Institution: University of Sheffield

Unit of Assessment: 7 – Earth Systems and Environmental Sciences

Title of case study: Biodiversity in Urban Gardens (BUGS) – understanding nature in the garden

1. Summary of the impact

The BUGS research project (1999–2007) at Sheffield was the first large-scale study to reveal the importance of domestic gardens for urban biodiversity. The evidence gathered showed, for the first time, that the extent of gardens, their unique features, and the biodiversity they support makes them a nationally important ecological resource, contributing enormously to conservation and human–nature interactions in urban environments. The results were reported in a series of 13 ISI-listed papers, a popular book and two articles in *British Wildlife*. The research has had impacts across many audiences and applications ranging from evidence for planning policy changes, through the science to support advisory and campaign groups, to informing public awareness of the merits of individual garden management practices. BUGS research has been a key catalyst in the increased recognition of the importance of gardens in supporting urban biodiversity.

2. Underpinning research

The Department of Animal & Plant Sciences at the University of Sheffield has a strong record of research into the processes underpinning biodiversity at the local, landscape and global scales. The BUGS project was an application of this expertise to urban ecology, and specifically a neglected topic: the role of domestic gardens in the maintenance of urban biodiversity. The project was conceived by Prof Kevin Gaston, Prof Philip Warren and Dr Ken Thompson, and funded by the NERC Urban Regeneration and Environment (URGENT) programme in 1999. The 3-year project studied urban gardens in Sheffield, and **was the first large-scale systematic scientific study of the extent and nature of the habitat provided by gardens across an entire urban area, the patterns and determinants of plant and invertebrate biodiversity, and the effectiveness of widely cited advice on wildlife gardening**.

The paradigm-shifting impact of the initial findings was such that Natural England and the Countryside Council for Wales initiated a proposal to extend the project to other cities. These agencies brought in the Environment and Heritage Service (Northern Ireland), Scottish Natural Heritage, The Scotland and Northern Ireland Forum for Environmental Research and DEFRA to co-fund (without RCUK support) a second phase of BUGS, which examined the extent to which the results from Sheffield could be extended to five additional, very different, UK cities. DEFRA, in commissioning this work stated: "*The project is necessary to help underpin the policy of encouraging the use of domestic gardens as a means of increasing public awareness and involvement in the maintenance and improvement of biodiversity*." This second BUGS project lasted 3 years, finishing in 2007.

The BUGS research addressed a fundamental knowledge gap in urban ecology, providing important data on the extent and characteristics of garden habitats for the first time. For example, the project showed that gardens make up about 25% of a typical UK city [**R6**]; that small gardens are disproportionately important because of their number [**R6**]; and that because of the subdivision of gardens the cumulative numbers of habitat features such as ponds, trees, nest boxes and compost heaps are significant at the city scale [**R3**]. Analyses of biodiversity revealed that plant diversity was both vastly higher within gardens and across gardens than in any other UK habitat and, whilst non-natives are a major component of this, native species are more widespread in gardens than previously assumed [**R1**, **R4**]. Determinants of invertebrate biodiversity were complex, and related both to internal features (trees and structural complexity) and the adjacent land use [**R5**]. Results from the study challenged some widely cited ideas about garden biodiversity, such as the importance of native plants over non-natives for invertebrates, and experimental tests found that several widely advocated 'improvements' for wildlife (e.g. nesting sites created to encourage bumble bees) had limited practical effect [**R2**]. Policy and planning implications of the results were evaluated and reported in the published outputs: for example demonstrating the effects of housing densification on the loss of important, beneficial features of gardens, such as trees, with reduced garden size.

Key findings from BUGS were summarised in two publications in *British Wildlife* – a publication with a circulation of about 9000 designed to make ecological and conservation science available to a wider audience of conservation practitioners and naturalists than academic journals:

Gaston K J *et al.* (2004) Gardens and wildlife: the BUGS project. *British Wildlife* 16: 1-9.

Gaston K J *et al.* (2007) Urban domestic gardens: improving their contributions to biodiversity & ecosystem services. *British Wildlife* 18: 171-177.

3. References to the research [* = References that best indicate the quality of the research]

R1 Thompson, K, Austin, K C, Smith, R M, Warren, P H, Angold, P G, Gaston, K J (2003) Urban domestic gardens (I): putting small-scale plant diversity in context. *Journal of Vegetation Science* 14:71-78 (**80 citations** Scopus)

R2 Gaston, K J, Smith, R M, Thompson, K, Warren, P H (2005) Urban domestic gardens (II): experimental tests of methods for increasing biodiversity. *Biodiversity and Conservation* 14:395-413 doi: 10.1007/s10531-004-6066-x (**71 citations** Scopus)

R3* Gaston, K J, Warren, P H, Thompson, K, Smith, R M (2005) Urban domestic gardens (IV): the extent of the resource and its associated features. *Biodiversity and Conservation* 14:3327-3349 doi: 10.1007/s10531-004-9513-9 (**97 citations** Scopus)

R4* Smith, R M, Thompson, K, Hodgson, J G, Warren, P H, Gaston, K J (2006) Urban domestic gardens (IX): composition and richness of the vascular plant flora, and implications for native biodiversity. *Biological Conservation* 129:312-322 doi: 10.1016/j.biocon.2005.10.045 (**75 Citations** Scopus)

R5 Smith, R M, Warren, P H, Thompson, K, Gaston, K J (2006) Urban domestic gardens (VI): environmental correlates of invertebrate species richness. *Biodiversity and Conservation* 15:2415-2438 doi: 10.1007/s10531-004-5014-0 (**55 Citations** Scopus)

R6* Loram, A, Tratalos, J, Warren, P H, Gaston, K J (2007) Urban domestic gardens (X): the extent & structure of the resource in five major cities. *Landscape Ecology* 22:601-615 doi: 10.1007/s10980-006-9051-9 (**57 Citations** Scopus)

4. Details of the impact

The research has had impacts on a wide range of audiences: from UK Parliament, local authorities, non-governmental organisations, wildlife and gardening organisations, charities, gardeners and members of the public. The research findings have been used in many contexts from advisory publications and reports, to planning applications and campaigns. It is notable that in many of the situations where it is used in evidence, the BUGS project is the only primary scientific research cited, reflecting its unique role as the first and only large-scale study of its kind to date.

The BUGS project provided evidence for: (i) the magnitude and importance of gardens as a habitat in urban areas [**R3, R6**]; (ii) the high biodiversity in gardens, which were historically considered as 'ecological deserts', [**R1**, **R4-R5**] and (iii) the features that make a garden good for wildlife [**R2**]. This evidence has been cited as evidence for policy positions in a range of contexts, as illustrated below.

Policy, Planning & Practice

One of the BUGS project leaders, Kevin Gaston, was a lead author in the chapter of the UK *National Millennium Ecosystem Assessment* Technical Report on Urban systems, and BUGS publications are used in evidence in the section on gardens.

BUGS research was used in evidence to Parliament: The Royal Horticultural Society, in a written memorandum to the Parliamentary Select Committee on Environmental Audit (2008), used results from BUGS papers to support the evidence it was submitting [**S1**]. Two of the six papers they cite in their evidence (the only two scientific papers) are from the BUGS project [**R3, R4**].

The Local Biodiversity Action Plans developed by Local Authorities, in partnership with relevant organisations, which identify local priorities for biodiversity conservation and work to deliver agreed actions for priority habitats and species, often cite the BUGS project as evidence of the importance of gardens and their management for biodiversity (e.g., Kensington & Chelsea (2010), Norfolk Biodiversity Partnership - Allotments, (2012); London Biodiversity Partnership – Private Gardens (2008); Tees Valley Biodiversity Partnership – Gardens and Allotments (2012); Edinburgh Biodiversity in Parks and Green Spaces (undated)) [**S2**]. This demonstrates direct practical application to local conservation planning. The project has also been used as supporting evidence in planning and ecological impact/mitigation documents (e.g. biodiversity management plans [**S3**] and local planning applications [**S4**]).

The BUGS project has also had direct influences on the thinking that underpins the design and implementation of urban landscape planting. The high-profile planting of the 2012 Olympic Park in London – featured widely in the media – drew on BUGS science:

> *We've based our design and species choices on scientific research. Evidence for the value of urban gardens and native/exotic vegetation mixes to native invertebrates has come from projects like Biodiversity in Urban Gardens (BUGS), which investigated the variety of living things that city gardens support, and the complex relationships between them.* [**S5**]

This use of the BUGS project work is recorded as a noteworthy impact of NERC science in NERC's 2012 Impact Report [**S5**].

Reaching a public audience

The BUGS research is relevant to multiple audiences, with one of those being the public, and gardeners specifically. Consequently, impact is likely to be through sometimes small, but widespread, changes in the garden management practices of individuals. Accessible publication of the results is key to this impact. The results provided the scientific basis of a very successful popular science book (18,500 copies sold) written by Dr Ken Thompson, one of the project leaders (now retired):

> Thompson K (2006) *No Nettles Required: the truth about wildlife gardening*. Eden Project Books. *This cheerful hand grenade of a book debunks the myth that wildlife gardening needs large gardens, native species and beds of stinging nettles ... Fantastic science writing for a lay audience...* (New Scientist 2006).

The BUGS project website (www.bugs.group.shef.ac.uk) has been active since the first phase of the project, and consistently receives ***400–700 visits per month***, with links coming from websites as diverse as the Royal Horticultural Society (RHS), BBC, Wildlife Trusts, wildlife discussion forums and gardening blogs. ***Approximately half the visits are from outside the UK, showing its strong international reach***.

Reference to the project, and the website as a source of information on the science behind wildlife gardening, occur in a number of popular wildlife gardening books: e.g. *Collins Wildlife Gardener*, Stephan Buczacki (2007), *RSPB Gardening for Wildlife* Adrian Thomas (2010). To quote from the introduction to the latter:

> *… in 1982 the RSPB produced a book called Gardening for Wildlife. So why another one now? Well the science has been moving forwards, including pioneering work by the Biodiversity in Urban Gardens (BUGS) project in Sheffield. There are more ideas now than ever to get your teeth into…*

All these provide evidence of the effective dissemination of the results to those likely to make actual practical changes to their garden management practice in the UK and overseas. Impacts of this sort are small individually, but collectively very important.

Advice and advocacy

The results from the BUGS project played a significant role in the development of advice on, and promotion of, the value of gardens for biodiversity on the websites, and activities of the statutory bodies involved in the project, and a range of other organisations (such as the RHS and Wildlife Trusts, e.g. [**S6**]).

Subsequent initiatives to develop and influence gardening practice acknowledge the key role that the project played, e.g., the Royal Horticultural Society's Plants for Bugs project:

> *The Sheffield BUGS project was instrumental (an essential precursor) both in inspiring and in the practice of the RHS Plants for Bugs (P4B) project – have a look at the project page for P4B – BUGS papers cited several times. The BUGS project – in combination with Jennifer Owens' 30-year study – have clearly shown the value that gardens have for wildlife.* [**S7**]

The second of the *British Wildlife* articles was co-written by the project investigators and the representatives of the key agencies involved, and the ideas from BUGS summarised in that article fed directly into the development of the Wildlife Garden Manifesto [**S8**,**S10**], produced by the Wildlife Gardening Forum, coordinated by Natural England (discussed further below).

In addition to the statutory agencies, individual campaigns, for example concerned with preventing the loss of gardens to development, also make use of evidence from the project [**S9**].

Overall impact

As the examples above demonstrate, BUGS has had, and continues to have, significant impacts on advice, policy and practice. These are perhaps best summarised in some quotations from an appraisal of BUGS from the Head of the Wildlife Gardening Forum (WLGF) [**S10**]:

> *… there is increasing recognition that gardens are the most biodiverse part of urban Green Infrastructure. Most of the credit for this lies with the exemplary detailed work of the two BUGS campaigns, which has provided the statistically sound evidence base that we are now using to convince decision makers such as planners and local and national government.*
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> *Evidence from BUGS moulded the WLGF's Manifesto, which was adopted by Natural England and DEFRA, and launched in July 2007 by Sir Martin Doughty, Chair of Natural England, supported by Joan Ruddock, Minister for Biodiversity. Subsequently the WLGF has submitted BUGS-generated evidence to a number of Government consultations, including the White Paper "The Natural Choice: securing the value of nature"* [2011] *which extensively referenced the importance of garden habitats, and led to the Government providing public funding for the "Big Wildlife Garden" scheme now managed by the Royal Horticultural Society and The Wildlife Trusts.*
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> *Following submissions by the WLGF and its members, we were delighted that the 2012 publication of the NPPF* [National Planning Policy Framework] *did reinstate considerable recognition and protection for the garden environment. This would never have been possible without the sound evidence base that the BUGS projects created.*
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> *In summary, the work of the Biodiversity in Urban Gardens studies has revolutionised the ecological understanding of what we now recognise as a key urban habitat, and this is reflected not only in action by conservation agencies, but by national and local government, and increasingly by studies in other countries. There can be few studies which can have practically single-handedly created a new ecological discipline, but this is certainly true of BUGS.*

5. Sources to corroborate the impact

S1 Royal Horticultural Society submission to the UK Government Select Committee on Environmental Audit (2008) (http://tinyurl.com/laa7sdb)

S2 London Biodiversity Partnership (2008) Habitat Action Plan: Private Gardens. (http://tinyurl.com/mlt2oq8) (NB this is a specific example from the list of examples given: the others are publicly available also).

S3 FPCR Environment and Design Ltd (2013) Biodiversity Management Plan for Shipley Lakeside. (http://tinyurl.com/nfrzwpo)

S4 London Conservation Services (2011) 123 Grove Park, Southwark: ecological assessment and critique. (http://tinyurl.com/oa6atvm)

S5 NERC *Planet Earth* (2012) Parklife. Dunnett, N & Hitchmough J. (http://tinyurl.com/nrm5etc)

(Planet Earth is the magazine published by NERC to publicise NERC Science of particular public interest – articles are solicited by NERC).

S6 Sussex Wildlife Trust website – information and advice pages on wildlife gardening (http://tinyurl.com/odxcuyk)

S7 Senior Entomologist, Royal Horticultural Society [Letter on file]

S8 Wildlife Gardening Forum: *A manifesto for gardens, people & nature* (http://tinyurl.com/qqqnymz).

S9 Garden Organic website (2012) Seven reasons against Garden Grabbing. (http://tinyurl.com/of8xmbk).

S10 Coordinator and Chief Executive of the *Wildlife Gardening Forum*. The WLGF was set up in 2005 by English Nature (Natural England) to increase communication between organisations and agencies concerned with promoting the role of gardens for wildlife. The Forum now has 480 members, representing over 200 organisations, and has become an independent small charity. [Letter on file].