Ecological benefits of urban green infrastructure

Introduction

Nearly all urban green infrastructure has some benefit to biodiversity. Developments can and should incorporate elements suitable for wildlife: in addition to birds and plants, mammals, insects, fungi and fish can all benefit from well-designed green infrastructure. Even patches too small to support breeding populations can be used as permeable habitat for movement or to provide a resource such as nectar. The amount of benefit created relates mostly to the provision of different habitats and the quality of those habitats.

Provision of green infrastructure in urban areas can help meet targets for UKBAP priority habitat ('Open Mosaic Habitat On Previously Developed Land'), broader habitats such as native woodland, and UKBAP priority species.

Increased opportunities for species movement are considered a key adaptation to climate change for UK biodiversity. The creation of ecological networks is advocated as a key adaptation to climate change in both policy and scientific literature.

Benefits

Benefits include increased habitat area and diversity, increased populations of rare or protected species and habitats, and increased opportunities for species for longer-distance movement.

Evidence linked to increasing biodiversity

- The green space patches of Birmingham contain thousands of plant and carabid species (NERC URGENT project). The bigger the patch the more plant species it holds, whereas for some species such as ground beetles habitat quality is more important (Angold *et al.*, 2006).

- In total 561 individuals of 71 arboreal species and 579 individuals of 43 grassland species of Hemiptera ('true bugs') were recorded from just 18 roundabouts in Bracknell, Berkshire. The majority of species were found on bigger roundabouts, roundabouts with more naturalistic grass regimes, and roundabouts with native shrubs and trees on them (Helden and Leather, 2004).

- In a range of bird-based case studies across Europe, most 10-35 ha parks contain all the birds recorded in any urban area of that region (Fernández-Juricic and Jokimäki, 2001).

- Road verges support a wide variety of plants and insects, especially if they are not too intensively mown and have suitable trees planted on them (Whitmore *et al.*, 2002).

- A survey of 3980 people (largely readers of *Gardeners' World* magazine or members of the Mammal Society) found that urban mammal occurrences in gardens increase with the availability of nearby green infrastructure. Grey squirrels and mice were most frequently reported by respondents but bats and hedgehogs were also noted (Baker and Harris, 2007).

- Birds and a wide range of invertebrates, including beetles, ants, bugs, flies, bees, spiders and leafhoppers, have all been recorded using green roofs (from a range of studies reviewed by Oberndorfer *et al.*, 2007). Large numbers of collembolans, an important group of invertebrates for soil carbon cycling, also favour green roofs (Schrader and Bonning, 2006).

- Fifteen UKBAP priority invertebrate species have been recorded in 'artificial' habitats and 12-15% of rare or scarce UK invertebrate species have been recorded on brownfield sites. That number was expected to rise with additional recording effort (Gibson, 1998).

- Two systematic reviews have found clear indications that urban habitats, with their strong dissimilarity to semi-natural habitats in terms of microclimate, structure and resources, are less permeable to species movement (Prugh *et al.*, 2009; Eycott *et al.*, 2008). There is a broad range of evidence (not yet subjected to meta-analysis) that UK species benefit particularly from linear features and wildlife underpasses (Eycott *et al.*, 2008).

Practical considerations

Two of the most immediate ways of improving urban green space for biodiversity are to change the management of close-mown amenity grass and to encourage wildlife-friendly gardening (Mitchell *et al.*, 2007).

CABESpace recommend that 'maintenance contractors and client officers need …to look anew at the vegetation they manage as habitats for biodiversity'.

The Town and Country Planning Association recommend considering increasing plot ratios to leave a greater amount of communal green infrastructure and connective linear elements. This has to be done in consideration of the local heritage and character.

Links to climate change

Researchers modelling the movement of the climatic conditions to which species are adapted have suggested a species may need to move north and west to keep track of their 'climate space'. Even species which do not move far may need to move to a new habitat with a more suitable microclimate (Davies *et al.*, 2006). This move is likely to occur over several generations, and urban green infrastructure may provide 'stepping stones' of habitat and greater permeability of urban areas between habitat patches.

Some of the impacts of urbanisation (elevated temperatures and increased surface runoff) reflect the changes predicted for wider areas by some climate models (Wilby and Perry, 2006). The ameliorating impacts of green infrastructure on temperature should take some of the immediate temperature pressure off thermally-sensitive species.

Freshwater species face particular pressure from the combination of climate change and urban impacts on habitat, which can both serve to elevate temperatures, affect flows through impacts of runoff on hydrological regimes and affect biological and chemical water quality. Green 'buffer zones' along rivers can be used to mitigate all of the above impacts, improving habitat quality for fish and invertebrate species (Wilby and Perry, 2006).

Tools

Urban Greenspace toolkit
The Urban Greenspace toolkit issued by the Wildlife Trusts is a 'how to' document aimed at groups trying to create and improve local green space (Calvert *et al.*, 2007). It contains information in colour-coded sections on objectives and evaluation, creating community groups, partnership working, land management and dealing with problems, and finally funding. It contains snippets of case studies clearly referred back to sources.

Case studies

Increasing habitat: Sheffield Estates meadowland

Increased habitat: River Quaggy, Lewisham

Protected species: the Ham lizard hibernacula, Lowestoft

Benefits beyond individual elements: Broadhurst Clough, Moston, Manchester

Project Habitat on the upper tidal Thames and tributaries

Increased species movement: Glasgow Clyde Valley: Integrated Habitat Network

Increased species movement: Chattanooga Greenways, Tennessee, USA

Knowledge gaps

The past five years have seen a rise in the number of publications on urban ecology. The greatest remaining gap in knowledge of the ecological benefits of urban green infrastructure relates to 'permeability', i.e. how easily a species moves through the habitat. General patterns of the benefit of increased habitat permeability cannot be extrapolated to predict individual species' behavioural responses to specific changes in landscapes.

In a similar manner, general patterns of response to climate change cannot necessarily be extrapolated between species. This problem is compounded by the uncertainty that remains in climate models' specific predictions for particular locations, timescales and climate variables such as precipitation (IPCC, 2007).

Citations of national policies/priorities

Defra (2007). Guidance for local authorities on implementing the biodiversity duty
http://www.defra.gov.uk/environment/biodiversity/documents/la-guid-english.pdf

Defra (2007). A strategy for England's trees, woods and forests
http://www.defra.gov.uk/rural/documents/forestry/20070620-forestry.pdf

Defra (2007). Your region, your nature
http://www.defra.gov.uk/environment/biodiversity/documents/20060810YourRegion.pdf

Office of the Deputy Prime Minister (2002). Planning policy guidance 17: planning for open space, sport and recreation
http://www.communities.gov.uk/publications/planningandbuilding/planningpolicyguidance17

Communities and local government (2010). 'Planning for a natural and healthy environment'
http://www.communities.gov.uk/documents/planningandbuilding/pdf/1498981.pdf

UK Biodiversity Partnership (2007). Conserving biodiversity - the UK approach
http://www.ukbap.org.uk/library/UKSC/DEF-PB12772-ConBio-UK.pdf

References

Angold, P.G., Sadler, J.P., Hill, M.O., Pullin, A., Rushton, S., Austin, K., Small, E., Wood, B., Wadsworth, R., Sanderson, R. and Thompson, K. (2006). Biodiversity in urban habitat patches. *Science of the Total Environment* **360** (1–3), 196–204.

Baker, P.J. and Harris, S. (2007). 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), 297–315.

CABESpace (2006). *Making contracts work for wildlife: how to encourage biodiversity in urban parks.* CABE, London.

Calvert, C., McPherson, S. and Dall, J. (2007). *Connecting communities, neighbourhoods and nature: a toolkit.* The Wildlife Trusts, Newark.

Davies, Z.G., Wilson, R.J., Coles, S. and Thomas, C.D. (2006). Changing habitat associations of a thermally constrained species, the silver-spotted skipper butterfly, in response to climate warming. *Journal of Animal Ecology* **75** (1), 247–256.

Eycott, A., Watts, K., Brandt, G., Buyung-Ali, L., Bowler, D., Stewart, G. and Pullin, A. (2008). *Which landscape features affect species movement? A systematic review in the context of climate change*. Forest Research report for Defra. Forest Research, Farnham.

Fernández-Juricic, E. and Jokimäki, J. (2001). A habitat island approach to conserving birds in urban landscapes: case studies from southern and northern Europe. *Biodiversity and Conservation* **10**, 2023–2043.

GHK Consulting (2009). *UK Biodiversity Action Plan: preparing costings for Species and Habitat Action Plans*. Updating estimates of current and future BAP expenditures in the UK. Final report to Defra and partners.

https://statistics.defra.gov.uk/esg/reports/bioactionplan/BAP%20Funding%20Report%20-%20Final%20V2.pdf. Accessed 19th February 2009:

Gibson, C.W.D. (1998). *Brownfield: red data. The values artificial habitats have for uncommon invertebrates*. ENRR 273. English Nature, Peterborough.

Helden, A.J. and Leather, S.R. (2004). Biodiversity on urban roundabouts - Hemiptera, management and the species-area relationship. *Basic and Applied Ecology* **5**, 367–377.

IPCC (2007). *Climate change 2007: synthesis report*. Contribution of working groups I, II and III to the fourth assessment report of the Intergovernmental Panel on Climate Change. Geneva, Switzerland, 104.

Mitchell, R.J., Morecroft, M.D., Acreman, M., Crick, H.Q.P., Frost, M., Harley, M., Maclean, I.M.D., Mountford, O., Piper, J., Pontier, H., Rehfisch, M.M., Ross, L.C., Smithers, R.J., Stott, A., Walmsley, C.A., Watts, O. and Wilson, E. (2007). *England biodiversity strategy - towards adaptation to climate change*. Final report to Defra, London.

Niemela, J. and Kotze, D.J. (2009). Carabid beetle assemblages along urban to rural gradients: a review. *Landscape and Urban Planning* **92** (2), 65–71.

Oberndorfer, E., Lundholm, J., Bass, B., Coffman, R.R., Doshi, H., Dunnett, N., Gaffin, S., Koehler, M., Liu, K.K.Y. and Rowe, B. (2007). Green roofs as urban ecosystems: ecological structures, functions, and services. *Bioscience* **57** (10), 823–833.

Prugh, L.R., Hodges, K.E., Sinclair, A.R.E. and Brashares, J.S. (2008). Effect of habitat area and isolation on fragmented animal populations. *Proceedings of the National Academy of Sciences of the USA* **105** (52), 20770–20775.

Saarinen, K., Valtonen, A., Jantunen, J. and Saarnio, S. (2005). Butterflies and diurnal moths along road verges: does road type affect diversity and abundance? *Biological Conservation* **123** (3), 403–412.

Schrader, S. and Boning, M. (2006). Soil formation on green roofs and its contribution to urban biodiversity with emphasis on Collembolans. *Pedobiologia* **50** (4), 347–356.

Whitmore, C., Crouch, T.E. and Slotow, R.H. (2002). Conservation of biodiversity in urban environments: invertebrates on structurally enhanced road islands. *African Entomology* **10**, 113–126.

Wilby, R.L. and Perry, G.L.W. (2006). Climate change, biodiversity and the urban environment: a critical review based on London, UK. *Progress in Physical Geography* **30** (1), 73–98.