Roundabouts:
Our neglected nature reserves?

Roundabouts are common in our towns and cities but how many of us realise – as we jostle for position and try to avoid being cut up by other drivers – that we are circling a habitat not only startlingly rich in biodiversity but in some cases, full of rare and unusual species of insects. Are these reviled objects our future nature reserves?

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Title image: Roundabouts are islands of diversity, this one situated in the centre of Bracknell, Berkshire

At first sight, the connection between a Swedish botanist working in the early part of the 20th century and roundabouts in Bracknell, Berkshire, might seem a little tenuous! The connection is however, closer than you might think. In 1921, the Swede Arrhenius published a seminal paper entitled *Species and Area*, in which he demonstrated that as one searched a greater and greater area of a habitat, the more species of plants one would encounter (Figure 1). Each habitat type had a different species accumulation curve reflecting its inherent degree of biodiversity.

This was not the first time that someone had remarked on this pattern but it was the first time that a mathematical description had been given of the phenomenon. Matters largely rested there until, in the 1950s, an American Zoologist named Darlington described a similar relationship for Caribbean reptiles and amphibians; the bigger the island, the greater the number of species one would find on a particular island (Figure 2). This was perhaps the real birth of the concept of *island biogeography*. This developed into a science of its own, incorporating factors such as isolation, species-abundance relationships and species turnover (Whittaker, 1998), and textbooks such as the seminal work by Robert MacArthur and Edward Wilson (1967) appeared. At

the same time ecologists were coming up with other ingenious ways in which to use the species-area relationships, for example by using analogues for area (such as the range of a host plant) and relating that to the number of insect species associated with it (see Strong, 1974; Strong *et al.*, 1984).

Relevance to conservation

The relevance to conservation, however, is more direct although not as straightforward as one would think. It seems inherently sensible, taking as one's premise that a nature reserve is an island surrounded by a sea of non-nature reserve, that the bigger your reserve (island) the more species of plant and animal that you will find within it. Certainly, if one looks at woodland fragments for example, one can see clear relationships between size of the forest and not only the number and abundance and species present, but also the number of rare and uncommon species (Peterken, 1993). In addition, the larger the habitat fragment, the more robust it will be against the possibility of losing species. A related debate that arose in the 1980s was described as SLOSS (is a Single Large or Several Small nature reserves the most effective way of conserving species? (Murphy, 1989; Quinn & Harrison, 1988)). This is often illustrated using circles of varying sizes separated by areas of non-reserve space (see Box 1).

What has this do with roundabouts and other urban green spaces? Unfortunately, conservation is often considered by the general public to be something that occurs in exotic far away places although of course this is not the case. Internationally important nature reserves exist within the British Isles, as well as many more nationally important sites such as Sites of Special Scientific Interest (SSSIs). There is also much evidence that considerable biodiversity exists within urban areas.

Interest in urban biodiversity has been evident for many years, particularly focusing on birds and mammals and, to a lesser extent, on more charismatic insects such as butterflies and moths. For example, the British Government started publishing reports on the status and conservation of birds in London parks in the 1920s, and there are a number of earlier publications on similar topics (Simms, 1974). Consequently much is known about the bird and mammal life of urban parks in many major cities, such as London and Madrid (Fernández-Juricic, 2000). Although the conservation value of city parks has long been recognised, as has that of surviving

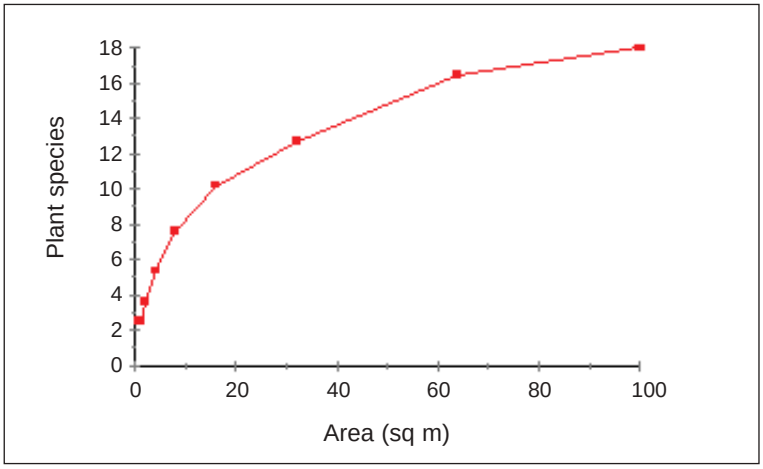


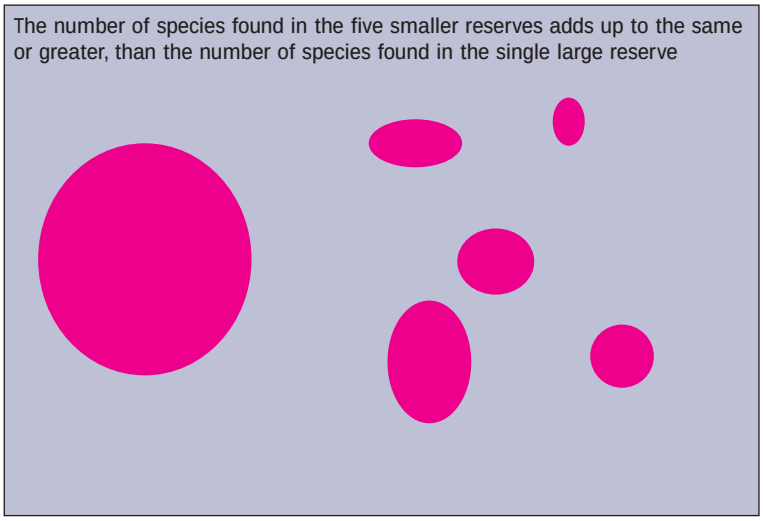
Figure 1. Relationship between area sampled and plant species richness. Data taken from Arrhenius (1921).

fragments of forest, a small but growing number of studies have also described significant biodiversity within other types of urban land use, such as roadsides, so-called brownfield sites, gardens, and roundabouts. McIntyre (2000), in her review of the ecology of urban arthropods, found that within 79 peer-reviewed publications there was a strong bias towards forest fragments and parks, and also towards groups such the Lepidoptera and Coleoptera. As a result of this imbalance of interest, a very great deal still remains to be discovered about the biodiversity and conservation value of many urban land use areas, such as roundabouts and similar road delimited green spaces.

The case of Bracknell

Residents of Bracknell in Berkshire cannot help but be struck by the abundance of roundabouts in and around their town. Bracknell Forest Borough Council has a refreshing approach to them in that they have, over the years, obtained sponsor-

Box 1. Schematic illustration of SLOSS (Single Large or Several Small)



Nebria salina was one of the more unexpected finds. Photo courtesy of Roy Anderson.

ship from several local companies that has enabled their management in a fairly imaginative way.

Being involved with teaching ecology in an urban setting means thinking of ways in which the concepts covered can be made accessible and relevant to the student audience. The idea of urban and suburban areas as being important for conservation is not that new an idea: the late Denis Owen and his wife Jennifer wrote about this in the 1970s. More recently Jennifer Owen's book on the flora and fauna of her garden has been warmly welcomed by specialists and others. Our first study arose out of two final year undergraduate projects, in which pitfall trapping of spiders and ground beetles on a selection of Bracknell roundabouts was used to ask essentially two questions: first, was there anything interesting living on the roundabouts; and secondly, if there was, did it conform to the classic species-area rules?

To our surprise, both questions were answered in the affirmative. Big roundabouts had more species of ground beetles and spiders than smaller roundabouts and the result could be modified by the number of habitats (i.e different plant species) found in these spaces. In other words, a medium sized roundabout with a large number of plant species present tended to have more species of beetles and spiders present than a large roundabout dominated by grass and flowerbeds. The best situations of course were the large roundabouts with the largest range of plant types, i.e. ranging from mature trees, shrubs, herbs and grassy areas. Those roundabouts that were small and essentially nothing but grassy knolls proved to be those with the fewest species (Leather and Helden, 2005). Not only that, but some of the species found, although not uncommon, were not species that one might expect to find in the middle of a town, for example *Nebria salina*, which is more often associated with moorland!

Thus encouraged we started to look at different insect groups and also to examine the management of roundabouts and other green areas within Bracknell. We chose to look at the Hemiptera (Heteroptera, Auchenorrhyncha and Psylloidea), which were sampled from both grassland and arboreal habitats of 18 roundabouts and other similar road-enclosed areas, using suction sampling and tree beating, respectively (Helden and Leather, 2004). Arboreal Hemiptera were found to show a significant species-area relationship which was found to be strongly related to habitat diversity. Larger roundabouts were found to have larger numbers of tree species which, given the host plant specificity of many of the arboreal Hemiptera, were equivalent to different habitats. This increase in species richness with roundabout area was in agreement with the habitat diversity hypothesis, which states that larger areas have a greater number of habitats, resulting in a greater number of species in total.

Grassland Hemiptera showed a quite different result. No species-area relationship was detected, although grassland plants, sampled during the same study, did show a significant relationship. The lack of a species-area relationship is thought to be due to the effect of management practices, in this case mowing frequency, which when increased resulted in a significant reduction in species richness. Higher mowing frequency also led to a reduction in plant species richness but the effect did not appear strong enough to

prevent a species-area relationship (Figure 3).

City nature reserves?

Apart from their value in studying species-area relationships, the work on roundabouts illustrates the biodiversity and conservation potential of urban areas (Helden and Leather, 2004). Although sampling was only carried out on one day for grasslands and one day for trees, for each of the 18 sites, a combined total of 134 species were found, consisting of 55 Heteroptera, 67 Auchenorrhyncha and 16 Psylloidea species. This represents approximately 17% of the national UK species total for these three groups combined. Had sampling been carried out throughout the year, and if in addition it had included bushes and herbaceous plants, the true species richness would certainly have been found to be considerably higher.

In addition to high species richness, several unusual or rare species were recorded, adding to the conservation interest of the study. These included the Heteroptera *Orsillus depressus* Dallas (Lygaeidae) and *Gonocerus acuteangulatus* (Goeze) (Coreidae), and the leafhoppers (Cicadellidae) *Athysanus argentarius* Metcalf, and *Pediopsis tiliae* (Germar). High species richness and the presence of some unusual species could certainly be used to justify the conservation of roundabouts and similar sites within urban areas.

In order to do this it would be necessary to consider issues of management techniques and SLOSS. Management techniques are known to have a major impact on biodiversity and our studies on Hemiptera indicate that reducing mowing frequency and planting of trees with rich insect faunal associations would be valuable (Helden and Leather, 2004), but of course these approaches are likely to be constrained by aesthetic, road safety and other human interest factors. In asking the question of SLOSS in this context, one would need to consider whether it is better to manage many smaller roundabouts for

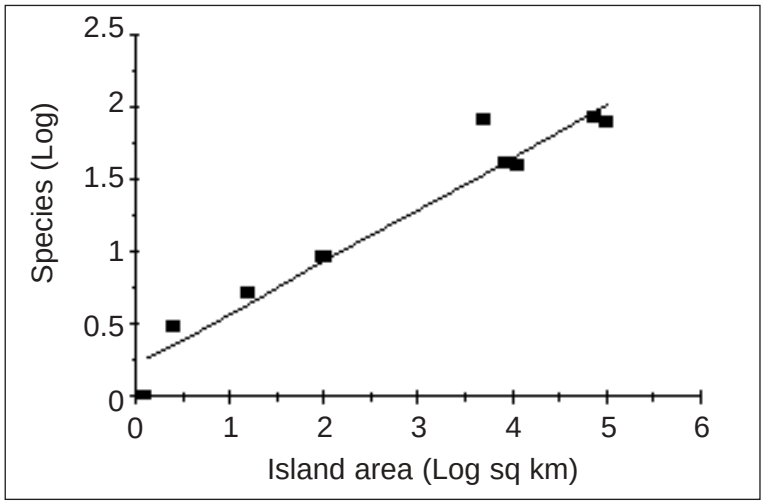


Figure 2. Relationship between area of island and number of species of amphibian and reptile recorded from that island. Data from Darlington (1957).

Figure 3. The mean (±SE) species richness of plants (a) and Hemiptera (b) from Bracknell roundabout grasslands with four different categories of management (A, mowed every 7 days; B, mowed every 14 days; C, mowed every 40 days; D, mowed once or less per year). (Data for Hemiptera taken from Helden and Leather, 2004).

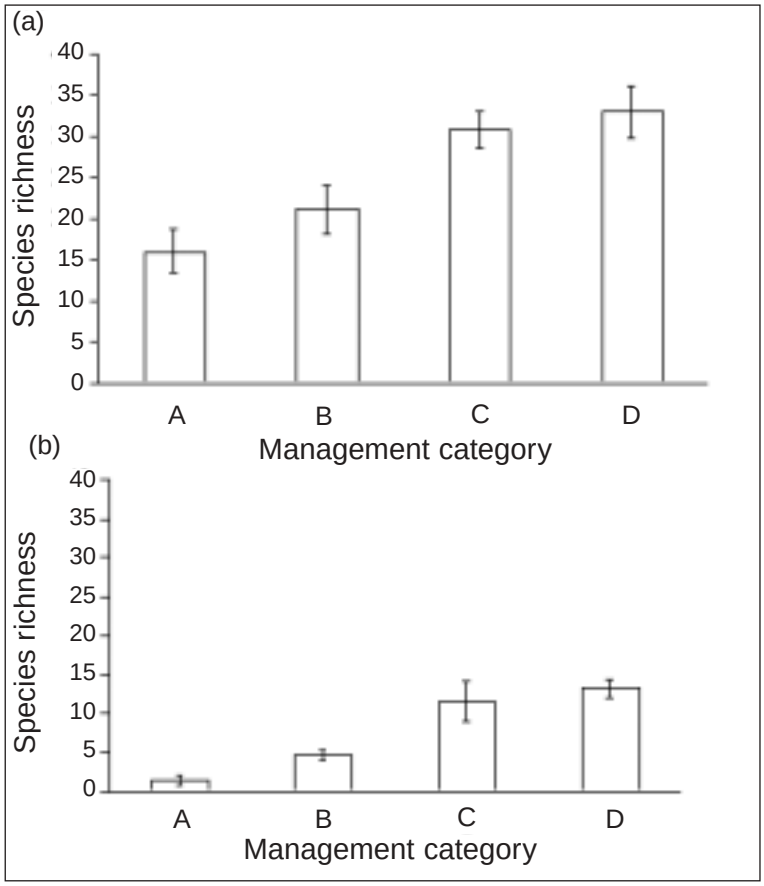


Table 1. The species richness of arboreal and grassland Hemiptera at the two largest Bracknell sites and all the other smaller sites combined (at the combined sites four species were found on both grassland and arboreal).

Site	*Area (m2)*	*Hemiptera species on trees*	*Hemiptera species on grass*	*Total Hemiptera species*
Mill Pond Park	63 681	32	13	45
Bill Hill	43 574	28	10	38
All other sites combined	51 504	67	38	101

Coreid Bug, Heteroptera, with young. Copyright Natural History Photographic Agency. Photographer: N A Callow.

biodiversity or just the larger sites. Brief consideration of the data would indicate that many smaller sites had a greater species richness that single larger sites (Table 1), although it should be borne in mind that the sampling effort was greater for the combined sites than for the large single sites.

Afterword

The levels of biodiversity of roundabouts and similar areas within towns and cities not only provide a focus for conservation interest and an opportunity to test scientific theory such as the species-area relationship and SLOSS, but also have a useful potential role for the formal and more general education of the urban population. Studies of roundabouts could provide useful case studies for teaching about biogeography and conservation, while many similar small urban areas have the potential, given appropriate safety considerations, to be valuable sites for fieldwork (Leather and Helden, 2005).

Highlighting the biodiversity of roundabouts within the local media may also help many local inhabitants realise that conservation is valuable and relevant in their own locality and not just in more exotic locations. As a result, it could help to nurture a greater pride and interest in the local environment. At present the work on roundabouts remains in its early stages, and further progress may depend on finding sufficient funds to support a PhD student. Given the opportunities arising from better understanding the inherent scientific and educational value of these pockets of biodiversity, we hope that may come sooner rather than later.

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