CHAPTER 7

TITLE: Ecological value of Urban Environments

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7.1 Introduction

Urban environments are an increasing proportion of the Earth's habitats and will undoubtedly have greater influence on future ecosystems. Ecologists working within these areas agree that not only are urban environments important because they may hold populations of interesting and sometimes characteristic flora and fauna but also because they are inherently distinctive (Harrison *et al*., 1987; Duguay *et al*., 2007). Urban environments exhibit combinations of environmental characteristics unusual elsewhere and often present environmental conditions analogous to those anticipated for climate change scenarios (Wildby and Perry, 2006) resulting in peculiar and unique species and habitat associations, and communities (Goode, 1989). Specifically, these are:

- A characteristic climate that buffers the environment from extremes (Catterall *et al*., 1998);
- Direct or indirect disturbances resulting from human activity (Rebele, 1994);
- Extreme subdivision and isolation of habitats (Dickman, 1987) leading to an intimate mosaic of differing site sizes (Young *et al*., 2008);
- Many transient habitats (Hansson and Angelstam, 1991);
- Habitats exhibiting extreme environmental conditions (e.g. devoid of vegetation) (Rebele, 1994);
- Availability of a varied or particularly rich food supply (Catterall *et al*., 1998);
- Extreme interventionist management (Young *et al*., 2008).

7.2 Ecological value

The natural environment provides people with goods and services that are fundamental to human wellbeing (DEFRA 2007). Probably the most direct benefits of nature for people concern health. Exposure to natural scenes reduces stress (Ulrich *et al*., 1991) while contact with even very small green spaces in cities leads to improvement in children's abilities to pay attention, delay gratification, and manage impulses (Faber Taylor *et al.,* 1998; Kuo, 2001). In addition to these "cultural services", there are also "regulating services" such as climate regulation, water purification and flood protection, which are provided by semi-natural vegetation (Wentworth, 2006).

The principal organisms in the urban environment are people, and the study of urban ecology is largely the study of anthropogenic influences. However, botanical recording in the urban area readily demonstrates high plant species-richness per unit area, quite comparable with countryside levels (Table 1). Some of this is undoubtedly due to the presence of large numbers of relatively small anthropogenic biotopes, each with its own set of characteristic species. A vast rural forest might include more species than a tiny urban copse, but alongside the latter there might well be canals, lawns, car parks, rubbish dumps, road verges, graveyards and umpteen idiosyncratic gardens all in the equivalent area. Apart from the opportunities given for plant colonisation and survival, the structural complexity also increases the habitat niches available for all kinds of organisms.

Many animals are adapted to urban environments exploiting the full range of biotopes available and utilising the structural complexity they offer. Few are solely reliant upon urban areas, though some have strong associations, e.g. Black Redstart in the UK (BBCBAP, 2000), but many exploit urban niches leading to important populations of some species. Due to the variability in the nature of resources in urban environments the most successful species tend to be generalists who are flexible in their life-history requirements and are able to adapt to the unusual spatial and temporal distributions of food resources. The ability of urban areas to support these species leads to some being found in greater densities than would otherwise be possible (e.g. foxes/badgers) (Dickman, 1987). However, for some species their urban success is down to the fact there are direct analogues of their natural habitats present (Szacki *et al*., 1994; Rossi and Kuitenen, 1996). For example, brownfield sites provide ideal conditions for many invertebrates that rely on open ground and early successional stages in their life cycles (Eversham *et al*., 1996). Some of the more charismatic species that exploit these opportunities are raptors, such as peregrines and kestrels (Pomerol, 1996), which nest on buildings using them in the same way as they would use natural cliff-faces.

Modern urban improvement schemes tend to sweep away this complexity and replace it with vast warehouse cities or neat neo-suburbias. Such is the intricacy of city life that the pattern might re-establish itself eventually, but we should try to make landscape architects (and maybe architects and designers of roads) consider how to engineer a slightly more environmental complexity into their new worlds. Wildlife can live successfully alongside people in those instances, where their needs do not cause conflict, can be accommodated or can be managed. Not only do these situations ensure the wider viability of wildlife, but it is these kinds of direct encounters with animals that gives an extra dimension to urban living and often provides an introduction to the natural world to urban residents.

7.3 Urban Habitats

Urban environments, globally, contain the full range of ecological habitats (with the possible exception of true wildland) and, as such, the generic problems of climate change such as sea-level rise and changing weather patterns may well have profound impacts on many of these (Wildby and

Perry, 2006). There are a range of habitats that are, however, widely-found or else have particular resonance in an urban context and we deal explicitly with these below.

7.3.1 Semi-Natural Habitats

Individual species-rich habitats do occur in urban landscapes. There are many urban examples of classical semi-natural vegetation (fondly known as "*trapped countryside*") and they are at least as difficult to conserve as rural examples. The advantages in protecting these sites include the fact that well-tested criteria for designation can be used. Once designated, urban planners are usually quite good at giving protection to such sites, even second and third tier conservation sites. The main problems, as in the countryside, are the usual twin evils of intensification and neglect. Although agricultural intensification is often less of a problem than in the countryside, pressures for development are more likely, and even excessive public interest (nature for *too many* people, most of whom are more interested in cycling, dog walking, jogging, amongst others) can be very damaging. On the other hand neglect, leading to succession – loss of fences, no grazing, desultory cutting, emotive issues with cutting down any trees whatsoever, fly tipping amongst others, can be even commoner than in the countryside.

7.3.2 Created Habitats

Creative conservation sites are probably special cases of the above. Some believe imitation hay meadows and ancient woodlands are inappropriate in the urban context, but they are not really any more artificial than flower beds or mown lawns and they do (sometimes) have the advantage of supporting a wider range of species and (occasionally) of looking quite attractive (Trueman and Millett, 2003). Whatever the merits, the issue is usually again how to provide long-term management, although there is, potentially, a very large issue about "officious" habitat creation in inappropriate sites. Like every other kind of development, habitat creation requires detailed prior site assessment for existing nature conservation value. For instance, the hybrid created habitats, with mixed natives and ornamentals, of the Dutch Heemparks and what are possibly their descendants from the Sheffield Landscape School (Dunnett, 1999), must surely present particular problems of management despite their often striking beauty. It is reported the Heemparks are very expensive to manage, especially in terms of labour.

7.3.3 Brownfield and Early-Successional Habitats

At the other extreme to the created and semi-natural classical habitats are those habitats resulting from the natural processes of invasion and succession after site demolition and clearance, which can be such a feature of the urban landscape. Although these are commonly termed ‘brownfield sites’ they often have complex origins and interesting and diverse communities as a result. Gilbert (1989) made the case for these *spontaneous successional communities* to be allowed to go through the early stages without hindrance. Beyond the obvious need to prevent premature landscaping of such sites and to protect them from abuse, conservation is probably a landscape issue. Long term survival of the species of these early successional communities probably does not depend on the conservation of the individual site, which would be futile anyway without programmes of repeated disturbance. The crucial factor must be the presence at any one time of sufficient examples of such sites within the conurbation, which can together regenerate the landscape seed bank for the next generation of examples. Ruderals with their abundant seed production, non-specific seed dispersal and long-lived seed banks would seem to be well adapted for survival under these conditions, but how important is connectivity between sites in the urban landscape? It stands to reason it is important (Dawson, 1994), but the urgent investigations (Austin and Angold, 2000) could not demonstrate any positive effect of the proximity of key linear features – canals, railways and rivers – on site plant assemblages. One problem may actually be recognising a corridor when you see one. Private gardens are perhaps part of connectivity and also examples of seed-generating foci. Also, allotments and other examples of frequent cultivation need to be included in the assessment.

The conservation of woodland, which arises through these processes of succession, also needs to be addressed. Such sites require an unusual length of time to elapse before they mature and they are, therefore, uncommon. They usually include an array of native and alien species and, therefore, cannot be easily matched with the National Vegetation Classification. They are often unscheduled, unprotected and require further study.

7.3.4 Post-Industrial Sites

Somewhere in between the classical sites and the successional sites are what are possibly the most characteristic urban sites. Anyone who has undertaken urban botanical recording, in particular, would recognise them. Often rich in species, with regionally or even nationally scarce species often present, the vegetation is typically unusual and possibly recombinant (Barker, 2000) without any exact model in the countryside. The conditions are often such that succession is proceeding sufficiently slowly for "quality" assemblages to develop and, therefore, also for the feasibility of conserving the individual site to be contemplated. In the UK West Midlands, these develop particularly on industrial waste, but also in quarries and on railway lines. Some old post-industrial sites have long been celebrated for their floristic richness (Davis, 1976; Greenwood and Gemmell, 1978) and a few are managed as nature reserves, but all conurbations include both large and small examples (Trueman *et al.,* 2001).

Urban-specific site-context evaluations of such sites directly comparing them using identical criteria to adjacent urban patches have helped to confirm their relative merits. Using a contextual landscape evaluation method that takes a suite of criteria and applies them equally across the landscape (Young and Jarvis, 2001a), post-industrial habitats within sites, such as Ladymoor Pools in Bilston, show up as being of equivalent, or superior 'value' to adjacent more characteristically 'worthy' grassland, woodland and open water areas (Figure 1).

What facilitates the development of interest? Repeated or even continuous disturbance may play a part. Stress such as nutrient poverty, drought, phytotoxicity, and mineral imbalance is clearly crucial in allowing large numbers of species to coexist indefinitely. Most of these controlling factors are subject to amelioration by succession but the process is often very slow because conditions are extreme. This impedance of succession is probably at the root of their ecological interest.

7.3.5 Garden Habitats

Garden evaluation is another important developing topic particularly relevant to the maintenance of a rich urban environment. Gardens are a significant proportion of the urban fabric (19-27%) and constitute a significant area of extensive interconnected greenspace (Mathieu *et al*., 2007; Smith *et al*., 2005). Possibly a nationally or internationally accepted classification of garden vegetation and garden types needs to be developed to aid this assessment and to give a fuller picture of the diversity and, therefore, greater insight into their true ecological value. A recent attempt at gaining an understanding of this diversity has been undertaken by the Sheffield-based Biodiversity of Urban Gardens project (Thompson *et al*., 2003 *et seq*.). Their findings corroborate the single-garden study by the Owens who monitored the ecology of their Leicester garden over an extended period and found significant numbers of many different groups represented (Owen, 1991). As an illustration, on the basis of the Ichneumon wasps alone, their garden should have been a Site of Special Scientific Interest (SSSI).

On a small scale what happens in gardens reflects the kinds of changes happening in the wider urban landscape, with constant turnover of species, extreme management, successional changes and all year round food availability, amongst others. As such gardens can be a resource in and of themselves for some groups, such as birds (Chamberlain *et al*., 2004), but they also provide linking greenspace permitting movement for other wildlife across the urban fabric, e.g. butterflies (Young, 2008). Significantly, the totality of urban gardens provides added value where they abut or are near to conventional conservation-worthy sites and, therefore, extends the influence of these sites beyond the constraints of their physical and administrative boundaries (Goddard *et al*., 2010).

Indeed, urban areas are often thought of as ecological deserts, yet this is far from the case as the intricate mix of gardens, conventional greenspace, semi-natural habitats and successional communities on brownfield sites contributes significant ecological variability even before the more hostile bits in between these areas are addressed. From a climate change perspective the role of gardens as refugia for species, with the added potential to buffer threats and provide ecosystem services is important and adds significantly to the wider value of urban greenspaces.

7.4 Landscape Scales and urban areas

From a landscape perspective, urban areas have a particular character that has significant impacts on the ecology of individual habitats, sites and areas that makes them distinctive (Young *et al*., 2008):

- Patch sizes tend to be smaller on average than non-urban areas;
- Patches are highly fragmented with obvious (and often characteristic) linear ‘corridors’;
- Boundaries are sharp with contrasting patch types next to each other.

Current trends to conserve wildlife in urban areas are developing very much towards the landscape-scale appreciation of the importance of areas as opposed to the site-by-site approaches traditionally adopted (Young and Jarvis, 2001b; Freeman and Buck, 2003; Thompson *et al*., 2003; Smith *et al*., 2005; Daniels and Kirkpatrick, 2006). Such a strategy recognises the importance of the successional and temporally variable nature of many urban ecological variables and the importance of functional and spatial linkages both within the built environment and between the built environment and the rural peripheries.

Individual sites may not be large enough to support viable populations or may not be large enough in themselves to attract support from conservation organisations for protection. Strategies that can account for the totality of urban green infrastructure its configuration, and the associated matrix variability in all its guises as well as provide scope for the movement through the urban matrix are going to have increasing significance since they provide one solution to help in buffering both flora and fauna from the effects of climate change (Rudd *et al*., 2002; Melles *et al*., 2003). The importance of such developments has been highlighted in a recent meta-study of the last 22 years of recommendations for adapting to climate change, which identified improving landscape connectivity, so that species can move, as the most widely-cited recommendation (Heller and Zavaleta, 2009).

7.5 Ecological Implications of climate change

Britain is in a good position to understand the implications of climate change on its flora. The Botanical Society of the British Isles (BSBI) undertook intensive surveys of flora in the middle and end of the 20^{th} century, which aimed to map the distribution of all vascular plant species on a 10km grid. These gave an excellent opportunity to study changes in the flora, and these are explored both in the 2002 Atlas (Preston *et al.,* 2002a) and in a specific publication (Preston *et al.,* 2002b). These investigations demonstrated massive change in the flora, mostly attributable to habitat loss and degradation. Plant species with different types of distribution in the northern hemisphere were also compared, the flora being divided into four types: (i) Widespread; (ii) Northern (arctic and boreal); (iii) Temperate; and (iv) Mediterranean. A marked decline in 'Northern species' in southern Britain was attributed to habitat loss, but there was also a relative increase in all three other types. The authors conclude it is possible that at least some of the Mediterranean species have been the beneficiaries of recent climatic trends. The study also showed when the flora is divided into natives, archaeophytes (introduced before 1500) and neophytes (introduced after 1500) there has been a relative increase in neophytes. The topic was further explored in Braithwaite *et al.* (2006), which compared 811 systematically distributed 2km x 2km samples across Britain surveyed by BSBI recorders in 1987-88 and 2003-04 and concluded that climate change has led to an increase in some species, particularly southerly species in neutral and calcareous grassland and ruderal species found in urban habitats and the transport network.

Although it is the general lack of sensitivity of plants to short-term, weather-related phenomena, which is particularly compelling, other groups have shown similar patterns and responses. For example, butterfly and moth distributions ebb and flow in response to weather and site management and are, therefore, somewhat easier to dismiss by sceptics. Yet this same sensitivity and responsiveness makes them good indicators of climate change, as they have quite particular climatic restrictions and respond to them rapidly. Changes in distribution patterns of these groups, over the last 15 years, indicate northward movement of warm-adapted species and declines in species typical of northern and upland areas (Morecroft *et al*., 2009). These trends are noted as much in urban areas as elsewhere, with the advantage of significantly larger numbers of interested observers noting changes in these kinds of fauna on their local 'patch'. Similarly, Hickling *et al*. (2005) noted northward shifts in 37 species of non-migratory British Odonata over the past 40 years, seemingly as a result of climate change. Although such species are largely benign, some problematic invasive species, e.g. the Chinese Mitten Crab *Eriocheir sinensis*, may also take advantage of warmer conditions (Wilby and Perry, 2006).

7.6 Implications of Climate Change for Urban Ecology

Implications for the value of urban environments probably focuses mainly on the interactions of these changes. There is much in the literature to suggest neophytes are the group most closely associated with human activity (Pyšek, 1988) and urban areas (Hill *et al.,* 2002). Human activity constantly introduces species from all over the world and creates disturbed conditions suitable for their spread. Very few neophytes are a problem, but some, such as Japanese Knotweed *Fallopia japonica* and Himalayan Balsam *Impatiens glandulifera* invade natural habitats and suppress biodiversity very effectively. Many recent invasive species in the UK, such as the Water Fern *Azolla filiculoides* and Floating Pennywort *Hydrocotyle ranunculoides,* are from milder climates than our own. It is possible the results of climate change will be gradual replacement of valued habitats not with different, but still biodiverse ones, but with monotonous stands of invasive species. An alternative and more optimistic scenario would be for climate change to give another dimension to the species assemblages and habitats by adding elements of the diverse continental flora and fauna to the largely retained existing individualistic communities. Whichever is the predominant outcome, further and sustained study of urban biodiversity will be necessary both to help determine the balance between gains and losses, and to act as a measure of the long-term and general impact of climate change on nature.

7.7 Solutions to Climate Change Challenges for the Built Environment

If we therefore acknowledge that climate change is affecting our flora and fauna whether we like it or not, there are a number of ways in which we can adapt to the challenges this offers.

- We should maintain and develop networks of open spaces of different sizes, shapes and configurations within urban areas to ensure that they are ecologically permeable. The built environment is part of the wider landscape dynamics, rather than separate from it.
- At the same time we must be vigilant, since ecological permeability is particularly helpful to invasive alien species, which themselves may well be encouraged by climate change.
- It also needs to be recognised that examples of species-rich habitats, whether primary and post-industrial, are, in addition to their intrinsic value, reservoirs of biodiversity. These may need to be utilised in the re-creation of habitats lost in climate change.
- The pressure to convert gardens into multiple dwellings should be resisted, as the garden habitat is unique and provides both significant urban greenspace and helps to deliver ecosystem services.
- We should resist the urge to 'tidy' as much as we can. Maintaining successional and transient communities alongside more conventional greenspaces will give the existing species, and those moving through, the resources they need.
- Change should be acknowledged as part of the built environment for wildlife as much as for people. Excessive effort to maintain things as they are will be money down the drain in the light of wider climate changes.

Changes may be inevitable, but we can adapt how we manage the built environment to work with the changing patterns of biodiversity as long as we take a longer-term view. In many cases this can be for the benefit of both people and wildlife: surely the best all-round outcome.

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Table 7.1 The ten most species-rich tetrads in Montgomeryshire.

Tetrad grid reference	**No mapped species**	**Locality**	**Habitats**
SJ22Q	275	Llanymynech Hill	Rural (post-industrial)
SJ22K	246	Llanymynech Hill	Rural (post-industrial)
SO29X	224	Cornden Hill	Rural
SJ31C	203	Breidden	Rural
SJ20I	201	Welshpool	Mostly urban
SJ11S	189	Near Meifod	Rural
SN98M	198	Llanidloes	Mostly urban
SJ20D	188	Near Welshpool	Urban fringe, mostly rural
SO08J	188	Llandinam	Rural
SO29I	187	Montgomery	Includes entire town, but mostly rural

NOTE: The figures relate to the number of mapped species per tetrad (i.e. 2 km x 2km square) recorded for the Flora of Montgomeryshire (Trueman *et al* 1995). The figure excludes the 184 commonest species in the vice county, which were not mapped.

Plate 7.1 A West Midlands example of an “ancient” post-industrial site (ladymoor.jpg)

This 19th Century blast furnace slag heap and associated wetland in Bilston carries a rich vascular plant, lichen and bryophyte flora including winter annuals such as *Cerastium semidecandrum* and *Aira caryophyllea*, mire species such as *Triglochin palustris* and four species of Sphagnum moss.

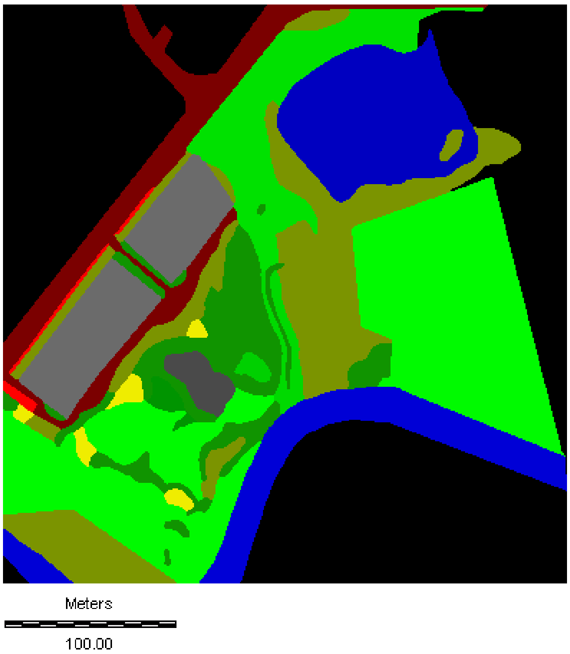

Figure 7.1(a) Ladymoor Pool, Bilston, West Midlands (Light green = grassland, Dark green = scrub, Green = Woodland, Blue = open water, Light Grey = residential, Dark Grey = Industrial Waste (Slag), Yellow = tall/short herb communities, Red = Miscellaneous, Brown = Transport).

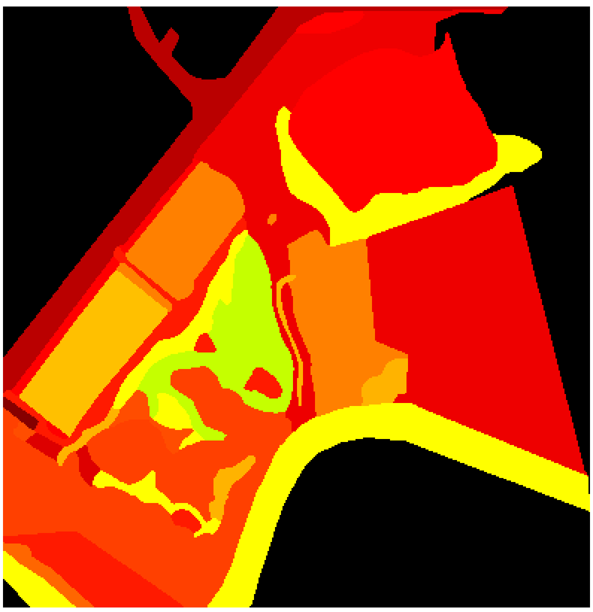

Figure 7.1(b) Habitat Value evaluation of Ladymoor Pool. The brighter areas have higher 'value' as calculated by the Habitat Vale Index. Note the relatively high values in the centre-west

associated with the area of most significant remaining industrial slag waste. (Black = no data) (Young, 1999).

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