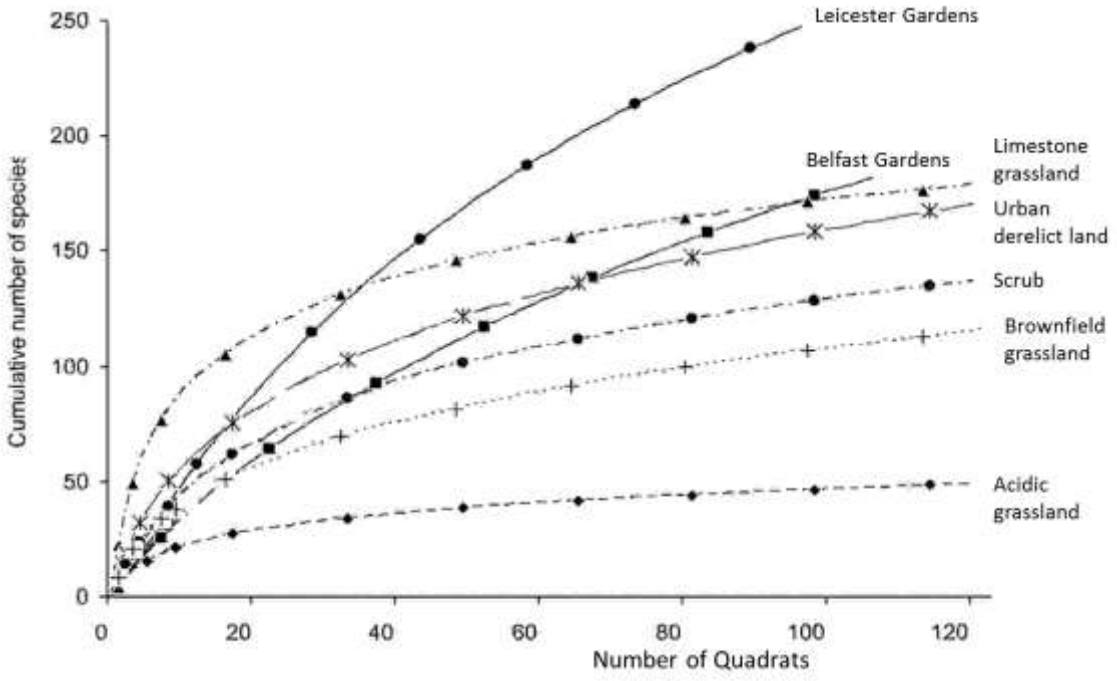
Why are gardens so rich in species?

Ken Thompson and Steve Head

Jennifer Owen identified a number of likely factors which support the extraordinary biodiversity of gardens[1].

First, an almost ridiculous level of "contrived" plant diversity. No natural habitat manages to cram together so many different plants into such a small space. What is more, gardeners don't all grow the same plants, and as the BUGS project demonstrated[2,3] as you sample more gardens, you quite quickly run out of native plants (although Owen found 11% of the British native total in her small garden[4]), but you just continue to find more and more non-natives.



Species accumulation curves comparing gardens and other habitats It shows the results from the most diverse gardens (Leicester) and the least diverse (Belfast), showing how the number of plant species recorded increases as more quadrat samples are added. After 100 quadrats, even the Belfast samples have recorded more species than Limestone grassland, the most diverse semi-natural habitat. Graph adapted from BUGS studies in 5 British cities[5].

Since plants are the basis of the garden food web, and most herbivores have different plant preferences, this enormous plant diversity leads naturally to a great deal of animal diversity. To put this in context, Owen calculated plant diversity in her garden to be 3,563 species per hectare (2.4 acres in old money). Tropical rainforest is dominated by trees and epiphyte plants that live on them in the upper canopy, and the deeply shaded ground surface has few

small plants. A one hectare plot of African rain forest contains up to 135 species of tree above about 10 cm diameter[6] or 3.8% that of the garden. As Owen pointed out, it is unlikely that the inclusion of all types of plant would raise the total to the same level as her garden.

The second, and less obvious factor, is continuous change. Ecology is a bit short of general rules, but one that has stood the test of time is the *intermediate disturbance hypothesis*, which states that along any gradient of disturbance, the highest disturbance is found somewhere in the middle. In an extremely disturbed habitat, such as an arable field, very few species can survive the constant upheaval and diversity is low. On the other hand, if you left a garden completely alone, it would eventually turn into deeply-shaded woodland, dominated by a few large trees, and most of its plant and animal diversity would be lost. Not only are gardens somewhere between these two extremes, every garden is different, some more disturbed than others, and the whole garden estate occupies the entire zone of potentially high diversity.

Note, however, that there is plenty of wildlife that really does like habitats that are essentially undisturbed (and especially undisturbed *and* infertile), and this wildlife does not get on with gardeners and their constant messing about. There is a reason why butterflies that eat nettles and cabbages are common in gardens, and why, for example, the pearl-bordered fritillary, white-letter hairstreak and marsh fritillary, which need undisturbed woodland, are not.

Third, 'structural heterogeneity'. Natural habitats, even those highly prized for their biodiversity, such as limestone grasslands and ancient woodlands, are relatively structurally homogeneous. Gardens are not like that – they consist of a complex mosaic or patchwork of tall and short vegetation, light and shade, dry and wet, so that much of a typical garden consists of edges or transition zones between different types of habitat (*ecotones* in the ecological jargon). Such edge habitats, wherever they occur, are known to be highly diverse, for the simple reason that they provide living space not only for species that like one or other of the adjoining habitats, but also for a third group that like the edge itself.

Owen's garden was extremely rich in hoverflies, and she was able to show that much of this diversity is because there are species of open habitats, species of woodland, and species that range across both habitats. Much of this diversity is extremely local; for one year Owen operated two Malaise traps (to catch flying insects) in different parts of the garden, and found that the size and composition of the hoverfly catches from the two traps were quite different.

Fourth, but related to high plant diversity and structural heterogeneity, is food webs, which are the complex pathways where plant primary production passes through herbivores into carnivores or parasites. Owen gave the example of well-lit rosebay willowherb clumps that support a special community of aphids, with ladybird and hoverfly larvae eating them, and ichneumon wasps parasitizing the hoverfly larvae. On the same clumps the aphid's honeydew exudate supported more hoverflies, bumblebees and wasps. All the vegetation clumps in gardens could support similar food webs but probably with different species.

Fifth, the suburban lawn. Owen singled out lawns - which are the largest component by area of most gardens - as specially interesting. Mowing lawns mimics the way large herbivores keep natural grasslands at an early successional state, and encourages a special flora of

grazing-adapted plants such as yarrow, bird's-foot trefoil, clover, dandelion and daisy. The Sheffield BUGS project recorded 159 species of plants in lawns[7] . These may not all flower (except when you are on holiday and the lawn is unmown) but will support herbivorous insects. The complex layers of grass leaves and roots are habitats for ants, spiders and predatory beetles, and lawns provide open areas for foraging by many species of birds.

Sixth - Food supply. Relating to structural heterogeneity and food webs, gardens contain a great amount of living and dead plant material per square metre, and plant production is high (although more studies here would be useful). As gardeners we are only too aware of caterpillars, aphids, slugs and other herbivores eating our crops, but practically all the plants will be being used by various chewers and suckers, not just on the leaves but within the stems and on the roots as well. Fruits, when they appear, are harvested by more insects, birds and mammals, and even when dead, plant material supports a whole extra community of decomposers and detritus eaters. All of these herbivores or detritivores are prey for another great array of predatory species.

To Owen's list of factors could be added one other, implied under discussion of structural heterogeneity, in that many of the habitat patches in gardens resemble or substitute for semi-natural habitats in our countryside. We have seen that lawns represent grazed grassland, and that the garden patchwork of hedges and shrubs creates edge-zones, like the rich interface between woodlands and grasslands at the wood edge. Then compost heaps and wood piles represent the deep detritus layer in woodlands, and multi-species hedges can bring some of the diversity of deciduous woodland into a small space. Garden ponds can be as species-rich as small natural ponds, and rockeries and gravel can mimic screes and coastal habitats.

It is clear that high garden biodiversity is due to a number of inter-related factors, rather than to any one over-riding feature, although the diversity of structure and plants rank high. Remember that these are all characteristic of *ordinary* gardens, managed in a conventional way. All gardens are wildlife gardens!

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