments and an eightfold increase in the proportion of land cover which is allotments in Poznan. The allotment complexes themselves are also roughly 8 times larger in Poznan.

4 Methodology

The researcher visited Poznan between 3rd June and 1st July 2014. Site visits were undertaken on 12 allotment complexes with the assistance of Professor Janina Borysiak, an expert in geobotany from Adam Mickiewicz University. Two parks were also visited in Poznan. Site visits to 9 Manchester allotment complexes and 8 parks were undertaken in the weeks either side of this trip. See Figures 4.1 and 4.2 for locations of the allotments and parks. Two of the Manchester allotments belong to different districts (Trafford and Stockport) within Greater Manchester but the land use is expected to be the same as those within the Manchester district.

4.1 Desk study

Georeferenced aerial photographs were used within ArcGIS software to calculate allotment and average plot areas. The satellite images are dated 2009 for Manchester and 2011 for Poznan and were both taken in summer. Polygons were drawn to approximate the proportion of land surface area which is under tree canopy. This was a fairly straightforward visual task, as the summer images allow for easy identification of both evergreen and deciduous tree canopies. Polygons were also drawn for buildings on the allotments, also easily identified from satellite images, for verification of the building land use proportion estimated from the site walkovers.

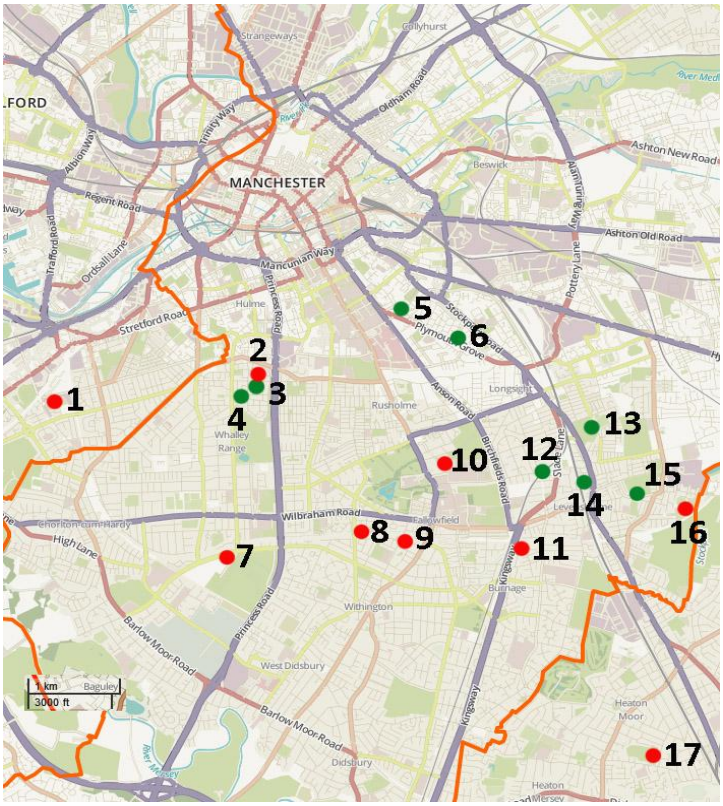

Figure 4.1 – Locations of sampled allotments (red) and parks (green) in Manchester. Note two of the allotments are outside the Manchester district boundary (orange line). (Map source: openstreetmap)

1 Firswood
2 Great Western
3 Great Southern
4 Rosebery Street
5 Dryden Street
6 Plymouth Grove
7 Hough End
8 Bethnal Road
9 Wellington Road
10 Brighton Grove
11 Acorn Close
12 Slade Lane
13 Crowcroft Park
14 Park Grove
15 Greenbank Park
16 Levenshulme
17 Green Lane

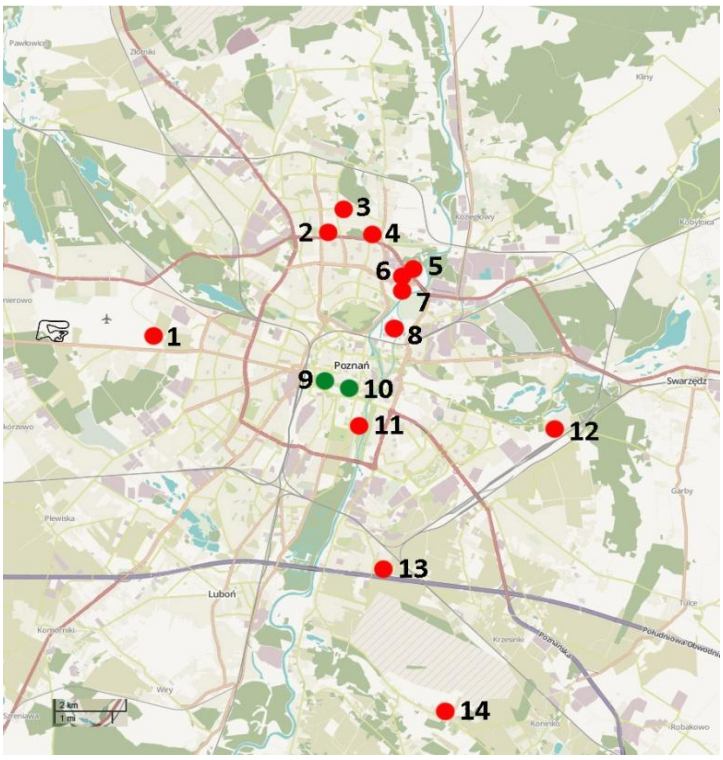

Figure 4.2 – Locations of sampled allotments (red) and parks (green) in Poznan. (Map source: openstreetmap)

1 Armii Wojska
2 23 Lutego
3 Budowlani
4 Roosevelt
5 Urodzaj III
6 Urodzaj II
7 Urodzaj !
8 Energetyk
9 Dabrowskiego
10 Chopin
11 Bielniki
12 Kobylepole
13 Minikowo
14 Gluszynka

4.2 Site walkovers

21 allotments were visited in total and the following actions carried out:

- Trees were counted and identified and the height was estimated to the nearest metre. The heights were later organised into three bins:
    - 0 – 3 metres
    - 4 – 6 metres
    - > 6 metres
- The proportion of cultivated ground in each plot was estimated as being zero, a third, a half, two thirds or fully cultivated. An abandoned, overgrown plot thus represents zero cultivation and a plot with a high apparent level of maintenance (weeding, mowing, etc.) on all available land is described as fully cultivated.
- A list of vegetables and herbs grown on each allotment complex was compiled. It was also noted if a plot was not used for growing vegetables.
- The number of plots in each allotment complex growing fruit was noted. The main fruit were raspberries, gooseberries, blackberries, strawberries, currants, rhubarb and grapes. Fruit trees (apple, apricot, etc.) are included in the tree count.
- The area of land used by buildings was estimated by eye and occasionally measured using a tape measure where access was granted. The building types were divided into sheds/chalets, greenhouses and polytunnels and it was noted whether the building was collecting roof rainwater runoff in a container for use later in dry periods.
- The amount of land taken up by impermeable paved paths and patios was estimated by eye or measured with a tape measure where access was granted.
- The land use in the immediate vicinity of the allotment complexes was recorded using the classification of Stewart and Oke (2012).
- Allotment holders were interviewed and additional ecosystem services identified, such as using herbs for medicine/tea and installation of beehives and ponds.

Ten parks were also visited and trees were counted, identified and heights estimated as for allotments. Due to privacy issues most allotment surveying was carried out from the paths outside the plots unless invited onto the plots by the owners

Tables 4.1 and 4.2 show the areas of the allotments in this study. A full list of the allotments can be found in Appendix 1. It has already been established in table 4.1 that Polish allotments are much bigger than UK ones but it is important to determine the areas covered in the present study. The mean average allotment complex area

sampled in Poznan is smaller than the overall mean in Table 4.1 because larger allotments were not surveyed in their entirety due to time constraints. Randomly selected subdivisions were surveyed instead. Manchester allotments were all surveyed completely.

	Manchester	**Poznan**	**Parks**
n	9	12	10
Mean area (m^2)	15 091	39 470	13 072
Median area (m^2)	8 072	40 020	9 493
Area range (m^2)	1 597 – 51 315	23 961 – 64 357	3 368 – 37 180

Table 4.1 – Summary statistics for study site area

	Manchester	**Poznan**
n	497	1 164
Mean area (m^2)	211	369
Median area (m^2)	205	335
Area range (m^2)	107 – 375	305 - 560

Table 4.2 – Summary statistics for individual allotment plot area

4.3 Botanical survey Manchester - allotment and park comparison

For Manchester allotments spontaneous vascular plant species growing in the paths and verges, on abandoned plots and between vegetable rows, were identified and cover/abundance estimated using the Domin scale (Table 4.3). This scale is a measure of the vertical projection on to the ground of the extent of the living parts of a species and is used within the UK National Vegetation Classification (Rodwell, 2006). Each allotment complex was treated as one 'relevé' so the cover estimate is based on cover of the whole surveyed land.

Cover	Domin
91 – 100%	10
76 – 90%	9
51 – 75%	8
34 – 50%	7
26 – 33%	6
11 – 25%	5
4 – 10%	4
< 4% (many individuals)	3
< 4% (several individuals)	2
< 4% (few individuals)	1

Table 4.3 – the Domin scale of cover/abundance

Harrap's (2013) guide to wild flowers was used for identification of the species encountered. Grasses were identified using a Field Studies Council guide to common grasses (FSC, 2010). Botanical surveys were also carried out for Manchester parks, with care taken to note whether the plant species were growing ubiquitously or only in the verges and un-mowed areas. The botanical survey was not carried out on Polish allotments due to inherent differences between Polish and English biodiversity rendering comparisons meaningless for the purposes of this study.

In addition, lists were compiled of herbaceous flowering plants that were deliberately planted on Manchester allotments for aesthetic, culinary or pollination value. This is considered to be supplementary to the main research as the data is incomplete. Allotments, especially in Poland, are frequently used for growing an incredibly wide variety of ornamental shrubs and flowers, identification of which is beyond the capabilities of the researcher given time constraints for the main research. An extensive cataloguing of all flora on allotments is a suggestion for future research.

4.4 Ecosystem service provision assessment

A list of ecosystem services was derived from the literature using the Millenium Ecosystem Assessment (MA 2005) as a baseline. These are divided into four groups – Supporting services, Provisioning services, Regulating services and Cultural services. Burkhard et al. (2009) propose an assessment scale of 0 – 5 with 0 being no relevant capacity of the land to provide a particular ecosystem service, up to 5, very high relevant capacity. In that paper, they consider 44 land use types, however, allotments is not one of them. Therefore, scoring of ecosystem service provision for the land use types in this study was based on judgements which take into account the quantification work undertaken (tree counts, etc.) and the experience of the researcher during the field work.

5 Results

5.1 Food production

One of the main differences between allotment gardens in the study is how they are used for food production. Figure 5.1 shows all the allotment plots in Manchester are used for growing vegetables of some kind, whereas in Poznan only a third of plots, on average, were observed to have land allocated for vegetables and this usually consisted of a vegetable bed with a mean average size of 30 m^2. Table 5.1 shows the diversity of vegetables grown in the two countries. A lot of similarities are apparent but there were some notable cultural differences in the types and amounts of the vegetables grown. For example, Kohl Rabi and Celery are very popular vegetables in Poland but not so common in the UK (and were only observed growing on one single allotment plot). However, the variety of vegetables grown was larger in Manchester with more allotments experimenting with 'exotic' and unusual vegetables like the cucamelon and tomatillo from Central America.

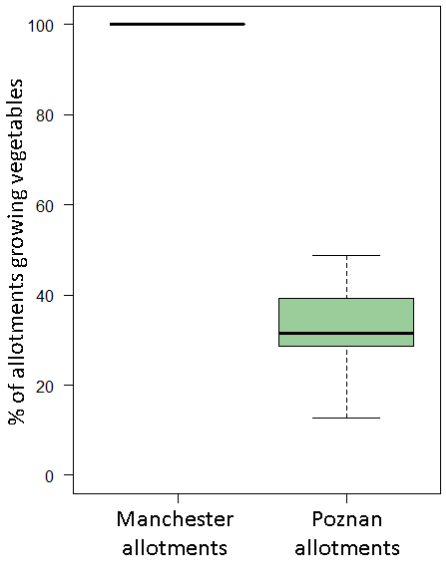

Figure 5.1 – Proportion of allotment plots which grow vegetables

Poznan and Manchester			Manchester only
Asparagus	Horseradish	Pumpkin	Aubergine
Beetroot	Jerusalem	Radish	Cardoon
Broad bean	artichoke	Rocket	Chilli pepper
Brocolli	Kale	Runner bean	Cucamelon
Cabbage	Kohl rabi	Shallot	Globe artichoke
Carrot	Leek	Spinach	Romanesco
Celery	Lettuce	Spring onion	Tomatillo
Chard	Onion	Sweetcorn	
Courgette	Parsnip	Tomato	
Cucumber	Pea		
French bean	Pepper		
	Potato		

Table 5.1 – Diversity of vegetables grown on allotments in the study

Data on the highest yield available for the vegetables identified in Table 5.1 were averaged and multiplied by the area of land given over to growing vegetables (not including abandoned plots etc.) to derive estimates of the yield on the allotments (Table 5.2). It is clear that even though Manchester allotments are smaller in total area, there is more land used for vegetables, resulting in an eightfold yield increase over Poznan allotments.

	Manchester	Poznan
Area vegetable production (m^2)	89 090	11 070
% of total area	65.6%	2.3%
% of non-paved area	70.7%	2.7%
Mean potential yield (Tonnes)	615	76
Min potential yield (Tonnes)	62	8
Max potential yield (Tonnes)	2 744	341

Table 5.2 – Summary statistics for allotment food production. Potential yield is based on data from Mobbs (2003) and considering only the vegetables found to grow in the study sites. Minimum and maximum potential yield are based on using the land for growing monocultures of sweetcorn and potatoes respectively.

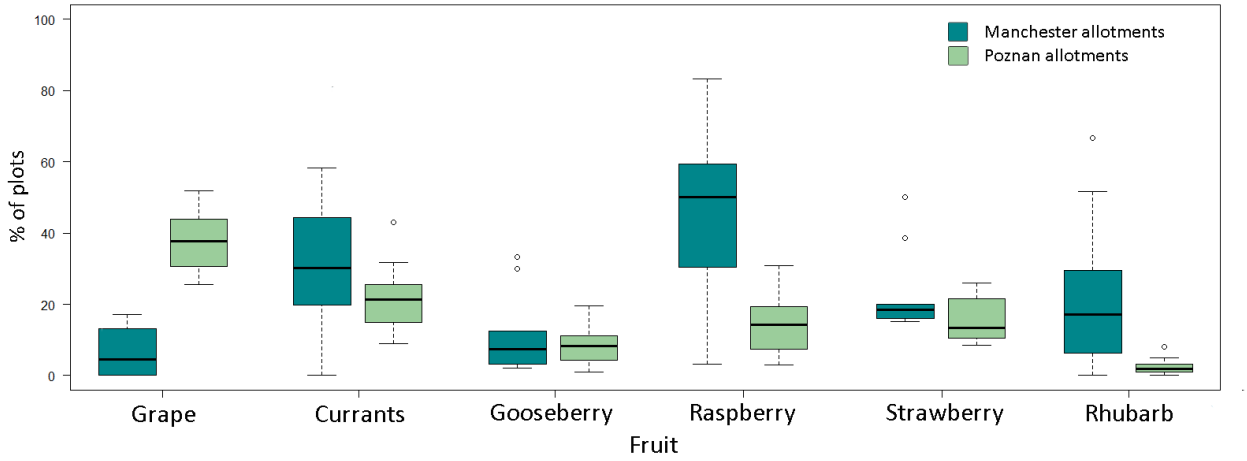

Figure 5.2 – Percentage of all plots surveyed growing soft fruit.

Figure 5.2 shows the percentage of all plots where soft fruits were being grown. Grapes are less common in the UK because the climate is not suitable for growing grapes outdoors, so a greenhouse is needed. Grapevines were more common than vegetable plots in Poznan. Raspberries and rhubarb are more common in Manchester and there are no real differences for the other fruit. Blackberries were also commonly found in both cities. Manchester allotment holders were found to grow unusual fruits such as tayberries, kiwi fruit and blueberries.

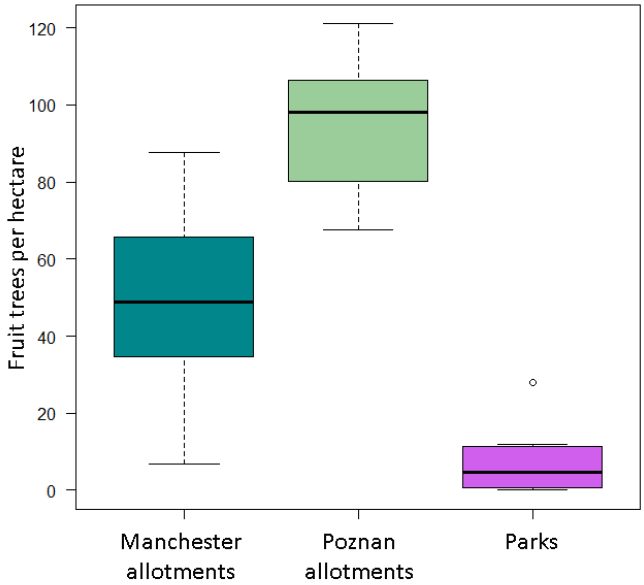

Figure 5.3 – Number of fruit trees growing per hectare in the three land use types

Allotments in Poznan had roughly double the amount of fruit trees than Manchester. Apricot and Peach trees were also more common in Poznan and most allotments had

at least one apple or cherry tree, even if they were not growing any other fruit or vegetables. Walnut trees were also very common in Poznan. Apricots and peach were seldom found in Manchester, due to the climate, but again Manchester experiments with unusual trees such as fig and damson. Fruit trees are occasionally found in public parks and cherry trees dominate, with some apple trees found occasionally.

5.2 Trees

The area under tree canopy is greatest for parks, with Poznan allotments showing similar average values (Figure 5.4). Manchester allotments had much less land under tree canopy. Parks also had the tallest trees (Figure 5.5). At first glance, it appears that Poznan and Manchester had similar average tree height but it is necessary to divide the tree heights into groups to look closely at the patterns. In Figure 5.6 it is clear that the high density of trees in the lower height bracket may be bringing the overall average down. The truth is that Poznan allotments not only have more trees than Manchester, but have more taller trees also. Parks have the greatest amounts of taller trees.

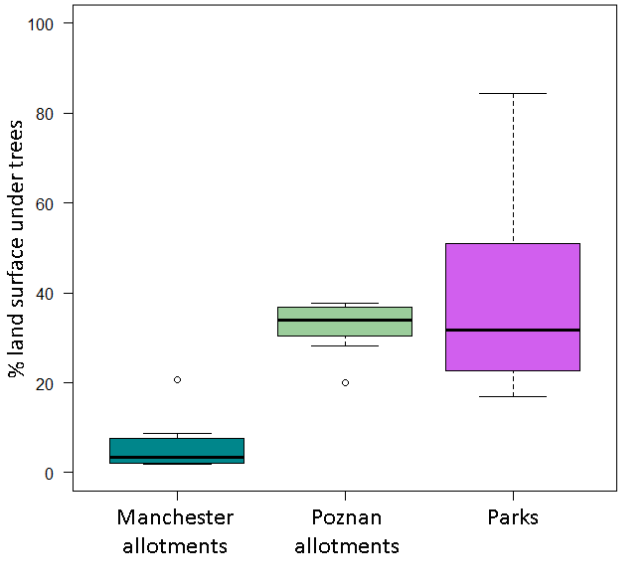

Figure 5.4 – Proportion of land surface area under tree canopies

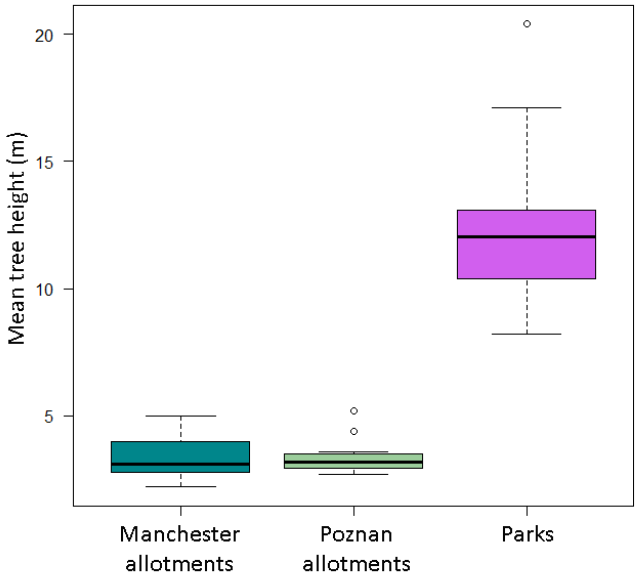

Figure 5.5 – Mean average tree height

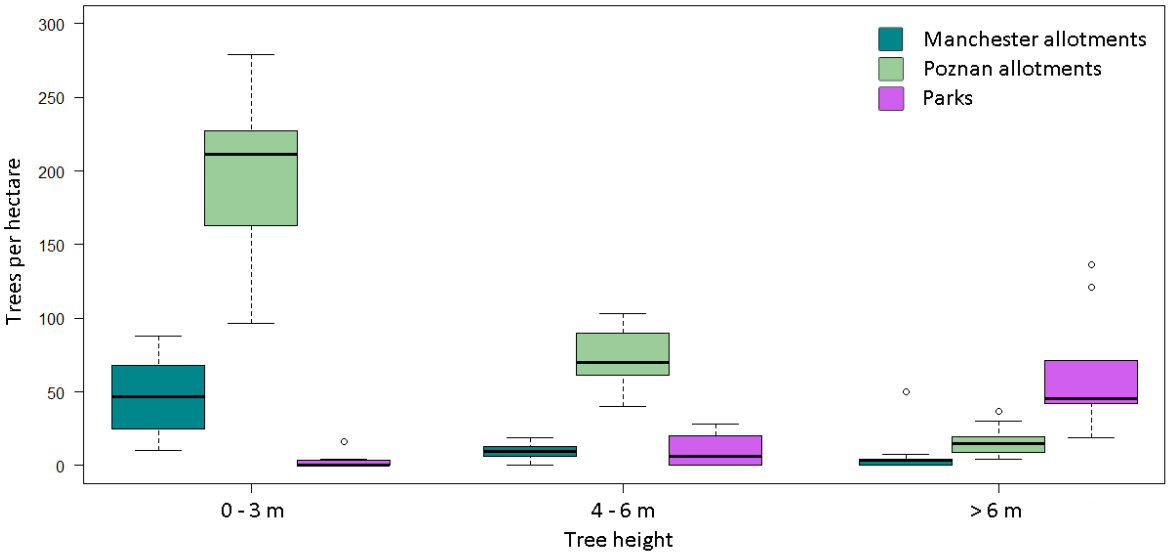

Figure 5.6 – Number of trees per hectare separated by three tree height brackets

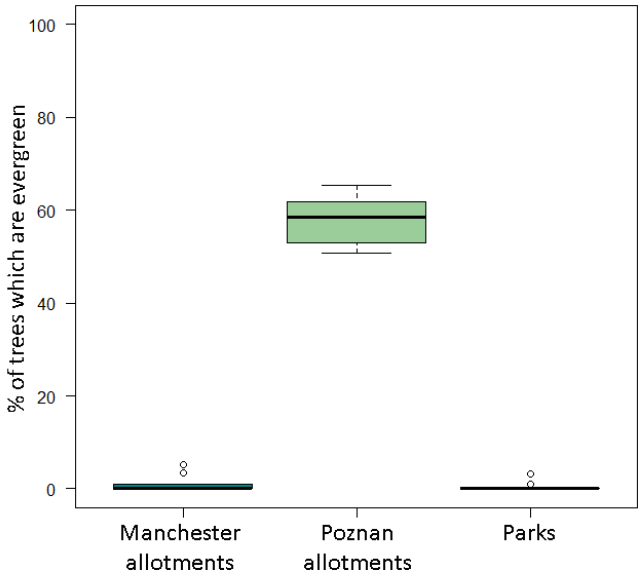

Figure 5.7 – Percent of trees encountered which are evergreen

Over half the trees encountered on Poznan allotments are evergreen. These mostly comprised tall hedges separating the plots made of cypress trees. Large individuals of conifer trees (*Pinus* genus) were also common.

5.3 Infrastructure

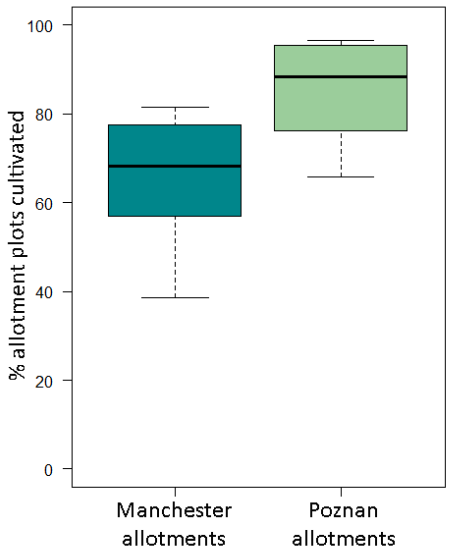

Figure 5.8 – Degree of cultivation of the land

More of the land is fully cultivated in Poznan than in Manchester (Figure 5.8). This resulted from a larger proportion of abandoned plots in Manchester but also a larger

proportion of plots with sections overgrown by weeds. The proportion of the land given over to impermeable surfaces (Figure 5.9) did not vary considerably between the three land use types. Poznan allotments had the most buildings but Manchester allotments occasionally had large areas paved for car parks and paths. Parks with high amounts of paved areas usually contained features such as tennis courts and children's playing areas.

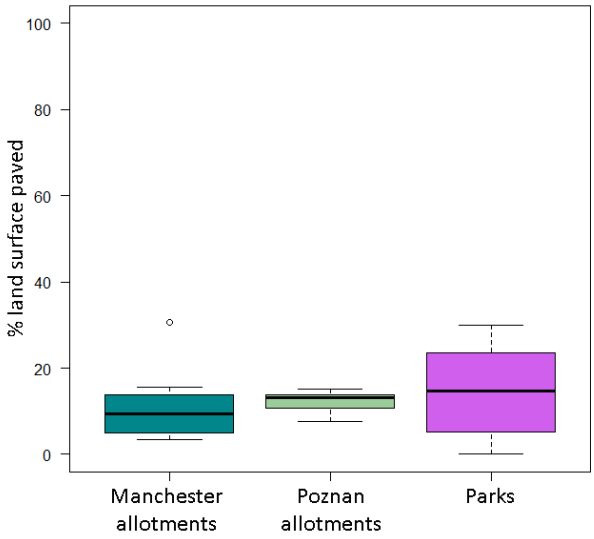

Figure 5.9 – Percent of the land surface area paved (paths and buildings)

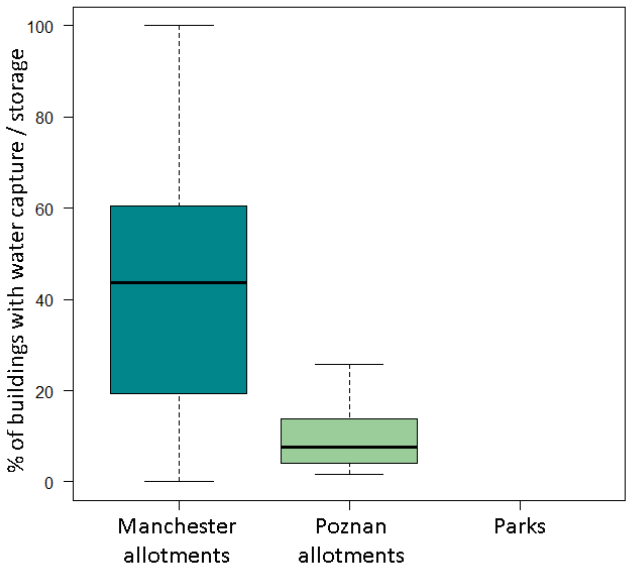

Figure 5.10 – Percent of the building infrastructure fitted with the means for capture and storage of rainwater

Manchester allotment holders are much more likely to capture rainfall runoff from sheds and greenhouses in a barrel for use in dry periods (Figure 5.10). Manchester's average annual rainfall (for the period 1981 – 2010) is 828.8 mm and that of Poznan is 515 mm. Assuming all the rainfall is collected and stored this gives total volumes collected of 1295 m^3 in Manchester and 2239 m^3 in Poznan. The greater number of buildings on Poznan allotments means that the total volume figure is larger, therefore normalising for total land area gives 12.6 litres per m^2 in Manchester and 5.1 litres per m^2 in Poznan.

5.4 Ecology

The full list of species and domin abundance scores for each of the relevés can be found in Appendix I. The main findings are summarised in Table 5.3.

	Allotments	Parks
Overall species richness	87	55
Plant families represented	34	18
Species unique to the land use	47	16
Plant families unique to the land use	16	1
Average site richness per hectare	48	25
Tree species richness	28	33
Tree families represented	14	13
Tree species unique to the land use	12	18
Tree families unique to the land use	5	4

Table 5.3 – Summary of the ecological survey data

The species richness of spontaneous vascular flora is much higher on allotments with parks having roughly 63% of the species richness, including when adjusted for land area. Allotment flora belong to a greater range of families than the park flora. In addition the families found in parks could all be found on allotments with the exception of Asparagaceae from one specimen of bluebell – *Hyacinthoides non-scripta*. Figure 5.11 shows species richness tends to increase as the area of the surveyed plot increases but this relationship is non-linear as it would eventually plateau. The average site richness per hectare varied greatly with one allotment, Hough End, being small in area but with a large species richness, possibly due to its location next to a large park and wasteground.

Domin scores show the majority of species encountered on both land use types exhibited cover abundances less than 4%. The dominant species tended to be grasses (*Agrostis sp.* and *Lolium multflorum*) and white clover (*Trifolium repens*) which were found in the main grassy areas of parks and in the turf paths of allotments. Associated with these ground cover species would frequently be found broad leaved plantain (*Plantago major*), dock (*Rumex obtusifolius*), dandelion

(*Taraxacum agg*.) and creeping buttercup (*Ranunculus repens*). Daisies (*Bellis perennis*) were also widespread in parks. The verges and abandoned plots of allotments were frequently dominated by nettles (*Urtica dioica*), cleavers (*Galium aparine*), and herb Robert (*Geranium robertanium*).

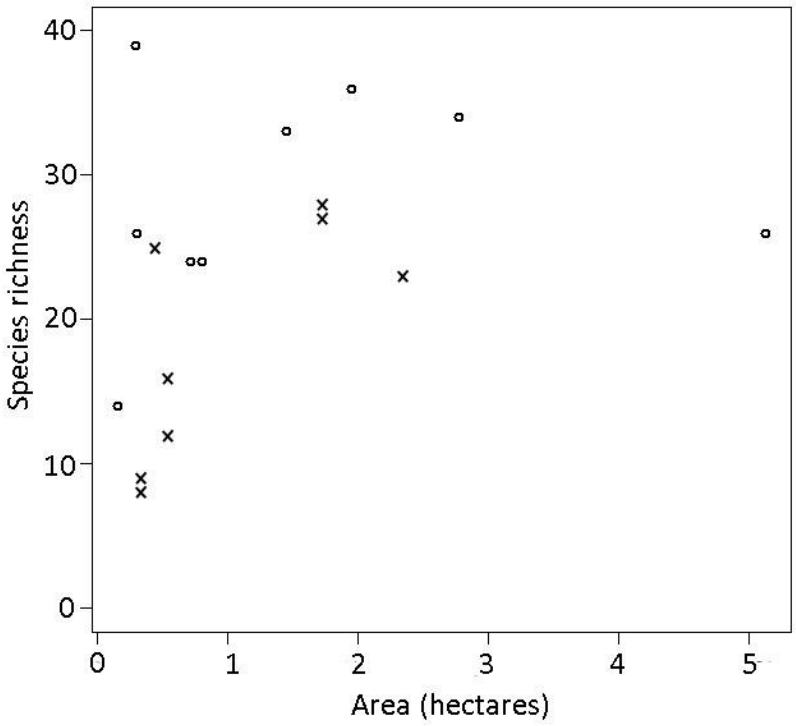

Figure 5.11 – Plot of species richness against land area for Manchester allotments and parks. O = allotments, X = parks

The number of tree species was slightly greater in parks. The species found only on parks (Appendix II) included more ornamental trees such as dogwood (*Cornus sp*.), tree of heaven (*Ailanthus altissima*) and black locust (*Robinia pseudoacacia*). Conversely the species found only on allotments included more fruit trees such as fig (*Ficus carica*), olive (*Olea europaea*) and pear (*Pyrus communis*).

5.5 Additional ecosystem services

There are a number of additional ecosystem services that were observed on the allotments. Chickens were kept on a couple of Manchester allotments, providing food from livestock. The figure would be higher but many UK allotments have strict rules about keeping animals. Beehives were also found on two of the Manchester allotments, thus providing pollination services. Ponds were common in both Manchester and Poznan, however, in Poznan the ponds were more for aesthetic purposes than for biodiversity or rainwater storage. The ponds on Manchester

allotments were less well manicured and their purpose was often to provide a home for frogs which help control garden pest populations.

Finally, it was apparent that a number of plots, in both cities, were growing medicinal herbs. These included lemon balm (*Melissa officinalis*), mint (*Mentha sp*.), St John's wort (*Hypericum perforatum*), rosemary (*Rosemarinus officinalis*) and lavender (*Lavendula angustifolia*) which all have medicinal uses in addition to any culinary uses. It is unknown if these plants were grown specifically for herbalist medicine use, but several allotment holders said they regularly drink herbal teas made from some of these herbs for the promotion of well-being. Figures 5.12 to 5.15 illustrate some of the additional ecosystem services provided by the surveyed allotments.

Figure 5.12 – Beehives on 'Hough End' allotments, Manchester.

Figure 5.13 – Ornamental pond on ‘23 Lutego’ allotments, Poznan

Figure 5.14 – Herbal tea made with lemon balm leaves

Figure 5.15 – Ragwort (*Jacobaea vulgaris*) providing food for caterpillars of the cinnabar moth (inset) on 'Firswood' allotments, Manchester

5.6 Ecosystem service matrix

Ecosystem Service	Manchester	Poznan	Park
Supporting services Σ	17	16	15
Biodiversity	3	3	2
Soil formation	4	3	3
Photosynthesis	3	4	4
Seed dispersal	4	3	3
Reduction of nutrient loss	3	3	3
Provisioning services Σ	20	17	6
Crops	5	4	1
Livestock	2	1	0
Fodder	4	4	0
Capture fisheries	0	0	0
Aquaculture	0	0	0
Wild food	2	1	1
Timber	0	0	0
Wood fuel	1	2	1
Genetic resources	4	3	2
Medicine	2	2	1
Fresh water	0	0	0
Regulating services Σ	17	19	18
Local climate regulation	3	4	4
Global climate regulation	1	2	2
Flood protection	1	1	1
Ground water recharge	2	2	2
Air quality regulation	2	3	3
Erosion regulation	2	2	2
Nutrient regulation	1	1	1
Water purification	1	1	1
Pollination	4	3	2
Cultural services Σ	18	17	17
Recreation	3	4	4
Intrinsic value of biodiversity	2	2	1
Aesthetic value	3	3	4
Social relations	3	3	3
Knowledge systems & education	4	2	2
Cultural heritage	3	3	3
Total	72	69	56

Table 5.3 – Matrix for the assessment of the different land cover types' capacities to provide ecosystem services. The assessment scale covers 0 (pink) = no relevant capacity, 1 (pale green) = low relevant capacity, 2 (light olive) = relevant capacity, 3 (dark olive) = medium relevant capacity, 4 (pea green) = high relevant capacity and 5 (dark green) = very high relevant capacity. Sums for the ecosystem groups are provided in orange.

6 Discussion

6.1 Ecosystem service provision

Table 5.3 is a neat way of summing up the ecosystem service provision by the different land use types. There are subtle differences between the two allotment types but on the whole they provide roughly the same amount/type of ecosystem services. The presence of beehives and livestock on Manchester allotments gave higher scores in those respective segments and the less manicured/maintained nature provides more opportunities for foraging for wild foods (wild blackberries were common). Support of pollinators is incredibly important at the moment given the reported decline of pollinators such as bees and the potentially disastrous consequences this will have on crop production (Goulson et al. 2008). Allotment tenants are increasingly aware of the benefits of attracting pollinator insects and the past few years has seen more flowers, such as *Phacelia tanacetifolia* and red clover (*Trifolium pratens*), being planted alongside vegetables (Figure 6.1). Clovers have the added benefit of being nitrogen fixers, thus providing an organic method of improving soil fertility.

Figure 6.1 – At least a hundred individuals of several bee species were observed on a patch of *Phaceila tanacetifolia* on 'Levenshulme' allotments, Manchester

Poznan allotments have much more trees, of a greater size and with a higher proportion of evergreen trees than Manchester. Trees provide important ecosystem services of climate modification (evapotranspirative cooling and shade provision) and trees also act as passive filters of urban air pollution. Evergreen trees in particular, are highly beneficial because they potentially capture air pollution year-

round. In this respect, Poznan allotments are much better than Manchester ones for climate change adaptation on a local scale. Non-fruit trees are generally absent, or of a small size, on Manchester allotments to reduce shade and maximise vegetable yield.

One interesting difference between the two cities is the fact that Manchester allotment tenants are more likely to capture rainwater for irrigation purposes in dry weather, despite Manchester receiving much higher annual rainfall than Poznan. This is probably due to a cultural difference related to an 'eco-minded', self-sufficient attitude among UK allotment holders. Taps are present on all the Manchester allotments surveyed but it is perceived to be a 'greener' use of resources to harness the rain water running off roof surfaces.

Poznan allotments were given a higher score for the recreation service because they are treated like summer homes, which tenants actually move to in the summer months. Outdoor dining, sunbathing and entertaining friends are common activities. On Manchester allotments, tenants spend much less time on the plots and it is usually to undertake gardening work and chat to other tenants.

Parks, despite having larger trees, lack a number of the ecosystem services that allotments provide such as food production and biodiversity. Trees in parks tend to be chosen for their ornamental or low maintenance value, and regular mowing of grass areas limits their ecological benefits. Parks are, however, communal spaces that can be used by many people. Allotments, on the other hand, tend to be fenced off and strictly for the use of tenants only, due to issues with vandalism and theft. This limits their impact in terms of providing all urban residents with access to green space, however, a recent trend in the UK is to create community allotment plots which can be used by large groups of people such as schools and community health projects. It is also true that many ecosystem services provided by allotment gardens have impacts beyond the spatial confines of the gardens. Local climate regulation, flood protection and air quality regulation will especially benefit local residents in cities. Allotment gardens will become more important in the future as urban populations rise further and climate change pressures in cities force local governments to invest in green space as a means of climate change adaptation.

Overall Poznan allotments score slightly better in the regulating services due to the large amount of tree planting, and Manchester allotments fare better in the provisioning services as a result of intensive crop growing.

6.2 Ecology

The higher species richness on allotments is a result of the differences in land management practices between parks and allotments. Parks are mowed frequently

and there are a limited number of species which can survive this regular treatment i.e. grasses, daisies, buttercups, clover and a few low-growing plants such as chickweed (*Stellaria media*) and speedwell (*Veronica sp*.). The mowing represents a selection pressure and prevents the establishment of a wide range of spontaneous vegetation. Most of the species richness in parks was consequently found in the verges and under benches, which escape mowing pressure.

On allotments there is a different selection pressure – that of regular digging and upheaval of the soil. This makes allotments highly suitable environments for a wide range of weed species which exhibit one or more of the following traits (Cousens and Mortimer, 1995):

- Long lived seed
- Rapid growth to flowering stage
- Ease of germination in a wide range of environments
- Self-compatibility
- High seed output
- Good competitors
- Vigorous reproduction from fragments

A lot of the plants found on the allotments exhibit these traits and the families Poaceae and Asteraceae were greatly represented. These two families make up 37% of global weeds (Holm et al., 1977) because they possess several of the traits in the above list. In addition, practices on allotments which are meant to stimulate vegetable growth and crop production can inadvertently stimulate weed growth i.e. addition of fertilisers and soil warming in late winter.

There were interesting differences in the species composition and richness between allotment complexes. For example, a common weed on allotments is horsetail (*Equisetum arvense*), however it was absent on three of the complexes surveyed. The influence of surrounding land influences on the species composition was potentially important. The high species richness on Hough End allotments, for example, could be explained by its location downwind of a large expanse of parks, wasteground and woodland which would provide an external input of wind-borne seed in addition to seeds lying dormant in the allotment soil. Management differences on the allotments themselves would also explain some of these inter-complex differences. An allotment complex with a high number of abandoned plots would have a large input of wind-dispersed seeds from weeds that have gone to seed on these plots.

There was some evidence on a couple of allotments of species planted on the allotments spreading to the paths and verges, such as the herbs oregano (*Origanum vulgare* – Figure 6.2) and lemon balm (*Melissa officinalis*) and the ornamental flower

granny's bonnet (*Aquilegia sp*.). Allotments may therefore act as launch sites for plants with traits that make them suitable for colonising urban habitats beyond the boundaries of the allotments.

Figure 6.2 – *Origanum vulgare* growing in rough ground adjacent to a paved path on 'Green Lane' allotments, Manchester

None of the spontaneous species found on the allotments were of any specific ecological interest or classified as endangered or vulnerable on the UK vascular plants red data list (Cheffings and Farrell, 2005). Some of the species are, however, classed as nuisance invasive species, namely Himalayan balsam (*Impatiens glandulifera*) and Japanese knotweed (*Fallopia japonica*), which were found on a couple of allotment complexes.

In terms of ecosystem services, some of the spontaneous species found are classed as very good for pollinator insects, such as rosebay willowherb (*Epilobium angustifolium*) and members of the Geranium genus. This is not to mention the wide range of vegetables and ornamental flowers grown on allotments. As mentioned above allotment holders are increasingly aware of the benefits of attracting pollinator insects via companion planting of species such as French marigolds (*Tagetes patula*) and teasel (*Dipsacus fulonium*). In a study in Stockholm (Ahrné et al. 2009) local flower abundance on urban allotments was found to be an important factor in determining bee abundance and species composition compared to more peri-urban sites.

7 Conclusion

This study has looked extensively at the ecosystem services, or benefits mankind receives from nature, which allotments provide. Services related to pollination, food provision, biodiversity and recreation rank very highly on allotment gardens. Differences were noted between the two cities studied, notably a lower amount of trees on Manchester allotments due to a cultural preference for vegetable growing. Allotment gardens certainly confer a wider range of ecosystem service benefits than parks, however, parks have much taller trees for local climate modification, and can be used for recreation by a greater number of urban residents.

While the study concentrated on biophysical impacts of allotment gardens, the importance of socio-psychological benefits must not be overlooked. These include: social cohesion brought about by bringing together people of different backgrounds with a common shared interest of gardening; education about nature and food production; and health benefits brought about by moderate physical activity, especially for elderly people. A study in the Netherlands suggested that elderly allotment holders enjoy greater health than their neighbours who do not own an allotment due to the maintenance of an active lifestyle (Van Den Berg, 2010).

Some suggestions for improvements on allotment gardens include the following:

- Strategic planting of trees on Manchester allotments to provide shade for a future warmer climate, in addition to the other benefits trees provide such as air pollution capture.
- Increase the amount of water capture from impervious roof surfaces for irrigation uses, to improve the hydrological sustainability of agricultural practices.
- Promotion of holistic, organic approaches to gardening which use techniques such as composting, companion planting and green manure crops to improve yield instead of relying on artificial fertilisers and pesticides.
- Install more beehives and non-ornamental ponds

The results of this study suggest that due to the high number of ecosystem services provided by allotment gardens, there may be a need for more formal recognition of their benefits in local government policy. Allotment tenants are essentially local stewards of urban green space and thus serve an important role in biodiversity protection and climate change adaptation, which are commonly-cited sustainability goals of local government. Green areas managed by local user groups may play an increasingly critical role in the future functioning and resilience of urban ecosystems (Colding et al. 2006).

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Appendix I

			Relevé																
			Allotments									Parks							
Common Name	Latin name	Family	Wellington Road	Levenshulme	Brighton Grove	Bethnal Ave	Acorn Close	Great Western	Hough end	Green Lane	Firswood	Plymouth Grove	Dryden Street	Greenbank Park	Park Grove	Great Southern	Slade Lane	Rosebery	Crowcroft
Orache	*Atriplex prostrata*	Amaranthaceae	2		3														
Cow parsley	*Anthriscus sylvestris*	Apiaceae			2							3							1
Ground elder	*Aegopodium podagraria*	Apiaceae		4	5				3		4								
Bluebell	*Hyacinthoides non-scripta*	Asparagaceae											1						
Coltsfoot	*Tussilago farfara*	Asteraceae									2								
Cotton lavendar	*Santolina chamaecyparissus*	Asteraceae							1										
Creeping thistle	*Cirsium arvense*	Asteraceae						3			1								
Daisy	*Bellis perennis*	Asteraceae			2	2						5	6	6	4	5	4	4	5
Dandelion	*Taraxacum agg.*	Asteraceae	5	4	4	4	4	3	5	4	4	5	5	5	5	4		4	3
Groundsel	*Senecio vulgaris*	Asteraceae	1	3	2		3		2	3	4					1			2
Hawksbeard sp.	*Crepis sp.*	Asteraceae										2							1
Mugwort	*Artemisia vulgaris*	Asteraceae														2			
Oxeye daisy	*Leucanthemum vulgare*	Asteraceae		2															
Pineapple weed	*Matricaria discoidea*	Asteraceae								5						2			1
Prickly lettuce	*Lactuca serriola*	Asteraceae							3		2								
Ragwort	*Jacobaea vulgaris*	Asteraceae	3	2	2	2	2		2	3	2	3	1	2			2		2

Smooth sow thistle	*Sonchus oleraceus*	Asteraceae	2	3	2	2	5		3		2	2	2	2					1
Spear thistle	*Cirsium vulgare*	Asteraceae				2						2				1			
spiny sowthistle	*Sonchus asper*	Asteraceae			2				3	2	3		2	1					
Tansy	*Tanacetum vulgare*	Asteraceae								2									
Woolly burdock	*Arctium tormentosum*	Asteraceae				1													
Yarrow	*Achillea millefolium*	Asteraceae																3	
Himalayan balsam	*Impatiens glandulifera*	Balsaminaceae			1														
Borage	*Borago officinalis*	Boraginaceae								2									
Forget me not	*Myosotis arvensis*	Boraginaceae	5		3		3		3	3									
Green alkanet	*Pentaglottis sempervirens*	Boraginaceae							1										
Wood forget me not	*Myosotis sylvatica*	Boraginaceae			1														
Charlock	*Sinapis arvensis*	Brassicaceae				2	1						3			2			
Common whitlowgrass	*Erophila verna*	Brassicaceae							1										
Garlic mustard	*Alliaria petiolata*	Brassicaceae				2	1						1						
Hairy bittercress	*Cardamine hirsuta*	Brassicaceae										3							3
Horseradish	*Armoracia rusticana*	Brassicaceae	5	3															
Lesser swinecress	*Lepidium didymum*	Brassicaceae							2										
Shepherds purse	*Capsella bursa-pastoris*	Brassicaceae											1						
Thale cress	*Arabidopsis thalania*	Brassicaceae									1								
Chickweed	*Stellaria media*	Caryophyllaceae					3	3				4		2			2		
Lesser stitchwort	*Stellaria graminea*	Caryophyllaceae											1						
Red campion	*Silene dioica*	Caryophyllaceae		3															
Sticky mouse ear	*Cerastium glomeratum*	Caryophyllaceae															1		
Fat hen	*Chenopodium album*	Chenopodiaceae		2	3		1	4	2		2		2						
Hedge bindweed	*Calystegia sepium*	Convolvulaceae	3	4	3	4	2	2	2	1	3			2					

Ice plant	*Hylotelephium spectabile*	Crassulaceae									1									
Wild teasel	*Dipsacus fullonum*	Dipsacaceae	3	3	4					2										
Wood fern	*Dryopteris sp.*	Dryopteridaceae							1											
Horsetail	*Equisetum arvense*	Equisetaceae			4	3		4	3	3	3									
Sun spurge	*Euphorbia helioscopia*	Euphorbiaceae			1				3	3	4									
Bush vetch	*Vicia sepium*	Fabaceae		2		2	1		2											
Lesser trefoil	*Trifolium dubium*	Fabaceae					3				1		3							
Red clover	*Trifolium pratense*	Fabaceae	4							2		2								
White clover	*Trifolium repens*	Fabaceae				2				6	6	4	7	7	3	6	5	5		
Cranesbill	*Geranium pratense*	Geraniaceae	3																	
Cut leaved cranesbill	*Geranium dissectum*	Geraniaceae											2							
Hedgerow cranesbill	*Geranium pyrenaicum*	Geraniaceae								1										
Herb robert	*Geranium robertanium*	Geraniaceae	2	5	4	2		3			3	3			2					2
Yellow flag	*Iris pseudacorus*	Iridaceae		1																
Rosebay willowherb	*Chamerion angustifolium*	Juncaceae		4	2	2	1				2		2	3						
Hedge woundwort	*Stachys sylvatica*	Lamiaceae							1											
Lemon balm	*Melissa officinalis*	Lamiaceae								2										
Oregano	*Origanum vulgare*	Lamiaceae								5										
Red dead-nettle	*Lamium purpureum*	Lamiaceae								2										
Rush	*Juncus sp.*	Lamiaceae		1					1		1									1
Poached egg plant	*Limnanthes douglasii*	Limnanthaceae	1																	
Hollyhock	*Alcea rosea*	Malvaceae								1										
Creeping jenny	*Lysimachia nummularia*	Myrsinaceae							1											
American willowherb	*Epilobium ciliatum*	Onagraceae	3		3				3		4	5								2

Broadleaved willowherb	*Epilobium montanum*	Onagraceae		3		4	1		3				1	1					
Great willowherb	*Epilobium hirsutum*	Onagraceae							3	3									3
Ribwort plantain	*Plantago lanceolata*	Onagraceae										3	4	4		4			
Creeping wood sorrel	*Oxalis corniculata*	Oxalidaceae							1	1									
Common fumitory	*Fumaria officinalis*	Papaveraceae					1												
Field poppy	*Papaver rhoeas*	Papaveraceae	3	2					2	2									
Broad leaved plantain	*Plantago major*	Plantaginaceae			5		3		4	4	5	5		4	4	4	5	3	5
Common speedwell	*Veronica officinalis*	Plantaginaceae								2	2								
Ivy leaved speedwell	*Veronica hederifolia*	Plantaginaceae											1				2		
Slender speedwell	*Veronica filiromis*	Plantaginaceae																	3
Thyme leaved speedwell	*Veronica serpyllifolia*	Plantaginaceae					2					2							
Barley	*Hordeum vulgare L.*	Poaceae									1		1			3			
Cock's foot	*Dactylis glomerata*	Poaceae		3	2							2	1	3					
Common bent grass	*Agrostis capillaris*	Poaceae								7									
Couch grass	*Elytrigia repens*	Poaceae	5		4								2	4				4	
Creeping bentgrass	*Agrostis stolonifera*	Poaceae	6	6	6	7	5	7	4		4	7		6			5		5
Meadowgrass	*Poa annua*	Poaceae														3			
Perennial ryegrass	*Lolium multiflorum*	Poaceae								6	5	7	7	6	8	8	8	5	6
Red fescue	*Festuca rubra*	Poaceae											2	2					
Timothy grass	*Phleum pratense*	Poaceae																	3
Yorkshire fog	*Holcus lanatus*	Poaceae			2	4	2	4	4	3	5			4	4	2			2
Dock	*Rumex obtusifolius*	Polygonaceae	5	5	4	6	3	3	3		4	3	4	4	3	5	3	3	2
Japanese knotweed	*Fallopia japonica*	Polygonaceae			2	1													
Knot grass	*Polygonum aviculare*	Polygonaceae							1								2		1

Redshank	*Persicaria maculosa*	Polygonaceae					1		2	1	2								1
Self heal	*Prunella vulgaris*	Polygonaceae								1									
Sheeps sorrel	*Rumex acetosella*	Polygonaceae								2									
Creeping buttercup	*Ranunculus repens*	Ranunculaceae	4	5	4	4	4	6	4		5	4	4	6	4	3	4		3
Grannys bonnet	*Aquilegia sp.*	Ranunculaceae								2									
Meadow buttercup	*Ranunculus acris*	Ranunculaceae										2							
Brambles	*Rubus fruticosus*	Rosaceae	4	3	3	4		3	1		2								
Creeping cinquefoil	*Potentilla reptans*	Rosaceae								1		3							
Silverweed	*Potentilla anserina*	Rosaceae	4								2								
Soft ladys mantle	*Alchemilla mollis*	Rosaceae			1		2			1									
Wood avens	*Geum urbanum*	Rosaceae	3	3	5	2	3		3	2		2		3					2
Cleavers	*Galium aparine*	Rubiaceae	4	5	4	4	5	3	2	1	2		2	3					1
Nettles	*Urtica dioica*	Urticaceae	4	6	5	5	4	4	2		3	3	2	3					2
Purpletop vervain	*Verbena bonariensis*	Verbenaceae							1										
Wild pansy	*Viola tricolor*	Violaceae							1	1									
Species richness			24	26	33	24	26	14	39	36	34	25	27	23	9	16	12	8	26
Area			7156	51315	14518	8072	2974	1597	2886	19524	27778	4396	17230	23438	3431	5507	5380	3368	17314
Richness per hectare			33.5	5.1	22.7	29.7	87.4	87.7	135.1	18.4	12.2	56.9	15.7	9.8	26.2	29.1	22.3	23.8	15

Species dominance and richness of the 17 relevés in Manchester. Light colours indicate domin scores of 1 – 3, medium-dark colours indicate domin scores of 4 – 6, and dark colours indicate domin scores of 7 – 9. Allotments are coloured green and parks are coloured orange.

Appendix II

Common Name	Latin name	Family
Lawsons cypress	*Chamaecyparis lawsoniana*	Cupressaceae
Fig	*Ficus carica*	Moraceae
Southern bluegum	*Eucalyptus globulus*	Myrtaceae
Lilac	*Syringa vulgaris*	Oleaceae
Olive	*Olea europaea*	Oleaceae
Austrian pine	*Pinus nigra*	Pinaceae
Pear	*Pyrus communis*	Rosaceae
Common osier	*Salix viminalis*	Salicaceae
Goat willow	*Salix caprea*	Salicaceae
Willow	*Salix alba*	Salicaceae
Buddleia	*Buddleja davidii*	Scrophulariaceae
Wych Elm	*Ulmus glabra*	Ulmaceae

Tree species only encountered on allotments

Common Name	Latin name	Family
Hornbeam	*Carpinus betulus*	Betulaceae
Italian alder	*Alnus cordata*	Betulaceae
Dogwood 1	*Cornus sp.*	Cornaceae
Dogwood 2	*Cornus sp.*	Cornaceae
Dogwood 3	*Cornus sp.*	Cornaceae
Black locust	*Robinia pseudoacacia*	Fabaceae
Beech	*Fagus sylvatica*	Fagaceae
Austrian oak	*Quercus cerris*	Fagaceae
London Plane	*Platanus x acerifolia*	Platanaceae
Service tree	*Sorbus torminalis*	Rosaceae
Willow species	*Salix sp.*	Salicaceae
Field maple	*Acer campestre*	Sapindaceae
Horse chestnut	*Aesculus hippocastanum*	Sapindaceae
Norway maple	*Acer platanoides*	Sapindaceae
Sycamore	*Acer pseudoplatanus*	Sapindaceae
Box elder	*Acer negundo*	Sapindaceae
Silver maple	*Acer saccharinum*	Sapindaceae
Tree of heaven	*Ailanthus altissima*	Simaroubaceae

Tree species only encountered in parks

Common Name	Latin name	Family
Elder	*Sambucus nigra*	Adoxaceae
Alder	*Alnus glutinosa*	Betulaceae
Hazel	*Corylus Avellana*	Betulaceae
Silver Birch	*Betula pendula*	Betulaceae
Leyland cypress	*Cupressus x leylandii*	Cupressaceae
English oak	*Quercus rober*	Fagaceae
Lime	*Tilia x europaea*	Malvaceae
Ash	*Fraxinus excelsior*	Oleaceae
Hawthorn	*Crataegus monogyna*	Rosaceae
Mountain ash	*Sorbus aucuparia*	Rosaceae
Peach	*Prunus persica*	Rosaceae
Plum/damson	*Prunus domestica*	Rosaceae
Cherry	*Prunus avium*	Rosaceae
Apple	*Malus domestica*	Rosaceae
Black poplar	*Populus nigra*	Salicaceae
Sycamore	*Acer pseudoplatanus*	Sapindaceae

Tree species encountered in both allotments and parks