

Habitat and drey sites of the red squirrel *Sciurus vulgaris* LINNAEUS 1758 in suburban parks of Wrocław, SW Poland

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Abstract. Studies were conducted in the late autumn of 2005 and in the early winter of 2005/2006 in 20 suburban parks in the city of Wrocław, SW Poland. All red squirrel core areas (N=140) were situated in broad-leaved or mixed tree stands. Common oaks were recorded in most squirrel core areas (90.2%). A total of 161 dreys were found. Dreys were located in 18 tree species. The red squirrel builds dreys in most common tree species, which, in addition, provide the largest amount of its staple food (*Quercus robur*, *Tilia cordata*, *Carpinus betulus* and *Betula verrucosa*; together 71.5%). Broad-leaved species comprised 97.9%, while indigenous species – 93.6% of all tree species with dreys. There was a clear preference for locating dreys on treetops, which can be viewed as an anti-predator adaptation. Dreys were located 5 to 25 m above the ground (60.2% of them were 12-18 m above ground), mostly at the very top (28.1%) or 1-3 m below the tops of trees (31.9%). Most dreys (63.1%) were not clustered but 38 (23.8%) formed groups of two, the remaining dreys formed groups of 3-6.

Key words: *Sciurus vulgaris*, habitat, nest site selection, suburban parks, urban ecology.

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I. INTRODUCTION

The red squirrel *Sciurus vulgaris* has declined or became locally extinct in many parts of its range, e.g. in Great Britain, Germany and Italy (GURNELL & PEPPER 1991; FORNASARI et al. 1997; LURZ et al. 2005; GURNELL et al. 2008). Extensive hunting, woodland fragmentation, habitat destruction, urbanization, road construction and natural diseases are major factors causing this decline (LURZ et al. 2005; GURNELL et al. 2008). In the British Isles and in northern Italy, the introduced grey squirrel *Sciurus carolinensis* GMELIN 1788 usually outcompetes the indigenous red squirrel (e.g. WAUTERS et al. 1997; WAUTERS et al. 2000; GURNELL et al. 2004; LURZ et al. 2005).

Although intensive studies have been conducted on the red squirrel in recent years in Great Britain (GURNELL et al. 2001; LURZ et al. 2005; GURNELL et al. 2008), no studies on the biology and ecology of this species in Poland have been undertaken to date. Virtually nothing is known about the well-established red squirrel populations in some of the biggest cities in this country in which they live under conditions different from those prevailing in forests.

The aim of this study was to investigate habitat use and drey sites in respect to tree species, location in the tree, and height of the drey site in a squirrel population inhabiting suburban parks in one of these cities.

II. STUDY AREAS AND METHODS

Studies were conducted in 20 suburban parks in the city of Wrocław, SW Poland (Fig. 1, Table I). The parks ranged in size from 2.9 to 110 ha (average: $24.5 \pm SE = 26.6$). In most parks mature and old oaks *Quercus spp.*, small-leaved limes *Tilia cordata*, maples *Acer spp.* and hornbeams *Carpinus betulus* predominated. Trees such as white birch *Betula pendula*, European ash *Fraxinus excelsior*, common beech *Fagus sylvatica*, black locust *Robinia pseudoacacia*, spruces *Picea spp.*, alders *Alnus spp.*, poplars *Populus spp.*, pines *Pinus spp.*, and others comprised an admixture.

The commonest shrub species included the hazel *Corylus avellana*, rowan *Sorbus aucuparia*, yew *Taxus baccata*, elder *Sambucus nigra*, dogwood *Cornus sanguinea*, forsythia *Forsythia x intermedia* and snowberry *Symphoricarpos orbiculatus*.

I searched for red squirrel drey sites in the late autumn of 2005 and in the early winter of 2005/2006. The following habitat characteristics were determined for each drey found (N = 161): tree species containing the drey, a rough estimate of the height of the drey site and drey groups. For

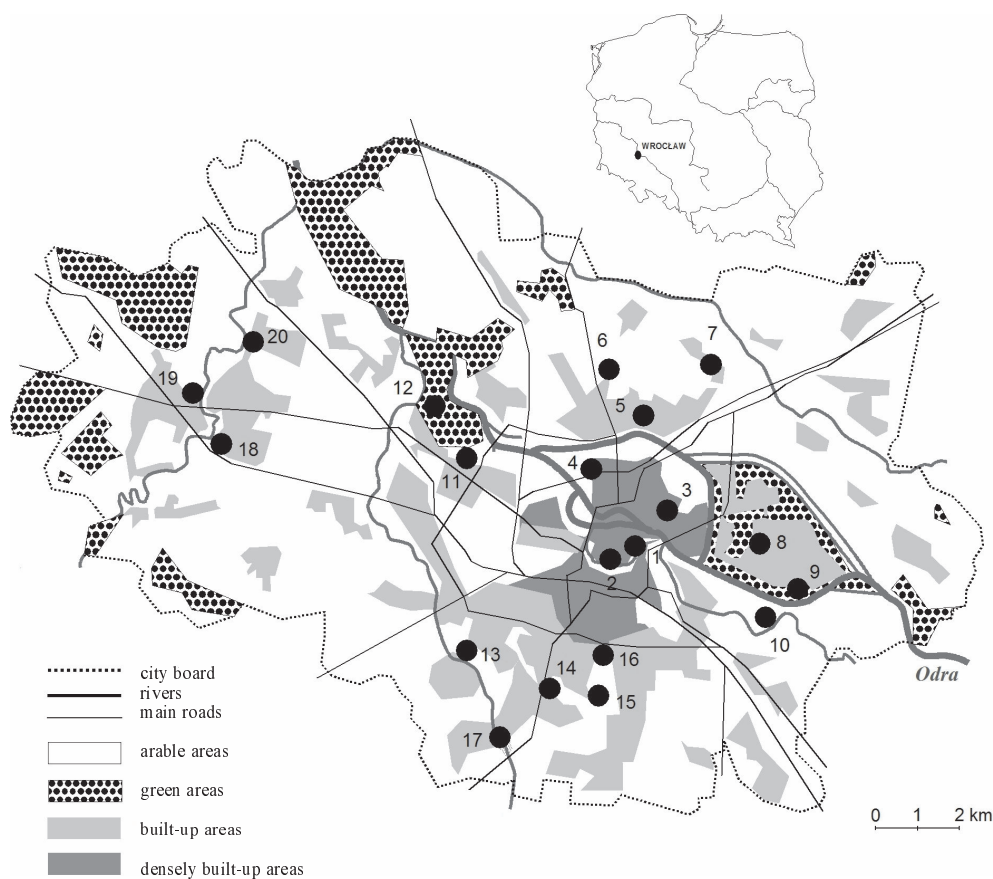


Fig. 1. Map of Wrocław with suburban parks indicated by numbered dots (numbers as in Table I).

Table I

Number of dreys found in suburban parks in Wrocław

No.	Park name	Acragage [ha]	Number of dreys	Dreys/10 ha
1	Słowackiego	10	0	–
2	Kopernika	2.9	0	–
3	Nowowiejski	5.0	0	–
4	Staszica	12	0	–
5	Kasprowicza	5.3	0	–
6	Dąbrowskiej	9	0	–
7	Sołtysowicki	22	1	0.5
8	Szczytnicki	110	17	1.5
9	Biskupiński	17	4	2.4
10	Wschodni	40	1	0.3
11	Popowicki	18	4	2.2
12	Zachodni	75	56	7.5
13	Grabiszyński	48	22	4.6
14	Południowy	20	18	9.0
15	Skowroni	25.3	28	11.1
16	Andersa	6.2	7	11.3
17	Kleciński	10	0	–
18	Złotnicki	20	1	0.5
19	Leśnicki	20	1	0.5
20	Stabłowicki	5.5	1	1.8
Total		489.8	161	3.3

140 out of 161 dreys, habitat structure within red squirrel core areas and the distance between dreys were determined.

The relative height was estimated for 140 out of 161 dreys found, placing each drey into one of the following height categories: 0-3 m, 3-6 m, 6-9 m, 9-12 m, 12-15 m, 15-18 m, 18-21 m and 21-24 m. Each of the trees harbouring dreys was divided into five equal height sections, i.e. 1/5 was the lowest section, 2/5 was the second lowest, 3/5 middle section, 4/5 the second highest and 5/5 the highest section (Fig. 2B). The section of the tree containing a drey was determined.

Drey location in relation to the main trunk was also determined for each of the 140 dreys, using the following criteria: a – placed on the treetop; b – placed against the main trunk; c – placed on a branch, far from the main trunk; d – placed on twigs at the end of a branch (Fig. 2A).

Because red squirrel core areas are usually about 1 ha (LURZ et al. 2000; WAUTERS et al. 2000), it was assumed that the core areas of red squirrels in suburban parks of Wrocław encompassed approximately 50 m around the drey. Therefore, if dreys were located within less than 50 m from each other, they were assumed as belonging to the same individual (therefore forming a drey group).

Habitat structure within the core area was described for 140 out of 161 dreys found. All tree species were identified and dominance was assessed using the following criteria: in a stand of two tree species, the dominant tree species was regarded as that which comprised more than 2/3 of all trees;

Table II

Habitat structure within red squirrel core areas (N = 140). A – frequency of occurrence of particular tree species in squirrel core areas; B – frequency of occurrence of dominant tree species within the squirrel core areas. Both A and B values are expressed as percentage from the total (140) number of dreys found

Tree species	A	B
Common oak <i>Quercus robur</i>	90	33.6
Small-leaved lime <i>Tilia cordata</i>	57.1	32.1
Hornbeam <i>Carpinus betulus</i>	47.1	9.3
White birch <i>Betula pendula</i>	38.6	2.1
Black locust <i>Robinia pseudoacacia</i>	26.4	2.9
Red oak <i>Quercus rubra</i>	20.7	10.0
Norway maple <i>Acer platanoides</i>	32.9	0.7
Cherry <i>Prunus cerasus</i>	1.4	0.0
European larch <i>Larix deciduas</i>	3.6	0.0
Grey alder <i>Alnus incana</i>	2.9	2.1
Hedge maple <i>Acer campestre</i>	2.9	2.1
Lombardy poplar <i>Populus nigra</i> 'Italica'	0.7	0.0
Cypress oak <i>Quercus robur</i> 'Fastigiata'	0.7	0.0
Sycamore maple <i>Acer pseudoplatanus</i>	3.6	0.0
Horse-chestnut <i>Aesculus hippocastanum</i>	15.0	0.7
Black pine <i>Pinus nigra</i>	0.7	0.0
Hickory <i>Carya sp.</i>	0.7	0.0
Scottish pine <i>Pinus sylvestris</i>	5.0	2.1
Common beech <i>Fagus sylvatica</i>	11.4	0.0
Eastern arborvitae <i>Thuja occidentalis</i>	6.4	0.0
European ash <i>Fraxinus excelsior</i>	2.9	0.0
Eastern white pine <i>Pinus strobus</i>	2.9	0.0
London plane <i>Platanus acerifolia</i>	2.1	0.0
European white elm <i>Ulmus laevis</i>	1.4	0.0
Canadian hemlock <i>Tsuga canadensis</i>	1.4	0.0
Douglas-fir <i>Pseudotsuga sp.</i>	1.4	0.0
White poplar <i>Populus alba</i>	0.7	0.0

in a stand composed of more than two tree species, the dominant species was that which comprised more than 1/2 of all trees. Trees were counted in 3-4 randomly selected plots (2-4 acres each) within each core area. The frequency of occurrence of particular tree species within red squirrel core areas was expressed as the percentage of area (i.e. <50 m around a drey) within which a particular tree species was recorded, to the total number of all core areas identified.

III. RESULTS

All red squirrel core areas were situated in broad-leaved or mixed tree stands. Common oaks were recorded in most squirrel core areas (90.2%). Oak was often the dominant species (33.6%) in the tree stands. The small-leaved lime was the second most important tree species within the core areas (Table II). The hornbeam, white birch, red oak and black locust were often recorded within the core areas, but they comprised a larger proportion in the tree stands only within a few core areas (Table II). Twenty other tree species constituted only an admixture. Coniferous trees (common pines) were recorded as a dominant tree species only within a few core areas (1.8%) (Table II).

A total of 161 dreys were found in 13 out of 20 (65%) suburban parks (Table I). There were, therefore, 8.1 dreys per park (including parks in which no dreys were found). Dreys were located in 18 tree species (Table III). Dreys were not detected in 10 other tree species recorded within the core areas (Table II). They were also not observed in shrubs, tree holes or man-made structures.

Broad-leaved species comprised 97.9%, while indigenous species – 93.6% of all tree species with dreys. Most dreys were located in oaks, small-leaved limes, hornbeams and white birches. They comprised together 71.5% of all tree species with dreys (Table III). Oaks with dreys were usually more than 100 years old. Other species were usually much younger. In suburban parks, the tree

Table III

Tree species harbouring dreys; N – native, E – exotic (well-naturalized tree species are treated as native)

Tree species (origin)	Drey trees	
	N	%
Common oak <i>Quercus robur</i> (N)	37	23.0
Small-leaved lime <i>Tilia cordata</i> (N)	36	22.4
Hornbeam <i>Carpinus betulus</i> (N)	24	14.9
White birch <i>Betula pendula</i> (N)	18	11.2
Black locust <i>Robinia pseudoacacia</i> (N)	9	5.6
Red oak <i>Quercus rubra</i> (E)	7	4.3
Norway maple <i>Acer platanoides</i> (N)	7	4.3
Cherry <i>Prunus cerasus</i> (N)	4	2.5
European larch <i>Larix deciduas</i> (N)	3	1.9
Grey alder <i>Alnus incana</i> (N)	3	1.9
Hedge maple <i>Acer campestre</i> (N)	3	1.9
Lombardy poplar <i>Populus nigra</i> 'Italica' (N)	2	1.2
Cypress oak <i>Quercus robur</i> 'Fastigiata' (N)	2	1.2
Sycamore maple <i>Acer pseudoplatanus</i> (E)	2	1.2
Horse-chestnut <i>Aesculus hippocastanum</i> (N)	1	0.6
Black pine <i>Pinus nigra</i> (E)	1	0.6
Hickory <i>Carya sp.</i> (E)	1	0.6
Common beech <i>Fagus sylvatica</i> (N)	1	0.6
Total	161	100.0

species most often chosen by red squirrels for drey sites were also the commonest ones within the squirrel core areas. The common oak and small-leaved lime were dominant tree species in most squirrel core areas.

Most dreys were located in treetops (28.1%) or 1-3 m below (31.9%). Dreys were also often located on branches, either against the main trunk (16.9%) or 1-5 m from the trunk (on branches skewed upwards, usually forked; 13.1%). Occasionally, dreys were located on the periphery of tree crowns (4.4%) or in the fork of the main trunk (5.6%) (Fig. 2A). Two dreys were found in mistletoes, *Viscum album*.

Dreys were located 6 to 24 m above the ground. Most (60.2%) were 12-18 m above ground (N = 140) and only a few were below 9 m or over 21 m (Fig. 3). Most dreys (62.1%) were placed in the highest (fifth) section of tree height; much fewer in the fourth and third sections, several in the second and none in the lowest (first) section of trees (Fig. 2B).

Most (63.1%) dreys were not clustered (Table IV), and most (80.0%) of those that were clustered were placed in a similar manner within a given group. In 14 (40.0%) out of 35 drey groups, dreys were located on the same tree species. In 21 (58.3%) groups, dreys within each group were located at the same height.

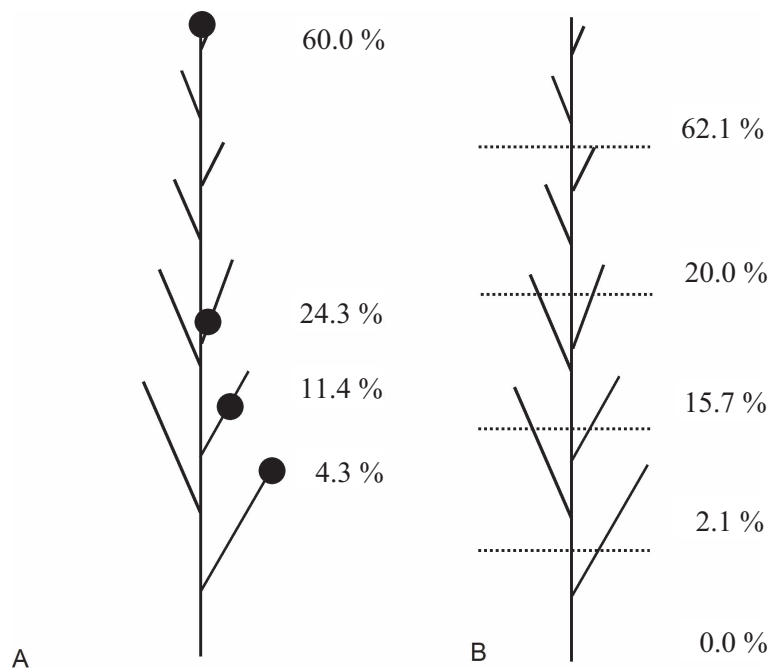


Fig. 2. The manner of drey placement (A), and drey location in relation to tree height (B) (N=140).

IV. DISCUSSION

In suburban parks of Wrocław, most red squirrel dreys were located in trees which provide its staple food (seeds), i.e. the common oak, hornbeam, small-leaved lime, red oak and cherry. Pines, spruces and especially common beeches may also provide food, but they were relatively uncommon in the suburban parks, therefore only a few dreys were found in these trees (Table II). In Great Britain almost all dreys are located in pines and spruces (LURZ et al. 2005; GURNELL et al. 2008), probably because forests are composed almost exclusively of these tree species. In mixed and deciduous

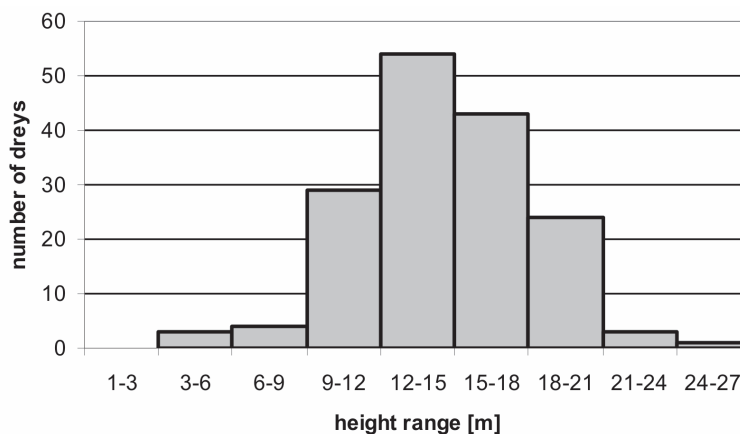


Fig. 3. Height of drey sites (N=161).

forests in this country, the red squirrel has been replaced by the grey squirrel (GURNELL et al. 2008). However, in northern Italy, in woodlands dominated both by oaks (32%) and pines (25%), with an admixture of birch, black locust, hornbeam and chestnuts *Castanea sativa*, red squirrels also strongly prefer common pine trees for drey location (FORNASARI et al. 1997).

The red squirrel's preference for coniferous trees for drey location recorded in Great Britain and Italy, and a lack of such a preference in suburban parks of Wrocław, may be explained in terms of differential predation pressures. The pine marten *Martes martes* might be a common predator in the coniferous and mixed forests of West Europe (LURZ et al. 2005). Squirrels must therefore hide their dreys in evergreen conifers, in climbing plants such as ivy *Hedera helix* or even in mistletoe. These plants provide better concealment than broad-leaved trees, at least in the period of the year when most broad-leaved trees are devoid of foliage. This period overlaps with the time when spring-born young are present in most dreys (LURZ et al. 2005). Among natural enemies, only the beech marten *Martes foina* occurs occasionally in suburban parks of Wrocław (personal observation).

In Parco Groane and Pineta, northern Italy, 84.5% dreys were located against the main tree trunk and 15.5% on branches (FORNASARI et al. 1997). In the present study, most dreys were located in treetops. Placing dreys at the tops of trees may represent an adaptation against cats, which often penetrate parks, although probably prey mainly in the undergrowth. Presumably for this reason dreys were not located in shrubs, even in dense evergreen yew, which commonly occurs in some parks.

Dreys were, however, located relatively high in suburban parks in Wrocław. Most passerine birds breeding in these parks place nests much lower (personal observation). In deciduous forests in

Table IV

Drey clustering recorded in suburban parks in Wrocław

Groups	Number of groups	Percent of groups	Number of dreys in group	Percent of dreys in group
Single	102	81.0	102	63.4
Two dreys	19	15.1	38	23.6
Three-six dreys	5	4.0	21	13.0
Total	126	100.0	161	100.0

Germany most dreys were located relatively high, 15% at 6-8 m above ground, 64% at 6-16 m, and 22% higher than 16 m above the ground (BORKENHAGEN 2000). Also in the British Isles most dreys are above 6 m (GURNELL et al. 2008). This may be because most red squirrel food is located at such heights in spring and summer. In addition, dreys are better protected against predators if located higher.

In Great Britain, many red squirrels have 2, 3 and sometimes even more (up to eight) dreys at a time (LURZ et al. 2005; GURNELL et al. 2008). The present study also suggests that some individuals maintained several dreys.

In conclusion, it should be emphasized that in suburban parks in Wrocław, the red squirrel shows preference for tree species which usually provide the largest amount of its staple food. There is also a clear preference for locating dreys in treetops, and this can be viewed as an anti-predator adaptation. Since suitable sites for dreys are abundant in suburban parks, they do not limit the squirrel population.

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