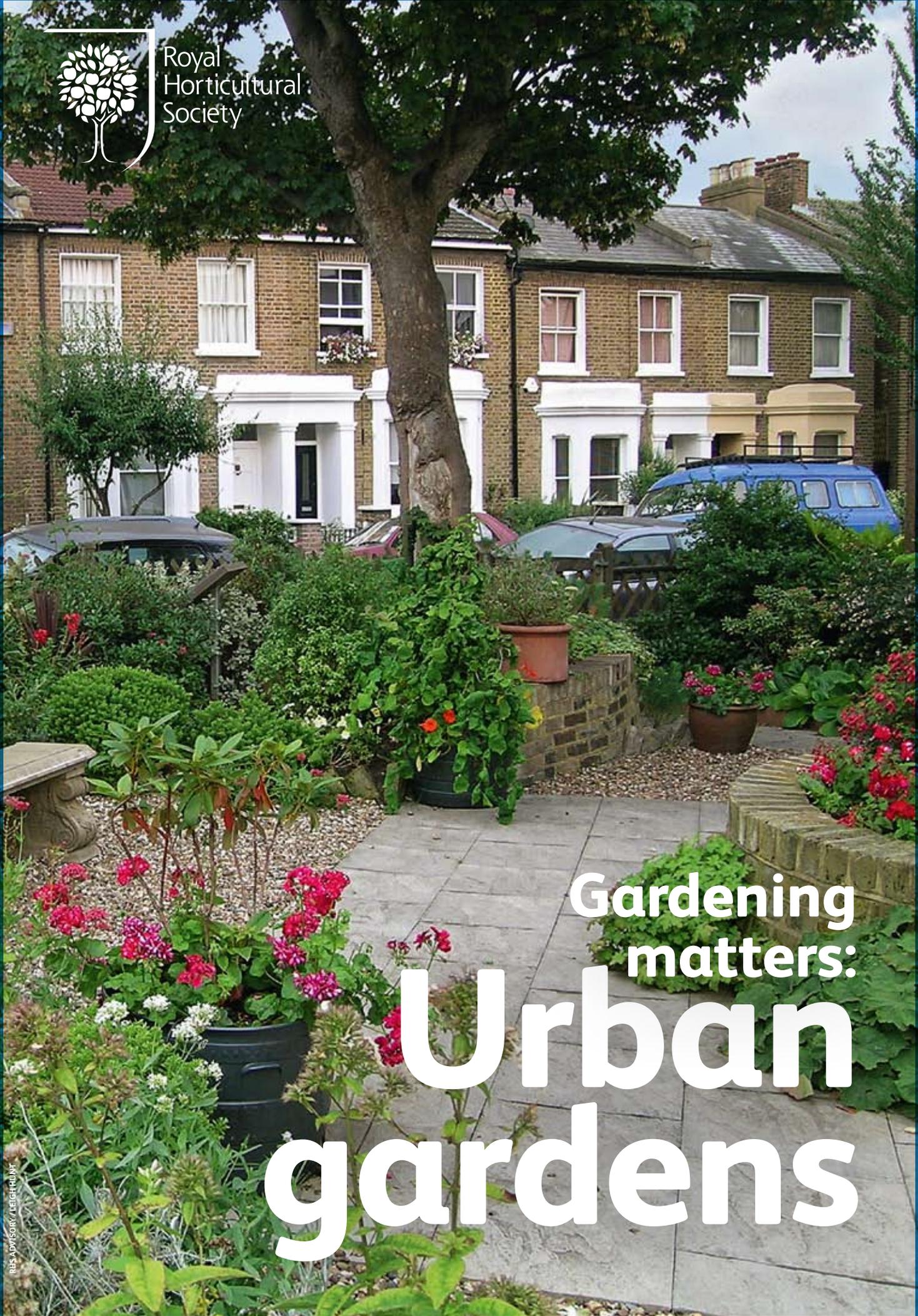




Royal
Horticultural
Society



Gardening
matters:

Urban gardens

What is the value of gardens in urban areas?

Do gardens sustain our cities?



It is often said that gardens are a vital part of our towns and cities, yet where is the scientific proof? To establish the facts, RHS scientists led an examination of all the available evidence from published research around the world. The results, brought together for the first time in this RHS Science Review, have revealed the remarkable depth and range of benefits that gardens provide in urban areas.

For example, gardens help control urban temperatures, protecting us from extreme heat and cold. They help prevent flooding, provide important habitats for wildlife and improve human health both psychologically and physically. This is why gardening matters.

So where next? In a way, this RHS Science Review serves as a starting point. It provides the evidence why urban gardens should be vigorously protected; pinpoints what further research is needed; and highlights the need to encourage good horticultural skills and future generations of gardeners. While the RHS is working in many of these areas, everyone – from homeowners to policy makers – can play their part. For everyone involved in creating and maintaining urban gardens, this RHS Science Review offers a suite of initial recommendations for action.

I hope you find the following pages of great interest and will use the recommendations (back page) and practical tips to make a difference in the gardens and green spaces over which you have influence. Indeed it is now clear that, as gardens account for almost half of our urban green space, simple steps carried out at home really do add up.

Sue Biggs, RHS Director General, May 2011



Introduction

By Tijana Blanusa, RHS Scientist

The UK is an urbanised society: more than 85 percent of the UK population lives in towns and cities¹. Urban domestic gardens are a significant component of our urban landscape. They contribute from 22–27 percent of the total urban area in many cities², and can represent nearly half of urban green space. Domestic gardens contain approximately 25 percent of the total non-forest and woodland trees³ and can contribute as much as 86 percent of the total urban tree stock⁴.

Given the major presence of gardens in our towns and cities, the Royal Horticultural Society wanted to understand more about the public function that gardens have in addition to the personal pleasure we know they bring. For that reason the Society, in partnership with the Universities of Reading and Sheffield, undertook a literature review of published academic evidence to examine the potential impact of the domestic garden on urban quality of life.

This report, which is a summary of that scientific review, highlights the fundamental role that domestic gardens play in making our cities somewhere we want to live. It looks at the ecosystem services provided by private gardens and considers their impact, positive and negative.

This review points to the need to protect our existing gardens and ensure their provision in urban expansion. In addition we must support those with access to a garden so they can tend it in a way that continues to enhance urban quality of life.

Over the following pages the specific benefits of temperature regulation, flood prevention, support for biodiversity, and promotion of human health are summarised, as are the potential pitfalls of urban gardening. It opens the debate about how urban domestic gardens can be protected, enhanced and exploited to ensure urban quality of life into the future, as well as offering some first steps that gardeners can take to support the ecosystem of their town or city.

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 3 Davies ZG, Fuller RA, Loram A, Irvine KN, Sims V, Gaston KJ (2009) A national scale inventory of resource provision for biodiversity within domestic gardens. *Biological Conservation* 142: 761–771.
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Moderating temperature

Domestic gardens are the equivalent of an air-conditioning system for our cities. **Urban-garden plants and trees help cool the air in our towns and cities, combating dangerous temperatures caused by urban heat waves.** Trees and hedges can bring heating costs and energy consumption down in winter by providing shelter and insulation

Cooling the urban environment

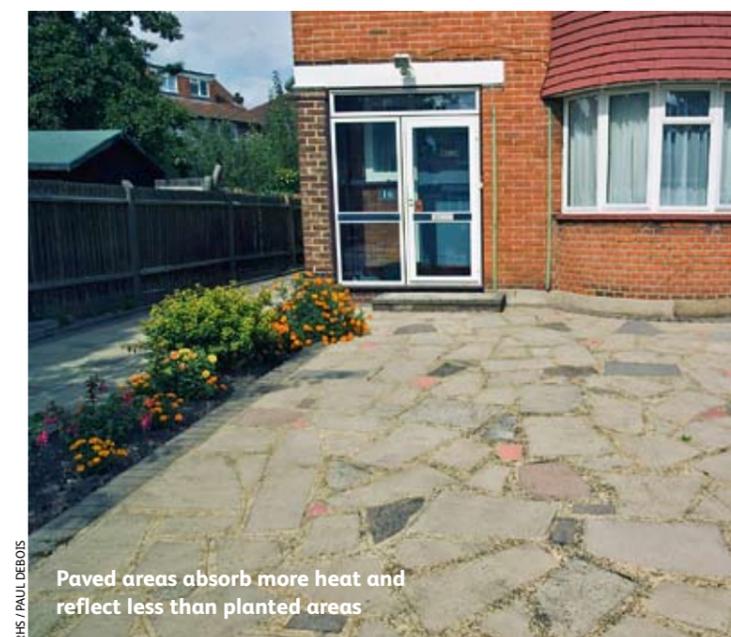
Urban environments are particularly prone to heating due to the replacement of vegetated areas with dark and impervious surfaces, with very different thermal and radiative properties (ie pavements and roads absorb considerably more heat and reflect considerably less than planted surfaces – this makes them warmer than planted surfaces). This results in urban air and surface temperature being significantly warmer than surrounding rural areas, the extent of which varies depending on the time of year and specifics of the location¹.

Urban heat waves have the potential to increase fatalities due to heat stress² and can increase the hazards arising from fires that occur (for example in Russia during summer 2010, 56,000 people are estimated to have died as a result of fire-related smog and high temperatures³).

Vegetation has the ability to provide aerial cooling by shading (primarily trees and climbing plants) but also through the plant-specific process of evapotranspiration (water loss through leaf pores). Current models predict that a 10 percent increase in vegetated surfaces in urban areas would help control the rise in summertime air temperatures due to climate change⁴.

The fact that urban trees and other forms of vegetation can provide cooling to buildings has implications for reducing the energy consumption associated with artificial air conditioning. Geographical location, building design and the prevalence and orientation of trees will all affect the extent of savings, but on average summer-cooling energy savings have been estimated to be around 30 percent; such savings also help reduce CO₂ emissions⁵.

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 3 <http://cred.be/sites/default/files/PressConference2010.pdf>
 4 Gill SE, Handley JF, Ennos AR, Pauleit S (2007) Adapting cities for climate change: the role of green infrastructure. *Built Environment* 33: 115–133.
 5 Akbari H, Kurn DM, Bretz SE, Hanford JW (1997) Peak power and cooling energy savings of shade trees. *Energy and Buildings* 25: 139–148.
 6 Meerow AW, Black RJ (2003) *Enviroscaping to conserve energy: a guide to microclimate modification*. In: Circular EES-43. Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Florida, USA, p10.
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Paved areas absorb more heat and reflect less than planted areas

Gardens as insulation

The use of trees, hedges and other forms of vegetation located carefully around houses can also enhance winter energy saving by reducing the speed of air movement reaching a building ('wind break') and/or reducing the temperature difference between existing and incoming air⁶.

To exploit fully the benefits of planting around houses, care does need to be taken in the design so that wind tunnels are not directed towards the house, and that maximum solar gain is retained in winter⁷. Winter thermal gains are most significant in cooler (northern) parts of the UK.

Preventing urban flooding

Urban gardens help keep our cities 'above water'. Garden plants and trees intercept intense rain, slowing runoff and so reducing the pressure on urban drains. Unlike hard surfaces, the soil in gardens naturally absorbs rainwater, reducing the risk of flooding in our towns and cities

Through the attenuation of storms and by affecting ground water recharge, gardens benefit the urban environment and help prevent flooding¹. Vegetation (especially trees) capture intense rainfall and hold rainwater temporarily within their canopy thus reducing initial flow of rainwater and easing demand on urban drains². In addition, vegetation limits flood risk by encouraging better infiltration of water into the soil, which reduces surface water flows³.

Despite these advantages, the area of hard paving in

domestic gardens is increasing, especially through the creation of patios and the paving of front gardens to reduce maintenance and provide car parking.

For example, in Leeds over a 33-year period, there was a 13 percent increase in impervious surfaces, 75 percent of which was due to paving of residential front gardens; this was linked to higher frequency and magnitude of flooding in the area⁴.

The benefits of vegetated front gardens and the risks associated with uncontrolled paving of these areas has now been recognised by the planning system in the UK; since October 2008 a planning application has been required for more than 5sq m of impermeable paving⁵.

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2 Xiao Q, McPherson EG (2002) Rainfall interception by Santa Monica's municipal urban forest. *Urban Ecosystems* 6: 291–302.

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MABLEY MEADOW / CHRIS KING

Providing urban biodiversity

Domestic gardens are among Britain's key nature reserves. Urban domestic gardens of all sizes support a substantial range of wildlife. Some animal species are now more common in cities, particularly domestic gardens, than in rural areas

While gardens will never replace species-rich, semi-natural habitats, they are still a useful complement to such habitats, and increasingly provide urban residents with their only close encounters with the natural world. Furthermore, there is growing evidence that some declining species, once common in low-intensity farmland, are now more abundant in urban areas, and particularly in domestic gardens, eg common frog, song thrush and hedgehog^{6,7}.

Neither the typically small size of urban gardens nor their isolation from countryside prevent them supporting biodiversity^{1,2,3}. Small, city-centre gardens support similar invertebrate wildlife (such as worms,

insects, spiders, etc) as larger, suburban ones^{4,5}. Furthermore, there is growing evidence that some declining species, once common in low-intensity farmland, are now more abundant in urban areas, and particularly in domestic gardens, eg common frog, song thrush and hedgehog^{6,7}.

One study found that in Sheffield's domestic gardens the density of birds is six times that of the nation as a whole⁸.



RHS / CAROL SHEPPARD

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Supporting human health

Domestic gardens are a 'public health service' for our cities. Gardening eases stress and improves psychological wellbeing. Gardening encourages sustained exercise and promotes physical health

Gardening has been identified as one of the activities associated with wellbeing and enhanced physical health, particularly with regard to community garden projects.

Most studies express the benefits of natural landscapes / green spaces in terms of stress avoidance or alleviation; other psychophysiological benefits recorded have included: improved cognitive function¹; improved self-discipline²; alleviation of attention deficit disorder symptoms in children³; reduced

incidence of illness or reported illness⁴; pain relief^{5,6}; improved relaxation⁷; and coping with trauma⁸ – as well as unusual indirect effects of stress reduction such as reduced crime (ie reduced domestic violence and aggression)⁹.

Furthermore, gardeners usually have a large element of control over the design and management of gardens; this can be linked with increased self-esteem, a feeling of achievement and fulfilment of talent and skill.

Physical health benefits

associated with gardening can relate directly to improved physical fitness (eg cardiovascular health). Gardening is one of a number of pastimes that encourage greater physical activity; long-term engagement with gardening is often achieved because this physical activity becomes an outlet for creativity and self-expression¹⁰.

The intensity of physical activity, however, will vary with type of gardening activity, age and ability of participant¹¹.



RHS / JULIE HENRY & DEBBIE BRAGG

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RHS ADVISORY / LEIGH HUNT

Impervious paved areas increase flood risk

Getting the balance right

Domestic gardens must be managed responsibly to ensure they contribute to improved quality of life. There are two main areas of concern: carbon emissions and water use

Carbon emissions

Gardens absorb carbon through plant growth and release carbon in death.

Gardening can contribute indirectly to carbon emissions through the consumption of manufactured and transported horticultural goods, and through the use of power tools for gardening maintenance

The extent to which urban domestic gardens act as a carbon sink or carbon emitter is unclear and there are suggestions that overall more carbon is emitted than captured through activities related to gardens and gardening. This does depend on garden style, function and management, and there are steps that gardeners can take to reduce their carbon footprint.

Gardens, as a form of green space, represent areas of significant carbon flux. At one level they are a direct carbon sink storing small amounts of carbon in plants, particularly long-lived woody species, and to a greater extent in soils. They are also a carbon source: carbon is released as plants decompose.

The process of gardening also contributes indirectly to carbon emissions through energy consumed

in plant production and transport, manufacture of chemicals and equipment, and consumption of energy in garden maintenance. Activities closely associated with the garden also have an impact on carbon release (use of plastics, greenhouses, peat, fencing and garden furniture, barbecue equipment, etc). Perhaps most problematic are lawns which, due to their intensive management (fertilisers, powered lawnmowing, etc), are carbon costly^{1,2}.

However, some carbon is stored in garden trees³. In addition, soils are the largest reservoirs of terrestrial carbon, and soils in lower-density residential urban areas, which contain more gardens, store over 40 percent more carbon than soils in areas of commercial land use⁴.

Water use

To enable plants and trees to perform their cooling effect in times of high urban temperature, water is essential. **Garden water use is predicted to rise as the effects of climate change are felt and as domestic housing stock grows, but water is likely to become more scarce as temperatures rise**

The volume of water used in gardens is strongly dependent on climate, weather, soil type, style of garden, and lifestyle choices and attitudes. There are no recent data available on garden water use in the UK; the last UK Government report was published 15 years ago⁵.

Available estimates suggest that the proportion of household water used in gardens will rise to almost nine percent in 2021. This calculation only considered the rise in housing stock and growing interest in gardening, but not any climate change effects⁵. Data from warmer

regions of the world (Mediterranean, Australia) suggest that, as temperature increases, the proportion of household water used in the garden can increase to more than 30 percent^{6,7}.

Watering, though, has a significant role, not just in maintaining the garden, but also in maintaining the cooling effects of planting in urban areas, and reduction of summertime air temperatures in cities. Currently, in times of drought, watering of urban vegetation including gardens is significantly reduced or fully ceases.



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Conclusions

This RHS Science Review summarises evidence, drawn from published scientific research from around the world, of the contribution gardens and gardening make to the urban environment. **The breadth of the information examined has made it possible, for the first time, to provide evidence-based conclusions about the benefits of domestic gardens for the urban environment and human wellbeing**

Key findings from the review

Beneficial effects

- Urban garden plants and trees help cool the air in our towns and cities, combating dangerous temperatures caused by heat waves.
- Trees and hedges can bring heating costs and energy consumption down in winter by providing shelter and insulation.
- Garden plants and trees intercept intense rain, slowing runoff and so reducing the pressure on urban drains.
- Unlike hard surfaces, the soil in gardens naturally absorbs rainwater, reducing the risk of flooding in our towns and cities.
- Urban domestic gardens of all sizes support a substantial range of wildlife.
- Some animal species are now more common in cities, and particularly domestic gardens, than in rural areas.
- Gardening eases stress and improves psychological wellbeing.
- Gardening encourages sustained exercise and promotes physical health.
- Gardens absorb carbon through plant growth and release carbon in death.

Room for improvement

- Gardening does have some potentially negative environmental impacts and we need to strike the correct balance in the way we garden. The issues to be aware of are:
- gardening can contribute indirectly to carbon emissions through the consumption of manufactured and transported horticultural goods and the use of power tools;
 - garden water use is predicted to rise over the coming years, but water is likely to become a more scarce resource.

These issues, however, can be overcome or minimised by using sustainable practices (eg choosing locally sourced and perennial plants to mitigate carbon issues, planting in spring and autumn when more water is naturally available, etc).



Recommendations

The findings highlight three areas where change or further work is needed.

- 1 We should all place greater emphasis on protecting and enhancing gardens and green space in our cities for the benefit of the environment and future generations.
- 2 Scientific research institutes should build and share expert knowledge of practices that will maximise the positive impact of gardens and gardening, with particular focus on:
 - the identification of which trees and other plants are most suited to providing the optimum cooling effect with minimum water use in domestic gardens;
 - determining the thermal insulating properties of a wide range of plants appropriate for use in domestic gardens;
 - understanding the best plant combinations to encourage a wide range of garden biodiversity.
- 3 Education and training organisations should safeguard and develop horticultural skills to ensure growth in gardening in urban areas by individuals, schoolchildren and community groups.

Ten tips for domestic gardeners

While one person may only have a small garden, when a street's-worth is added together, the amount of green space we look after really adds up. **In fact, our gardens account for about 25 percent of the land in most cities.** And because more than 80 percent of the UK population lives in a town or city, we can make a difference by ensuring that every available space in our front and back garden contains planting, and that we carry out sustainable practices

- 1** Plant a tree to provide shade and evapotranspiration, to help cool the air in summer. Fast-growing, deciduous trees that require little maintenance also provide maximum benefits in terms of carbon capture.
- 2** Plant a climber or hedge to provide shade and insulation for your house.
- 3** Minimise/avoid paving over large areas of your garden, and consider replacing existing impermeable paved areas with permeable surfaces, including vegetation.
- 4** Plant a variety of plant types and species to support a range of wildlife, eg a mix of trees, shrubs and flowering plants.
- 5** Grow perennial plants over large areas. As these grow in the same place year after year they
- 6** Consider reducing the area of lawn in your garden, replacing it with other permanent planting.
- 7** When renewing garden equipment bear in mind its energy and carbon efficiency.
- 8** Make compost and mulch, covering garden soil with organic matter such as bark to prevent evaporation of water.
- 9** Collect rainwater and use 'grey water' (previously used for washing dishes, baths etc and suitable for small scale, short-term use).
- 10** Think 'right plant, right place' to minimise water use and maximise energy saving and energy capture.

For more information please visit www.rhs.org.uk/urbangreening or email: gardeningadvice@rhs.org.uk

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