What Are the Special Features of the Urban Habitat and How Do We Deal with Urban Nature?

4

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Abstract

This chapter discusses the specific features of urban habitats for plants and animals, with which we are living together. Cities are extraordinary, differentiated habitats with many special offers, but also with restrictions for animals and plants. Urban flora and fauna and its habitats are in many ways special. Their development and their ecological characteristics are presented and illustrated through examples.

4.1 The Urban Habitat is Different

4.1.1 Urban Nature

Ecological site characteristics of the cultural landscape can be found in peripheral urban areas or special urban relief positions, for example, on hills or in river floodplains in the city (Fig. 4.1 and 4.2).

Nevertheless, the predominant locations in cities are special features that do not occur in the cultural landscape of countryside outside cities.

Ecological steering features such as temperature, humidity and water balance, light, air chemistry, soil condition, competition and disturbance are often significantly changed in contrast to the surrounding areas of cities. Their diverse, small-scale, often abruptly changing conditions and combinations of characteristics make up the diversity of urban site and habitat conditions and explain the special features of urban biodiversity (Breuste et al. 2020).

Urban biodiversity

As everywhere else, the climate (water supply, energy supply through light, temperature, chemical milieu, in part also nutrient supply through dust and precipitation) and the

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Fig. 4.1 Elisenhain urban woodland in Greifswald. (Photo © Breuste 2006)

Fig. 4.2 Meadow in the landscape protected bog Leopoldskroner Moos in the urban area of Salzburg. (Photo © Breuste 2003)

soil (mineral supply, water supply, chemical milieu) are the most important site characteristics for plants in the city. The important water supply is dependent on climate and soil. The interspecies competition, in which man intervenes deeply through use, care and planting, is ultimately decisive for the composition of vegetation (Wittig 1998).

The locations of the city are usually less favourable for plants in comparison with surrounding areas:

- The chemical milieu of the soil is often less favourable.
- The chemical milieu of the air is usually less favourable (gases, dust etc.).
- The enjoyment of light is reduced at many locations.
- The water balance is usually in imbalance. Higher temperatures cause water losses, soils are often reduced in their water storage capacity (low soil moisture content due to soil compaction).
- Soil sealing and compaction impede the colonisation by plants (Wittig 1998; Leser 2008).

The natural distribution of plants on urban sites is thus linked to the habitat requirements of the plants and the existing site characteristics. However, the real distribution of plants deviates from this relationship because humans limit competing species, exert disturbances, unconsciously improve site characteristics for target species, and consciously or unconsciously introduce non-native and non-site adapted species into the flora of the city.

While plants usually have a very close dependence on certain site factors, individual animal species or animal groups show a less marked dependence on certain ecologically relevant conditions, as their plasticity (morphological, physiological and ecological adaptability) is high (Leser 2008). Artificial sites and their "new" characteristics are often quickly accepted and colonised as attractive new habitats and replace natural habitats. From an animal-ecological point of view, buildings are artificial rocks (exterior) and artificial caves (interior). For missing natural structures (e.g. wood), technical replacement structures are used as residence, visit and nesting sites (Klausnitzer 1993).

The urban climate is less important for animals than for plants. Heat-tolerant species occur, but often in connection with nutrient plants. "Light pollution" (large and continuous supply of light) affects animals with a strict day-night rhythm (Eisenbais and Hänel 2009). Soil changes affect mainly the soil fauna. Unlike plants, water shortage is not a limiting factor. Since plants are the decisive basis of their occurrence for many animal groups (species spectrum, frequency, and physiological state), changes in flora and vegetation have impacts on their occurrence (e.g. insects - longer vegetation period) (Klausnitzer 1993). Rich food supply, diversity of nesting and habitats, lack of competition and displacement from extra-urban habitats are the most important factors for the occurrence of many animal groups.

Werner and Zahner (2009) and Möllers (2010) provide a detailed summary of the characteristics of urban spaces with explained criteria. Further references can also be found in Leser (2008) and Tobias (2011).

Humans are the decisive factor for the occurrence and distribution of species in the city (Wittig 1998, p. 220, 2002). Cities provide new habitat qualities for plants and animals, and in some cases, they also replace natural habitats outside the city. Urban space consists of a habitat mosaic of high heterogeneity (building structures, uses, unused spaces) and high area dynamics (pioneer species). Since the habitat conditions are directly dependent on urban structure and land use, this information is often used to develop an urban ecological biotope classification (Chapter 2) (Klausnitzer 1993; Table 4.1).

The urban habitat offers new environmental conditions, especially in connection with disturbance and stress factors, to which living beings react by their patterns of distribution and movement, but also by evasion or habitat preferences and changes as well as physiological (e.g. endogenous adaptation).

The reasons for the species richness and attractiveness of cities as habitats are

- urban landscape rich in structure,
- nutrient-poor, dry and warm biotopes/habitats,
- protected and safe habitat (see also Reichholf 2007).

Urban Biodiversity

Cities often have unique habitats whose characteristics and structures are the result of urban use (type, intensity and frequency of use and management). Land use (land use, land use, see Breuste 1994b) determines the structures and processes of the urban habitat. Its sub-habitats are not only characterized by new land conditions. They are complex ecosystems (biocoenoses) with special ecological characteristics, often influenced by anthropogenic factors. Diversity and smallness of the structures created by use are characteristic. They also offer many plants and animal habitats that have become rare outside of cities in Central Europe, especially due to intensive agriculture. Cities are thus also rich in species, including often a high proportion of non-native species, and different habitats. Cities are therefore often characterised by a high level of species diversity, for which humans are the decisive factor (Wittig 1998, p. 220, 2002) Cities offer new habitat qualities for plants and animals and in some cases also replace natural habitats outside the city. Since habitat conditions are directly dependent on urban structure and land use, this information is often used to draw up an ecological classification of the city (Chapter 3) (Klausnitzer 1993).

Table 4.1 Effects of human influence from the "point of view" of plants (from Wittig 1996, modified after Wittig 2002, p. 17)

Human influence			Effects from the "point of view" of plants*
Type	Object	Effect*	
INDIRECT	Climate	Warmer (especially also milder winters), drier, Air more polluted	Favouring thermophilic and drought-resistant species; increasing the chances of survival of frost-sensitive species; hardly any possibilities of existence for strongly (air-) moisture-dependent species (hygrophytes); extending the growing season Favouring toxitolerant species; disadvantageous to sensitive species
	Floor	More nutritious, basic more polluting, less water	Promotion of nutrient-loving, basophilic species, Competitive advantage for pollutant-resistant species, Advantage for water savers and/or extreme deep-rooting plants; hardly any possibilities of existence for hygrophytes
	Water	Groundwater lowered, surface water runs off more quickly	
	Waters	Framed, ducted or piped, dirty	Hardly any chance for marsh and aquatic plants (helophytes and hydrophytes)
	Entire location	Disruption, destruction, creation	Favouring annual species (therophytes) with a short generation cycle (several generations per year), high seed production, Effective dispersal mechanisms (e.g. wind dispersal), long-lasting seed bank; reducing competition; better chances for new arrivals (neophytes)
DIRECT	Plant	Combat	
		Mechanical damage	Advantages for species with strong regeneration capacity; disadvantages for delicately built and fragile species

* Compared to the surroundings of an urban area

4.1.2 Flora and Vegetation of Urban Habitats

Flora and vegetation in cities are largely determined by planted species. They dominate gardens, parks, tree stock, urban woodlands and accompany streets. Crops and even more so ornamental plants, whose species offered in nurseries and garden markets can hardly be surveyed. Fashion trends and sense of beauty determine even more than the urban ecological conditions (nutrient supply, water balance, soil conditions, climatic conditions, etc.), the species offered and planted. The favourable economic situation in many developed countries has significantly reduced the dependence on the cultivation of crops in cities or the urban surrounding, which is still high in many cities in Asia, Latin America and Africa. Planted ornamental plants, particularly perennial and low-maintenance species dominate. In the course of urban beautification and urban expansion, landscape gardening designs oriented to aesthetic ideas were implemented on a large scale in public and private spaces in Central European cities from the second half of the nineteenth century at the latest (Table 4.2). These urban gardens, which are in public areas maintained by urban garden departments, correspond to the social ideals of order, beauty and cleanliness. Many urban spaces created in this way by planted vegetation require intensive care (soil cultivation, pruning, removal of competing vegetation, increasingly also irrigation). Natural succession is hardly ever, if at all slowly, allowed, partly because of a lack of public funding for maintenance.

Flora
The totality of all plant species that occur in a certain distribution area (e.g. flora of Central Europe) and are systematically described. The term is species-related. There are also floras of urban areas (e. g. flora of Zurich). Zurich has one of the best-documented floras of ferns and flowering plants worldwide.

Vegetation
All the plants that cover an area and form plant formations and communities. The term refers to structures and communities of plants. Climate, soil, relief, rocks, water balance and the influence of fire, animals and humans shape the vegetation.

The flora of Zurich (ferns and flowering plants) includes 213 indigenous species, 119 neophytes and 84 archaeophytes (ten species are unassigned, 67 are lost or extinct; Landolt 2001).

Urban trees, the majority of which have also been planted, form an *urban forest* of numerous islands, rows of trees and individual trees of different sizes. The small areas create large marginal zones and the use and maintenance of missing undergrowth. Large cities alone have tens of thousands of planted and maintained trees along public roads (Wittig 2002; Chapter 6).

Table 4.2 Overview of the flora of the city of Zurich (according to Landolt 2001)

Native and naturalized species	1400
Occurring today	1210
Extinct over the last 160 years	190
Other species	600
Occurring only in the immediate vicinity	50
Introduced by chance and only occurring for a short time	150
Frequently cultivated, but hardly overgrown	400
Total number of species recorded	2000

However, geobotanical objectives of the investigation are usually not the planted and cultivated vegetation and flora, but primarily the spontaneous and possibly extensively cultivated vegetation and flora (Wittig 2002, p. 94). The spontaneous urban flora is composed of indigenous (native) and hemerochorous (non-indigenous) species. The indigenous species that have adapted to anthropogenic settlement sites are called apophytes. Among the non-native species, a distinction is made between those that immigrated in prehistoric times up to about the year 1500 (archaeophytes) and those that only immigrated after the year 1500 (neophytes). The proportion of neophytes in the urban flora is higher where the degree of disturbance (use, maintenance, emission etc.) is high (Lenzin et al. 2007). For some plants in cities no natural sites are known (anecophytes) (Table 4.3 and Fig. 4.3).

The urban flora can be divided into three categories according to the three main types of spontaneous plant distribution in cities - urbanophobic (urban sprawl, hardly ever found there), urbanoneutral (distributed in cities and surrounding areas) and urbanophilic (preferred in cities).

Typical urban species are usually no indigenous species, but predominantly neophytes. Only 5–6% of the flora of Central and North-eastern Germany are urbanophilic species (Klotz 1994).

Cities have significantly more species per km^2 than in the surrounding area only in the case of seed plants (especially representatives of the Asteraceae and Poaceae families)

Table 4.3 Increase in the proportion of non-native species in the fern and flowering plants of Central European cities by increasing settlement size (Sukopp 1983; in Leser 2008, p. 179)

City size	Total number of species	Percentage share Non-native species
Villages	No information	30
Small towns	500–600	35–40
medium-sized towns	650–750	40–50
Large cities	900–1400	50–70

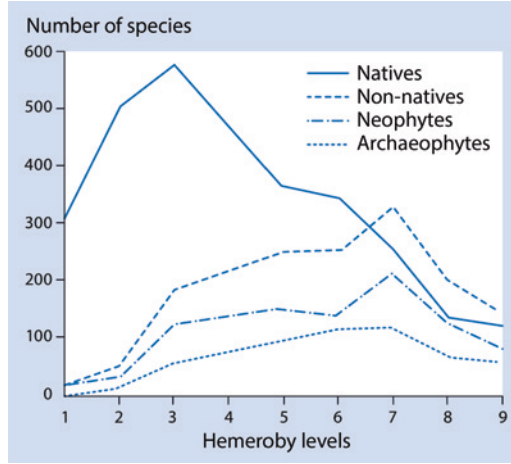

Fig. 4.3 Occurrence of native plant species as well as archaeophytes and neophytes (summarised as non-native) on differently disturbed sites in Berlin (hemeroby level 1: very slightly disturbed, hemeroby level 9: very strongly disturbed). (Data source 5136 vegetation surveys in: Kowarik 1988; from Kowarik 2010, p. 112)

do. This is due in particular to their high adaptability to warm and dry locations (well-developed water balance). Urbanophilic species are well adapted to urban drought by sclerophytic construction, life cycle and/or ecophysiological mechanisms. They often originate from warmer regions (Cornelius 1987; Wittig 1998). Within the same climate zones, there is a worldwide tendency towards the unification of urban flora due to increasing international exchange, disturbance adaptation, comparable thermal conditions and the occupation of vegetation gaps by pre-adapted newly establishing plants settlers (Sukopp and Wurzel 1995; Table 4.4).

Due to the ecological quality of certain urban sites, plant communities of spontaneous urban vegetation have developed in a mosaic-like pattern over the urban area, often sharply delineated from each other by use. They are characteristic of the respective structure or type of use (Chapter 2) or the respective urban zone (Wittig 2002). There is a close relationship between social structure, building structure and use on the one hand and vegetation patterns on the other (Hard 1985; Gilbert 1991; Wittig 2002). For this very reason, any inventory of urban flora and vegetation represents only a section of a dynamic development process, in which urban flora and vegetation can be interpreted ecologically (Fig. 4.4).

Table 4.4 Differences between urban and peri-urban flora in temperate climate zones. (Herbaceous vascular plants only, according to Wittig 1996; in Wittig 1998, p. 231)

Feature		Differences (compared to the surrounding area)
Number of species/ km^2		Higher
Non-native species (Hemerochoric plants)		More
Location requirements		More light-, heat-, base- and nitrogen-loving and drought-bearing species, less moisture-loving species
Family membership	Spectrum	Little one
	Percentage share	Asteraceae, Poaceae and Polygonaceae significantly increased, other families (e.g. Orchidaceae and Cyperaceae) reduced
Malfunction indicator		More
Life form		More Therophytes
Building plan		Less hygro- and helophytes, no hydrophytes
Dissemination mechanisms		More species with wind and adhesive or velcro dispersal
Flower	Size	More species with small flowers, lack of large-flowered species
	Quantity	More multiflowered species
	Duration	More species with a long flowering period (entire vegetation period)
	Pollination	More species with self-pollination and parthenogenesis, absence of species with complicated or specialised pollination mechanisms
Resistance to pollutants		More resistant species

Urban Biodiversity – Network BioFrankfurt

The Frankfurt area is home to 1675 fern and flowering plant species. This is about half of all known species in Germany on only 0.06% of the German territory. The close-by Taunus hills, which is 11 times larger, can only show 1250 species (Lehmhöfer 2010).

Cities are also *hot spots* of regional biodiversity. This is indicated by the high number of plant species found there and the high species density. Werner and Zahner (2009) found for Central Europe that for urban areas above 100 km^2 and over 200,000 inhabitants, 1000 plant species and 30–600 plant species per km^2 can be expected. This exceeds by far the intensively used cultural landscape. The

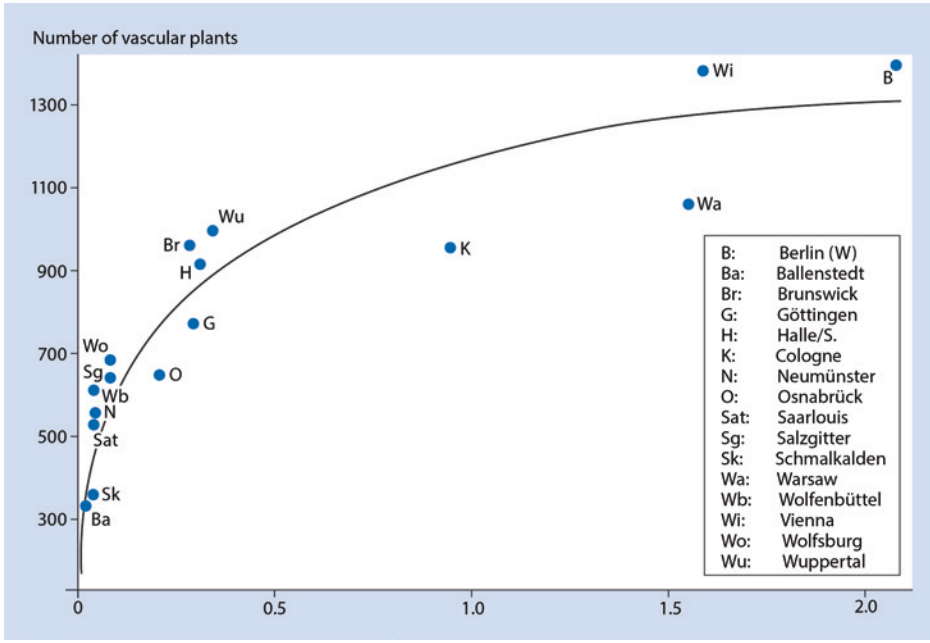

Fig. 4.4 Number of vascular plants in relation to the population of cities (according to Brandes and Zacharias 1990; Klotz 1990; quoted after Wittig 2002, p. 63)

high number of species in the city is explained by a variety of ecologically different sites. Usually, only spontaneous vegetation is included without differentiating between indigenous and hemerochoric species. A comparison with near-natural ecosystems, in which mostly only indigenous species occur, shows that urban biodiversity is not insignificantly caused by immigrated species and extreme and special ecological site conditions. This does not lead to the conclusion that nature conservation should concentrate on cities in the future since many species can be preserved or even protected with little effort in a small area, while in extreme cases protection measures outside cities can be reduced.

4.1.3 Animals of Urban Habitats

The importance of animals in urban ecosystems is often underestimated or less considered than that of plants. Although their biomass is much lower, their number of species is much higher than that of urban plants (by about 10 times; Tobias 2011). There is a considerable diversity of relationships with humans:

- Disposal of organic waste,
- Removal of insect pests from crops,
- Flower pollinators,

- Bio-indicators,
- Observation and encounter with animals as part of the contact with nature,
- Pests on plants, supplies and materials,
- Vector and exciter of diseases,
- Producers of troublesome waste (Klausnitzer 1993).

Livestock farming is still associated with settlements and also with cities. Not only in Indian cities you can find cattle breeding for milk production up to the city centres, but also in Salzburg, two kilometres away from the historical UNESCO world heritage city centre. The city is still home to agricultural land, also used for animal husbandry, whose importance is increasingly recognized today.

The keeping of pets without an economic but with an emotional benefit (dogs, cats, birds, small animals etc.) is becoming increasingly important. Insofar as they are active outside the home, they influence urban ecosystems to no small extent.

However, special object of investigation in urban zoological ecology are the wild animals (wildlife) in the city, which - due to the loss of habitats outside the cities and the attractiveness of the cities as a habitat - permanently colonise them. Their occurrence is also directly dependent on human uses (disturbances, food, etc.). Little research has so far been done on the soil animal world. Mammals in the city quickly come into the focus of general interest (wild boars, foxes, martens, squirrels, etc.). Here, too, the level of knowledge about populations, adaptation to habitat, dispersal, endangerment, etc. is still insufficient. They colonise replacement habitats with comparable, but also new characteristics to which animals adapt relatively quickly.

Best known is the avifauna of cities. The reason for this is - besides the widespread interest in observation (emotional attention) - the manageable number of species of this animal group and the relatively easy observability.

Big Garden Birdwatch

The special advantageous conditions of the city (rich food supply, winter feeding, hiding and sleeping facilities) are contrasted by disadvantages such as frequent disturbances, technical dangers such as traffic and light traps for insects. Many species from warmer countries are restricted to warmer building interiors as intramural fauna (Wittig and Streit 2004). In addition to parasites of humans and domestic animals, these include storage pests and species adapted to special habitats such as wood, roofs and damp cellars.

The following zoogeographical development trends can be generalized for animal groups and animals in the city:

- Reducing the diversity of their communities,
- Higher population density,
- Sudden changes in species numbers and urban distribution areas,
- Selective, species-specific preference of urban ecosystems against other ecosystems (“urban animals”),
- Development and expansion of familiarity and tameness,
- Change in food ecology,
- Change in the nesting method,

- Extension of the daily rhythms,
- Extension of the reproductive period,
- Behavioural changes (e.g. reduction of the migratory behaviour of birds),
- Extension of the average life span of individuals,
- Development of site stability of certain species (reproduction without exchange with surrounding populations)

(see Müller 1977; Klausnitzer 1993; Gilbert 1991; Klausnitzer and Erz 1998; Leser 2008; Tobias 2011).

Animals with urban colonization advantage

Especially those wildlife species are preferred which have the following characteristics:

- Short escape distance,
- No dependence on large open spaces,
- Adaptation to diverse structured, rocky terrain (z. B. former rock and cave dwellers, z. B. House Redstart, House Swallow),
- Similar food requirements as humans (omnivores, e.g. rats and mice),
- Specialists in certain foods or materials that are part of human needs (flour beetle, clothes moth),
- High reproduction rates (many offspring and short reproduction time),
- Low height,
- No great competition or disturbance to humans,
- Independent of high air or soil moisture,
- Not dependent on water or clean water,
- Not very sensitive to immissions (Wittig 1995; Wittig and Streit 2004).

Urban Blackbirds—Woodland Blackbirds

The woodland bird blackbird (*Turdus mercula*), which was still exclusively shy two centuries ago, became now an urban bird. The development of urban garden culture (Sect. 4.2.4) has opened up new habitats for blackbirds in the cities. The blackbird thus stands for the plants (apophytes) and animals (apozoes) of the forests that have become native to cities.

The breeding population of blackbirds in Nymphenburg Park in Munich fluctuated between 53 and 75 breeding pairs, about 30 per km^2, until 1982. In Munich's West Cemetery and the English Garden, this was as high as 86 and over 100 breeding pairs per km^2 respectively at the end of the 1970s and beginning of the 1980s. Natural sites such as the bog Murnauer Moos, on the other hand, had only 3.6 breeding pairs per km^2, forests in the vicinity of Munich even less (1–32 breeding pairs per km^2).

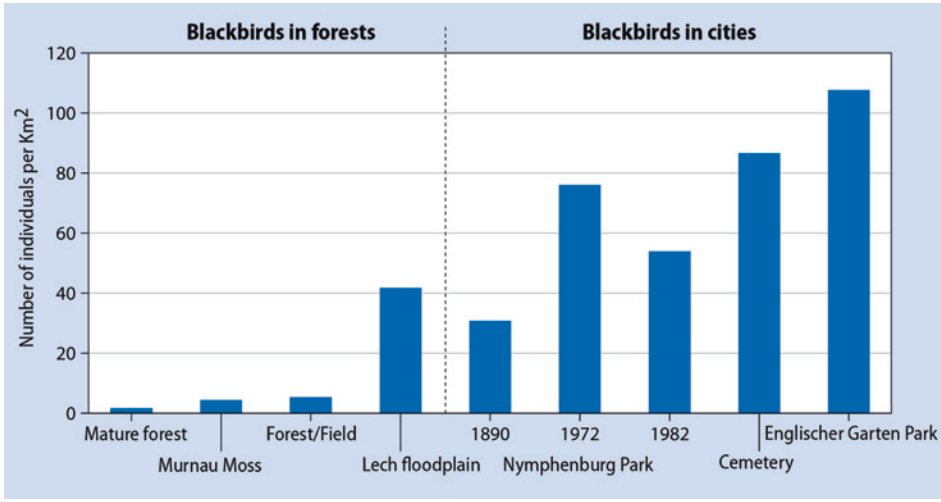

Fig. 4.5 Urban blackbirds—wood blackbirds in Munich's urban and suburban habitats (modified after Reichholf 2007, p. 104)

The blackbird reaches its highest population density ever in large urban open spaces (large parks, cemeteries, places where the ground remains accessible for foraging). The frequency of the species has been increased by a factor of about 10. The habitat change from woodland to urban also led to behavioural changes, so that today "woodland blackbirds" are distinguished from "urban blackbirds". The blackbirds often spend the winter in the city and take advantage of the wide range of food available. They are ecotypes of the species. The two-century advance from the forest into urban areas is an evolutionary process and is still ongoing (Bezzel et al. 1980; Wüst 1986; Reichholf 2007; Fig. 4.5).

Pet Ownership in Germany - One in Three German Households Has a Pet

22.6 million pets lived in German households in 2009. The majority of them lived in cities. Animals are kept in more than a third of all households. The numbers of animal groups are more or less constant. Cats and dogs have long been the most popular and most kept pets. The proportion of pet owners (over fifty years of age) has been growing slightly in recent years. But 53% of pet owners are younger than fifty years. The proportion of pet owners in multi-person households of the middle generations is also large. 74% of pets are kept in two-person and larger households. The proportion of pet owners up to 29 years of age (11%) and from 30 to 39 years of age (18%) has decreased. The share of 40-49-year-old pet owners remained unchanged at 24% compared to the previous years. Even though about a quarter of all pet owners live alone, pets are still predominantly family members (IHV 2010; Table 4.5).

Table 4.5 Pets in Germany (IHV 2010)

	Number of animals in million	Percentage of total pets kept
Cats	8,2	16,5
Dogs	5,4	13,3
Small animals	5,6	5,4
Ornamental birds	3,4	4,9
Animals in garden ponds	2,1	4,0
Aquarium animals	2,0	4,4
Terrarium animals	0,4	1,2

Ecological consequences on the native fauna can be observed especially with cats and dogs. The cats, most of which also run free, reduce the indigenous bird population. Free-ranging dogs considerably disturb ground-breeding birds and small mammals, but also game, especially in city forests and in nature reserves. Dog excrements in green areas are a hygienic burden, especially for children.

Big Garden Birdwatch

The *Royal Society for the Protection of Birds* (RSPB) organises the annual "Big Garden Birdwatch" in Great Britain, the world's largest organised bird survey. All citizens who carry out bird watching in their gardens or urban parks are invited to observe, record and report to the RSPB. This is a national event in which 590,000 people took part in 2013. On the basis of these observations, it has been established that most bird species are in decline. For example, the number of starlings recorded decreased by 16% compared to the previous year, and house sparrows by 17%. This is interpreted as a sign of a threat to the species and as a call to strengthen their protection. The house sparrow is already on the Red List of Threatened Species in Great Britain!

The RSPB states: Gardens are important habitats for the most endangered birds. However, they only cover 4% of the UK's land area (RSPB 2013).

4.2 Urban Habitats, Condition, Use and Maintenance

4.2.1 The Concept of the Four Natural Types

What is urban nature? This question can be answered very differently. The positions on this issue are shaped by different understandings of nature (Breuste 1994a; Brämer 2006, 2010). Nature is usually not sought in cities, but in "untouched" landscapes (forests,

mountains, etc., often distant to urban areas). The public rediscovery of "nature" (e.g. Müller 2005), "wilderness" (e.g. Rosing 2009) and "landscape" (Küster 2012, also 1995, 1998) in Europe is only just taking place. The "sense of nature" of the Romantics often mixes with scientific analysis and knowledge.

The realization is gaining ground that nature should not be understood as "untouched" and that everything created by man should not be understood as "non-nature". Leser (2008) justifiably demands that the concept of nature in the city should be defined so openly that "spontaneous to anthropogenic nature" is also included (Leser 2008, p. 214).

What is nature?

Kowarik (1992a) attempts a simple and pragmatic approach to urban nature by dividing it into four "nature types" based on the characteristics of urban flora and vegetation (but also indirectly of fauna). These natural species allow the diversity of anthropogenic shaped natural conditions in the city to be grouped into just four major groups, from which the habitats that shape them can be examined more closely.

Nature of the first type (Kowarik 1992a) are remnants of pristine landscapes, comprises woodland/forest and wetlands remnants, which are somewhat idealized as "pristine natural landscape", although they too have usually lost their "originality" through anthropogenic design (water balance influence, eutrophication, immissions, species changes, etc.). What is meant is their low urban character.

Nature of the second type, remnants of the cultural landscape, comprises agricultural areas, meadows, pastures, arable land and associated landscape elements such as hedges, heaths, drifts and dry grassland. This type of nature is characterised by varying degrees of intensive, often anthropogenic, influence, also in cities, through intensive farming. Their design is often already determined by the urban environment.

Nature of the third type, designed landscapes, refers to the "ornamental nature of the gardening facilities", the urban nature usually perceived as urban greenery, nature specially created for the design of the city and use - economically and aesthetically - in it. It has come into being as a kitchen garden for economic reasons or as a decorative garden (city garden or park), as an aesthetic structuring and design element, in the expanding and beautifying city. It combines very different, but very typical urban habitats such as house gardens, allotment gardens, traffic greenery, urban parks, large recreational parks, individual trees, avenues, etc. Their anthropogenic design through care and use varies greatly and is subject to temporal fluctuations, fashions and economic justifications. The designation of habitat, for example, park, can therefore provide rough indications, but does not yet say anything about the actual ecological status.

The **nature of the fourth type**, novel urban wilderness, enjoys special attention in urban ecology research as a "specific nature of urban-industrial areas", as it is not seeded or planted vegetation. This type of nature arose through spontaneous development under the more or less anthropogenic influence, but always in close relation to the strongly anthropogenic changed site conditions (soil, water balance, microclimate etc.) after the abandonment of previous uses. In accordance with the typical urban flora, pioneer communities, spontaneous bush communities up to urban pre-forests develop as stages of succession and adaptation to site conditions and disturbances. They are frequent objects

of study in urban ecology research and have been the focus of botanical interest since the 1970s and 1980s (see Rebele and Dettmar 1996; Wittig 2002 and others). Today this type of urban nature is also increasingly seen in its importance for humans (see Kowarik 1993; Wittig 2002 and others).

Urban habitats are all habitats within the city (Gilbert 1991; Aitkenhead-Peterson and Volder 2010). They are not just ecosystems shaped by gardening and spontaneous urban flora and fauna, that is, the nature of the third and fourth kind (green spaces and fallow land). Urban habitats should be understood as ecosystems that are located in the urban area (e.g. in an urban area or the area of urban development and its surroundings) and thus have a relationship to the city by urban utilization. Thus, the urban area is first and foremost a spatial dimension with a strong urban utilisation gradient, from intensive to low urban use (qualitative dimension). This use by urban dwellers and the design for urban dwellers always also influence the ecosystem state of ecosystems that are originally not specifically urban, such as woodland in a city (Gilbert 1991; Aitkenhead-Peterson and Volder 2010). In the following, some essential urban habitats of the four natural types and their management are presented as examples.

"Nature Obscure - How Young People Experience Nature Today"

Rainer Brämer, sociologist, at the Institute of Educational Science at the University of Marburg (Institut für Erziehungswissenschaft der Universität Marburg) with a research focus on the relationship between nature and man, has published numerous publications on empirical studies of nature relationships among young people (Brämer 2006). The Youth Report Nature 2010 (Brämer 2010) received special attention. The report notes that, among the 3000 sixth- and ninth-graders in six German federal states, the distance to nature already established in the previous studies appears to go further than expected. Contact with nature is only reduced. Brämer (2010) calls this "forgetfulness of nature" and "natural distance". Conservative ideals as cleanliness, order, tranquility and care also unite in children and young people transferred to nature and form an abstract image of nature that is shaped less by the school than by the media. Nature on the (urban) doorstep does not take place. Nature now functions only as a backdrop, although the sense of discovery, even for unknown landscapes, is still present and can be used for educational purposes.

Contact with nature takes place to 47% of the questioned scholars outside the city ("out in the country"), to 35% in the city and 28% in their own room (Table 4.6).

In the USA, Louv's (2005) report "Last child in the woods" has triggered a widely supported backlash against the remoteness of young people from nature, on a par with activities to tackle major environmental problems. This social reaction is still missing in Germany.

Table 4.6 Nature contact of young people (Brämer 2010)

Where do you prefer to spend your free time?	
Out in the country	47%
In the city	35%
In your own room	28%
I'm happy to do it, or would I like to do it!	
Discover unknown landscapes	74%
Mountain biking in the forest	53%
Walking through the forest	56%
Observe deer in the wild	49%

What is Nature?

The original total concept for the "totality of things of which the world consists" has meanwhile dissolved into various individual terms and made way for different "natures" (Leser 2008). Although the term "natural" still means "not influenced by man", it can hardly define this content ("pure" nature). Trepl (1983) states that this "good" nature is perceived in a diverse, decentralised, uncontrolled and spontaneous way and thus has the sympathetic features of a social role model.

Isolated nature (partial nature) - The nature of science remains a "mental isolate" of an unrecognizable wholeness of reality (Trepl 1983, 1988, 1992). The abstract "all-nature", the nature of philosophy, has today hardly any significance for the social image of nature. The symbolic nature ("culture-nature") of cultural history still determines our image of nature.

The admiration of nature led to a new and varied integration into social life. From this grew the longing for an ideal state, the view of nature as "good" nature, which, by turning back to it, would enable the solution of many social problems. Transfigured was the "lovely" agricultural landscape of the river-drained floodplains, which became the utopian shepherd's land of Arcadia and entered the cities through castle gardens, public parks and landscape gardens in the nineteenth century. This is contrasted by the woodlands/forest, which documents the power and primeval nature of the landscape (also applied to the individual tree). As a symbol of the primeval landscape "uninfluenced" by man, it showed the limits of human control over nature. Designed agricultural landscape and natural landscape as "pristine nature" formed the opposites of cultural appropriation of nature. Both can be found as symbols everywhere in the cities (sheared lawns from the cultivated floodplains, urban kitchen gardens from the village-agricultural environment, trees and shrubbery from the natural forest, pine and rock bushes as the fringe areas of ecumenism). Urban nature thus has a cultural-historical basis and is still accepted as a symbol (Breuste 1994a, p. 2–3, Breuste1999; Hard 1988).

4.2.2 Urban Forests

Urban forests can be assigned to all four nature types depending on the type of.

Urban forests are not only typical (remnant) elements of the agro-forestry cultural landscape into which cities have expanded and which are now located directly on their periphery, often near buildings, but also embedded in them (Jim 2011). They are also "park forests" of loose mixed structure, newly created by succession on fallow land. What is meant in the following is not the often common property designation "urban forest" as forest owned by the city, regardless of its location.

Large municipal forests in Germany are in Berlin (a total of 28.500 ha Berliner Stadtforsten) the Tiergarten (210 ha), the Grunewald (approx. 3000 ha) and Köpenicker Forst (approx. 6500 ha), the Frankfurt Stadtwald (3866 ha), the Dresdner Heide (6–133 ha), the Eilenriede in Hannover (650 ha), the Rostocker Heide (6004 ha) and the Duisburg Stadtwald (approx. 3000 ha). Baden-Baden has the largest municipal forest in Germany with 8578 ha and a share of 61% of the city's total area. The Leipzig floodplain forest (approx. 2500 ha) is one of the largest floodplain forests in Central Europe.

Since the late 1960s at the latest, there has been a continuous rethinking of forest management of urban forests, away from timber production and towards *urban and community foresty* (Johnson et al. 1990; Kowarik 2005; Burkhardt et al. 2008; Jim 2011) with multiple forest functions.

In the European research project "Urban Forests and Trees" (1997–2002), a systematic overview of the planning, management and use of urban forests and urban trees was compiled (Konijnendijk et al. 2005). For Germany, summarizing and special studies on the management and redevelopment of urban forests are available in Kowarik (2005), Kowarik and Körner (2005), Rink and Arndt (2011).

In the USA and increasingly also in Europe, the term *urban forest* is understood to mean the entire stock of all trees in the urban area, mixed according to species, age, ownership and density. It has no individual owner and is not subject to joint, coordinated management, but serves human needs in its entirety and its parts (Breuste and Winkler 1999; see ecosystem services, Chapter 5).

The urban city forest consists of woodlands of different sizes and many individual trees, rows of trees and avenues. Large contiguous forests (more than 60 ha) are rather rare, and there are the ecologically relevant border effects of small woodlands (Fig. 4.6).

The urban forests cover a whole spectrum of forests from successional woodlands to planted forest plantations. Forests with a species composition that deviates from the ecological site conditions are called forests. In the case of a site-appropriate combination of woody species, the term forest can be used regardless of whether it was created by original natural development or planting (Kowarik 1995; Table 4.7).

Urban forests are divided according to their functions. In addition to wood production, which can even take a back seat in urban forests, new tasks such as recreation, nature experience, environmental learning and others are being set.

Studies on species diversity of urban woodlands are often available, at least for urban planted forests. However, species diversity depends very much on the type of forest,

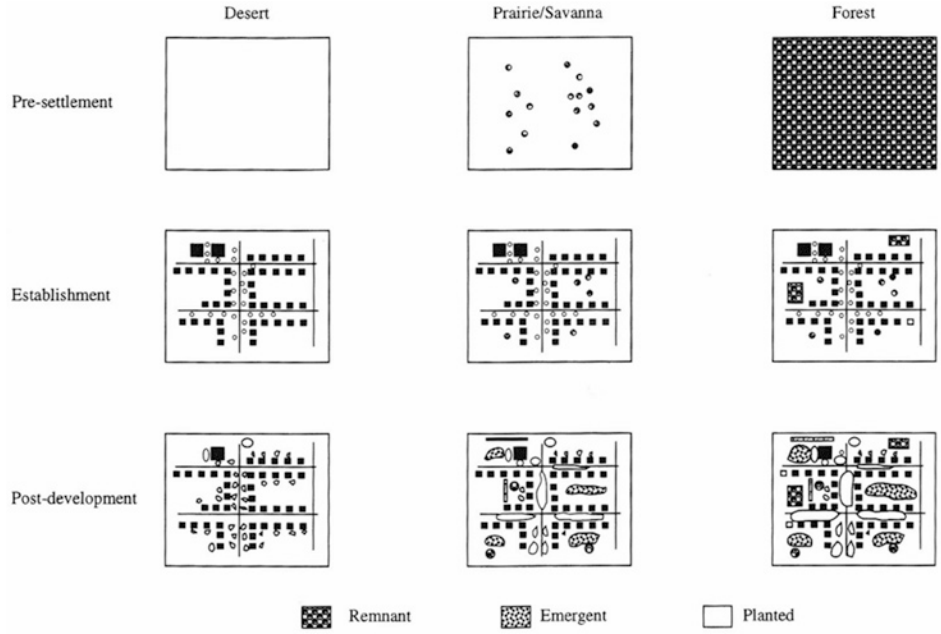

Fig. 4.6 Development of the *urban forest* through forest remnants, emerged and planted forests in three ecoregions (Zipperer et al. 1997, p. 235)

Table 4.7 Types of an urban forest (according to Kowarik 2005, modified)

Nature 1	"Old Wilderness"	Natural forests or their remains
Nature 2	"Traditional cultural landscape"	Forest, strongly influenced by traditional forestry
Nature 3	"Functional Green"	Park forest, planted trees in green areas and residential areas
Nature 4	"Urban Wilderness"	Succession forests on fallow land

its use and its maintenance, and therefore cannot be generalised. All in all, it can be expected that urban forests with near-natural tree stock and low disturbance will provide habitats for a large number of native plant species. For park forests and successional forests, this is only incompletely the case. Kowarik (1992a) lists 77 woody species for the spontaneous forests Berlin, including three tree species and four climbing plants. 50% of the woody plants are indigenous. In the remaining 50%, the shrubs are predominantly neophytes. 13% are also archaeophytes. Black locust (*Robinia pseudoacacia*, neophyte from America) dominates the tree and shrub layer, in which the native black elder

(*Sambucus nigra*) also occurs. The pioneer woody plants of the tree and shrub layer are too weak in competition with black locust (*Robinia pseudoacacia)* to displace it. The relative stability of this successional forest is assumed. Maple forests with beech could replace the black locust (*Robinia pseudoacacia*) after a longer period of time (Kowarik 1992b).

New planted forests - example Leipzig "Stadtgärtnerei Holz" (BfN 2010; Rink and Arndt 2011)

The higher the structural diversity of an urban forest, the higher the species diversity and population density. Tree species composition, habitat diversity (dead wood, earth and tree cavities, disturbed edge areas, hiding places, resting and reproduction areas) contribute to the quality of the habitat (Otto 1994). The settlements, agricultural use and conversion of forests into productive commercial forests have usually reduced the area of natural forests in urban areas of Central Europe to an extreme extent and changed their habitat quality. Their rare, little disturbed remains are often under strict protection as nature reserves in forests otherwise usually only protected as landscape protection areas.

The urban forests are the least impaired habitats for animals over large areas. Compared to other habitats, they are usually less affected by land fragmentation and reduction and high intensity of use (Gilbert 1991; Fig. 4.8).

The urban forest of Salzburg rises on hills to 190 m (up to 640 m height) above the city of Salzburg. The 75.5-hectare beech forest on limestone was designated as a landscape conservation area in 1981. After a long phase of open scrub formation by grazing, the hill was reforested with site-adapted beech trees, typical for the location, but as a secondary forest.

A large number of plant communities have been identified and determined for Central European cities (see Wittig 2002). Although Central Europe used to be a forest country, forests are no longer dominant components of the cultural landscape here. This is

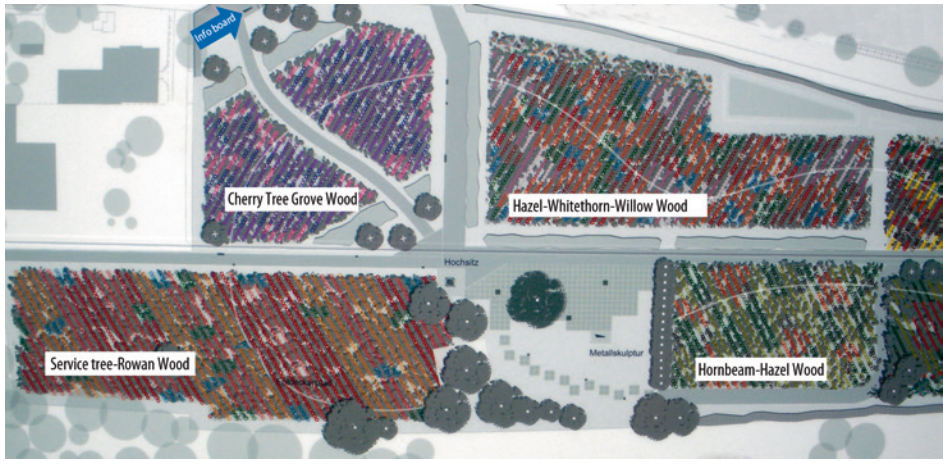

Fig. 4.7 Stadtgärtnerei-Holz, "urban forest" in Leipzig. (Photo © Breuste 2012)

Fig. 4.8 The Kapuzinerberg hill in Salzburg is a forest island in the midst of the city. (Photo © Breuste 2003)

Fig. 4.9 **a** Butterfly bush (*Buddleja davidii*) on a former industrial site Phoenix West, Dortmund (Photo © Breuste 2012), **b** Tree of the heaven (*Ailanthus altissima*) as a street tree in Bratislava, Slovakia (Photo © Breuste 2015), **c** black locust (*Robinia pseudoacacia*)as a spontaneous tree on the railway premises of the Zollverein former coal mine in Bochum. (Photo © Breuste 2011)

especially true for cities where often bush and forest plant communities of spontaneous vegetation have not been understood as typical for settlements (Diesing and Gödde 1989). Black locust (*Robinia pseudoacacia*) as single trees and Robinia forests are spreading to suitable locations in the warm continental area, for example, in the Upper Rhine area and the Vienna Basin. In northwestern Central Europe (e.g. Ruhr area), butterfly bushes (*Buddleja davidii*) - societies (neophyte from China) (Fig. 4.9a) are particularly characteristic (Kunick 1970). In the central and south-eastern area of Central Europe urban tree of heaven (*Ailanthus altissima*), a neophyte from Eastern China appears (Fig. 4.9b).

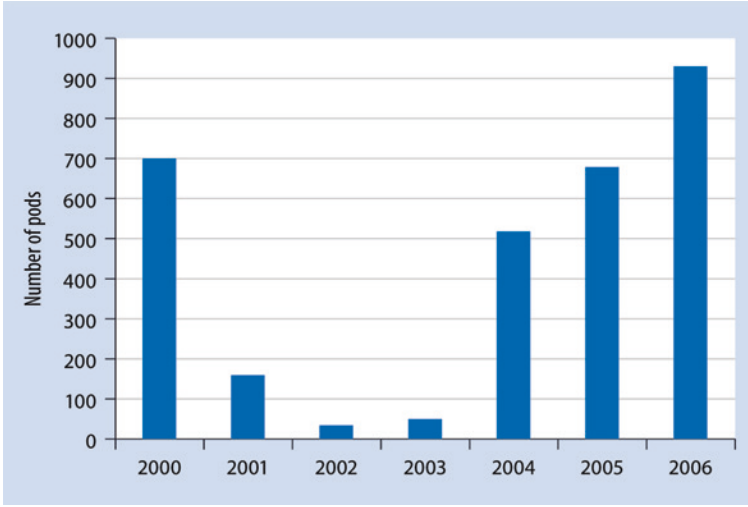

Fig. 4.10 Longer-term cycle of seed attachment (number of pods) of *Robinia pseudoacacia* in the garden of the State Zoological Collection Munich (Zoologische Staatsammlung München) (Reichholf 2007, Fig. 96, p. 1991)

Not only thermal adaptation enables these species to distribute in cities. In addition, other adaptations make them competitive, such as in the case of the black locust (*Robinia pseudoacacia*), the formation of root runners that make even closed plant stands possible to colonie, long-lived seeds, budding on underground runners (bud bank) etc. (Kowarik 1992a; Reichholf 2007; Fig. 4.9c, 4.10, and Fig. 4.11).

Arndt and Rink (2013) see to develop urban forests as innovative urban open space development strategies, especially in shrinking cities, where the opportunities for their implementation arise.

Structure of Urban Forests in Germany

Burkhardt et al. (2008, p. 32, modified) divide city forests functionally.

Neighbourhood forest

- Relatively small forests in the residential area,
- Particularly important for user groups with reduced mobility, such as children, elderly, disabled people
- Positive effects on the local climate, possibly on the immediate surroundings,
- Bright, transparent and inviting forest structure, gradation of the tree stock in height and density,
- Often insufficient care and disturbing waste disposal.

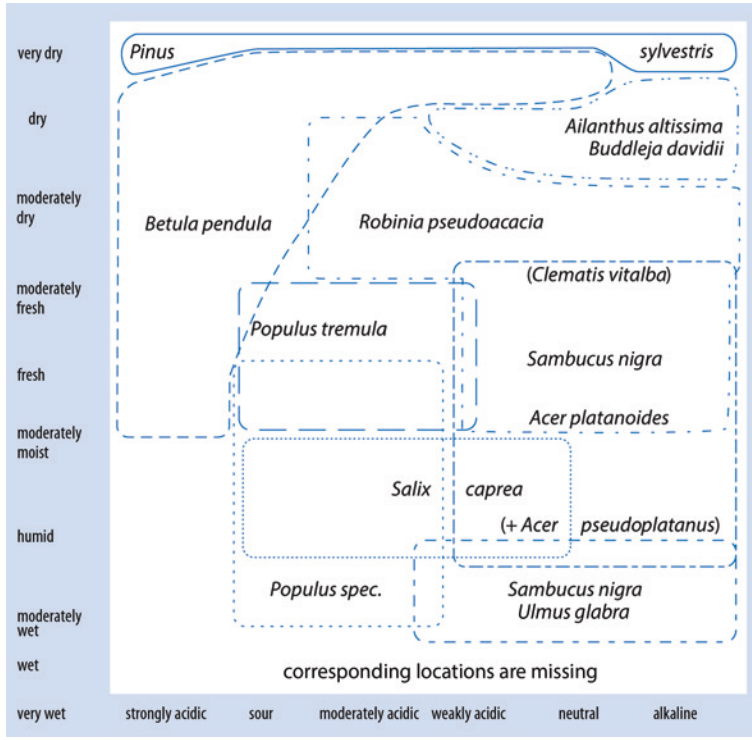

Fig. 4.11 Preference of the spontaneous woody plants common in the Berlin city centre with regard to soil moisture and soil acidity (according to Sukopp 1990; cited in Wittig 2002, p. 169)

District forests

- Multifunctional, medium-sized forests,
- Often located between city districts or in connection with new construction areas on the outskirts of the city,
- Use by residents and passing pedestrians and cyclists,
- Information and public participation are particularly important,
- Graduated management based on the intensity of use.

Recreational forests (mostly on the outskirts of the city)

- Mostly bigger than 60 ha,
- Different forest structures possible as a mosaic pattern,
- High diversity and closeness to nature are possible,
- Various possibilities for experiencing nature,
- Equipment with paths, meeting points, seats, information boards etc.

Productive forest

- Forest areas outside of cities,
- Focus on timer production,
- With additional functions as required (e.g. nature conservation, recreation).

Newly Planted Forests - Example Leipzig "Stadtgärtnerei Holz" (BfN 2010; Rink and Arndt 2011)

In the Leipzig district of Anger-Crottendorf, a city nursery that has not been used since 2005 was converted into an urban forest after the demolition of the building. The "Stadtgärtnerei Holz" was handed over to the public on 23 June 2010. The 3.8 ha large "Stadtgärtnerei-Holz" is the first completed sub-project of the test and development project (E+E) "Ecological urban renewal by planting urban forest areas on inner-city sites in a change of use - a contribution to urban development", which was funded by the German Federal Agency for Nature Conservation with funds from the German Federal Ministry of the Environment, Nature Conservation and Nuclear Safety. Using Leipzig as an example, the new creation of various types of inner-city forest areas is to be tested. These forest areas are to be an instrument of innovative urban development and at the same time contribute to the preservation of biological diversity. The action in Leipzig is also part of the implementation of the German National Strategy on Biological Diversity and the German Strategy for Adaptation to Climate Change.

More than forty percent of the surface of the location had to be unsealed. Fruit-bearing wild shrubs, which are reminiscent of the former horticultural use, can be found next to forest trees. Areas for playing, lingering and walking were created. The plantations consist of 30–50 cm high forest plants, which must be fenced in for the first five years.

Experiments are being carried out with different forest variants in relation to natural forest formations (oak-hornbeam forest, *Carpino-Quercetum*) and by admixture with fruit trees in relation to previous use (Fig. 4.7).

Nature Park Schöneberger Südgelände

In 1952 the railway operation at the Anhalter Bahnhof in Berlin was stopped. The natural succession of the railway wasteland began. The "Bürgerinitiative Natur-Park Südgelände" (Citizens' Initiative Nature Park Südgelände), founded in 1987, was able to prevent a reuse of the 18 ha large area by proving its ecological value, which has since been proven. In 1995, the Deutsche Bahn AG transferred the Schöneberger Südgelände to the Berlin Senate as compensation for interventions by its transport facilities elsewhere. The state-owned Grün Berlin Ltd., supported

with 1.8 million marks by the Allianz Environment Foundation, took over the further development of the forest park, which was placed under nature and landscape protection and symbolically opened in 1999. In 2000 it became an official German EXPO project.

In 61 years of more or less undisturbed succession, after pioneer stages of herbaceous vegetation and bushes, a new urban (pre-)forest developed, dominated by birch (*Betula pendula*) and black locust (*Robinia pseudoacacia*) as a new form of "urban wilderness" - a scientific and aesthetic object of experience of independent habitat development after the abandonment of use.

The spontaneous vegetation and the corresponding fauna are well studied. Thus, 366 different species of ferns and flowering plants, 49 species of large fungi, 49 species of birds, 14 species of locusts or crickets, 57 species of spiders and 95 species of bees can be seen there. A part of the area is designated as a nature reserve. It is not allowed to leave the paths here, especially to protect ground breeding birds. A 600 m trail above the ground, build by elevated steel grid paths, fixed to the old, still existing railway tracks, lead through the area. Grün Berlin Ltd. is currently developing further concepts for combining new urban nature with concerts, readings, as well as theatre and cultural projects. Guided tours of the flora, fauna and history of the area are held regularly. The combination of forested urban wilderness and urban culture and recreation seems to be a complete success (Kowarik and Langer 2005; Senatsverwaltung 2011; Grün Berlin GmbH 2013; Cobbers 2001; Table 4.8, Fig. 4.12).

Table 4.8 Differentiation of forests in relation to settlements (after Kowarik 2005, p. 9, modified in Burkhardt et al. 2008, p. 31)

Forest type	Subtype	Spatial situation	Function		Urban influence
			Social function	Production	
Urban forests	Forests within and on the outskirts of urban areas,	Insulated in the built-up area, Between the built-up area and open landscape			
Semi-urban forests	Forests near cities	Part of the cultural landscape near or adjacent to urban areas			
Non-urban forests	Forests far away from cities	Part of the open (semi-natural) landscape, far away from cities			

Fig. 4.12 Nature Park Schöneberger Südgelände. (Photo © Breuste 2011)

4.2.3 Urban Waters

Urban waters are running and still waters that are subject to characteristic urban influences (commercial use, flood protection, aesthetic design, pollution, eutrophication, etc.) (Schuhmacher 1998). They show considerable changes compared to waters of the same type outside cities. Still, waters are naturally occurring small waters, ponds, lakes, but also park waters and rainwater retention basins. Running waters are rivers, streams, canals and drainage ditches (Gunkel 1991). With their peripheral areas, they are important habitats for plants and animals (Gilbert 1991).

The following, in particular, have changed for urban waters

- Hydrology and hydraulics (flow dispensation/dynamics, flow velocity),
- Watercourse structure (width, course, profile, bank),
- Species spectrum of plants and animals, abundances,
- Waterbody use (e.g. recreational and leisure use) and water status (Endlicher 2012, p. 87).

Urban waters can thus take over functions in the city (Chapter 5)

- Habitat for flora and fauna (ecological potential),
- Urban climate improvement (climatic potential),
- Industrial and commercial use (utilization potential),
- Absorption of wastewater (disposal potential),
- Embellishment of the urban human habitat (recreational and aesthetic potential) (Endlicher 2012, p. 89).

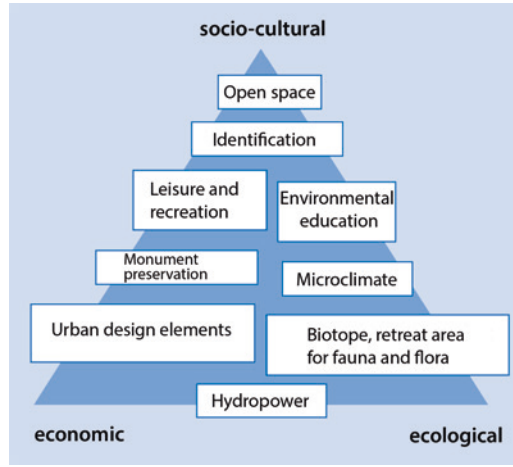

Fig. 4.13 Functions of urban waters (DVWK 1996)

Table 4.9 Nature Park Schöneberger Südgelände. The decline of herbaceous vegetation and the increase of woody vegetation in a 10-year period (Kowarik and Langer 2005, p. 289)

	1981	1991
Area under investigation (in ha)	22,4	20,0
Investigated vegetation area (in ha)	21,6	19,1
Cabbage vegetation (in %)	63,5	30,9
Forest vegetation (in %)	36,5	69,1
Dominated by:		
Robinia pseudoacacia (%)	11,2	21,3
Betula pendula (%)	13,7	23,8
Betula pendula & *Populus tremula* (%)	?	5,3
Populus tremula (%)	1,3	2,3
Acer platanoides, *A. pseudoplatanus* (%)	0,2	1,4
Other (%)	10,1	15,0

In 1996, the German Association for Water Management and Cultural Construction (DVWK) assigned them socio-cultural, economic and ecological functions (Fig. 4.13; Table 4.9, Table 4.10).

Water quality: Pollution of urban waters by material inputs is decreasing, at least in Central Europe, but still exists. They must be reduced at the source. Kausch (1991) distinguishes two groups of substance inputs, substances that directly or indirectly affect the oxygen content of water bodies, and substances that accumulate in organisms and can have toxic effects.

Due to the frequent loss of the filter function of ecosystems in the water environment, the oxygen content is often reduced, which is partly to be counteracted by technical means (weirs, etc.). Constant monitoring of water quality is necessary to detect and prevent pollution at an early stage.

Table 4.10 Change in the functions of water bodies and waters in Central European inland cities due to anthropogenic use and perception (Kaiser 2005, p. 22)

	Before 1750	1750–1850	1850–1915	1915–1950	1950–1980	Since 1980
Protection			–	–	–	–
Food, fisheries, irrigation					–	–
Route of transport						
Energy supplier						
Drinking water supply						
Service water supplier						
Disposal						
Leisure and recreational use	–	–	–			
Upgrading the living environment	–	–	–	–	–	
Habitat for plants and animals	–	–	–	–	–	

High significance,
Medium significance,
Low significance, - No significance

Due to the large urban sealing areas, a large part of the precipitation water does not seep away and is largely drained through the sewerage system and fed to nearby watercourses. This poses additional risks in the event of flooding there and lowers the groundwater level. Technical construction very often leads to the isolation of the habitats. The urban physical, chemical and biological conditions reduce plant and animal specialists and promote ubiquists (reduction of the species spectrum).

As a consequence, the often highly advanced technical expansion, especially of the watercourses for flood risk reduction, has destroyed many water-related habitats in the city or considerably impaired their habitat functions. Especially the river floodplains in cities as natural retention areas hardly fulfill their ecological functions anymore by straightening rivers to canals and lowering the groundwater table (Fig. 4.14). Where there is still a floodplain forest, the disturbance-influenced softwood floodplain habitat

Fig. 4.14 Salzach in Salzburg - a river canal with good water quality and recreational function. (Photo © Breuste 2003)

has largely given way to a mixed stand that has emerged from the hardwood floodplain (Gunkel 1991; Kasch 1991; DVWK 1996, 2000; Schuhmacher and Thiesmeier 1991; Schuhmacher 1998; Leser 2008; Endlicher 2012).

Waterbody renaturation is intended to restore the lost functions at least partially and in certain often only small areas. In most cases, the original condition cannot be the reference target. Instead, a "near-natural state" is redefined and supported by initially technical measures. The priority is to improve water quality by purifying the discharged water. The increase of low water discharge and the combination of flood protection with renaturation measures are current challenges in urban water management (DVWK 2000). Nature conservation and nature development on the one hand and recreational use on the other can also be brought together again using urban water bodies as highly attractive recreational areas in cities.

Renaturation of the Isar in Munich (2000–2011)

With its islands, gravel banks, meadows, floodplain forests and parks, the Isar river floodplain is an attractive recreational area for the whole of Munich and especially for the almost 200,000 people who live in the districts close to the Isar river. Cycling, walking, jogging, sunbathing, barbecuing, playing games and in winter sometimes even cross-country skiing are possible.

In 1988 the Isar Plan was created, a renaturation project that has been developed with the participation of citizens, associations and political committees since 1995 as part of the planning process. In February 2000, the exemplary Isar renaturation project began in Munich, with three objectives: improved flood protection, more

space and closeness to nature for the river landscape, improvement of the leisure and recreational function.

The river bed was widened and the flood dikes were repaired. Flat, partly terraced, accessible banks were created. Gravel areas and natural bank formations with recreational opportunities and new, interesting visual relations to the river are part of the project.

Sufficient water supply and quality support the developing near-natural habitat of fauna and flora. The river will continue to shape its river bed in the course of time. In eleven years, the Isar Plan was implemented over a length of eight kilometers by 2011. Unique in Europe were the successful efforts to achieve bathing water quality on the Isar river.

The first Award for Water Development for exemplary measures for the preservation, natural design and development of water bodies in urban areas was awarded to the Munich Water Management Office and the City of Munich for the Isar Plan project in 2007 by the German Association for Water, Wastewater and Waste (DWA).

The widening of the river bed improved the flood flow. Flat banks, offshore gravel banks, gravel islands and shallow ramps of large stone blocks with basins in between ("dissolved river bed ramps") make it a semi-natural river in the city again today. This improved the habitat diversity for the animal and plant species typical of the Isar river. Nature development, urban and recreational use can go together.

The costs for the project (flood protection and renaturation measures) amounted to approx. 35 million euros, 55% of which were borne by the Free State of Bavaria and 45% by the City of Munich (Wasserwirtschaftsamt München 2011; Fig. 4.15).

Fig. 4.15 Section of the renaturalized Isar river in Munich. (Photo © Voigt 2013)

4.2.4 Urban Gardens

Urban gardens in various forms are as nature of the third type (Kowarik 1992a) the typical and desired natural forms and habitats in cities. They are and were part of the urban beautification that began in the nineteenth century. Ignatieva (2012) sums up that these were influenced worldwide by the English garden idea ("Victorian Gardenesque" 1820–1880) and have led to similar garden (park) forms in different cities of the world. While private decorative greenery in the cities had previously been reserved for elites as a manorial park, the "greening" of the rapidly growing cities according to landscape gardening ideals has now begun. Public parks, avenues, decorative small green spaces, lawns and hedges became an element of the new urban development (Schwarz 2005a). To these was added in the second half of the nineteenth century the allotment garden (Schrebergarten), which was not concerned with the need for decoration but with the need to be active in dealing with nature and to profit from it (fruits, vegetables), thus bringing elements of our rural character into the city. This "symbolic nature of allotment gardens" can at least be divided into two large groups, the mostly public parks and the mostly privately used gardens, connected to houses or independent. In addition, there is a variety of small green structures such as roadside greenery, single trees, avenues, playgrounds, vest-pocket parks, etc. From these two groups, public city parks and allotment gardens will be treated here as examples.

4.2.4.1 Public Urban Parks

Different habitats belong to this urban nature category:

- Small neighborhood parks,
- Big city parks,
- Very large recreation and adventure parks, mostly on the outskirts of the city,
- Botanical and zoological gardens (theme parks),
- Cemeteries,
- Forest parks (transitions to the urban forest, see above).

The transitions to the urban forest are fluid, especially when the park is laid out in the forest (e.g. in many Scandinavian cities).

Key ecological features are:

- Equipment of the park with natural elements (trees, bushes, lawn, water etc.),
- Size (marginal effects of small parks reduce ecological functionality),
- Disturbances (especially noise, but also dogs running free, number of visitors and visitor activities, presence of less disturbed retreat areas)
- Tree stock (density, species spectrum, degree of canopy cover, age, etc.),
- Management (intensity, frequency, timing).

The typical features of a public park consist of large open spaces with sheared lawns, individual trees, sometimes ornamental shrub beds and flower beds that require more care. Small woody areas are often integrated with larger parks (see also Gilbert 1991). Park maintenance is mostly a public affair (e.g. in the USA also private) but is becoming increasingly expensive for the municipalities. Ways are being sought to reduce these costs, for example, by staggering the maintenance and allowing natural succession in parts of the park. Out of conviction for the spontaneous development of nature, ecoparks on urban wasteland (e.g. in Great Britain) have now also been created (Sect. 4.2.5).

People's parks (Volksparke) as public parks were created in Germany, for example, in Berlin, Hamburg, in the Ruhr area, in Düsseldorf, Leipzig or Munich, mostly only in the twentieth century (Endlicher 2012). The parks are used for recreational purposes. This has changed from a more contemplative use to active elements of use in recent years. In an open society, different culturally determined interests of use are added (e.g. sports on park lawns, camps and barbecues with large numbers of people on grass). Nevertheless, most parks are still natural cells of peace and relaxation. Children's play areas, sports fields or even dog meadows can be integrated. Their users are predominantly older people, young families with children at weekends; a cross-section of urban society (e.g. Krause et al. 1995).

Public parks offer opportunities for a variety of nature observations and allow an emotional or even intellectual approach to nature. For the majority of our children who live in cities, they are the most important places to learn about nature. In addition to recreation, parks can also take on important functions as meeting places with nature for learning from and with nature (nature experience spaces, nature experience spaces). This is particularly important when public parks are the only easily and quickly accessible nature elements in large cities. They are currently only partially fulfilling this important task (Breuste et al. 2013a).

Public urban parks are important habitats for plants and animals. The avifauna of urban parks is usually well studied. It is in Central Europe characterized by characteristic species composition. Blackbird (*Turdus merula*), starling (*Sturnus vulgaris*), greenfinch (*Carduelis chloris*), collared dove (*Streptopelia decaocto*), great tit (*Parus major*), chaffinch (*Fringilla coelebs*), blue tit (*Cyanistes caeruleus*) and wood pigeon (*Columba palumbus*) were frequently observed in Leipzig and Chemnitz (Wittig et al. 1998). Breuste et al. (2013b) show considerable differences in avifauna in the Linz parks and can prove the connection between low disturbance and high structural richness on the one hand and high breeding bird numbers on the other hand (Breuste et al. 2013b).

The "People's Park" for democracy: Central Park in New York

The rapidly growing metropolis of New York was to be given a new center in the middle of the nineteenth century, Central Park - a revolutionary new idea in modern urban planning. In 1858, 4000 men began the landscape design work of the creative visionary and father of the American landscape architects Frederick Law

Olmsted. Central Park became his masterpiece and "the greatest American work of art of the nineteenth century" (Schwarz 2005b, p. 135). The "artwork urban park ", completed in 1873, was also intended to combat the escalating problems of the rapidly expanding metropolis. The public urban park was literally assigned a therapeutic and healing effect for the social and health problems of the urban population. It is undisputed that Olmstedt's primary motive is to make it a place where all strata of urban society can meet nature. In such a park for the people, the different social classes were to meet and the "rowdies" and "ruffians" of the lower classes were to learn from the behaviour of the middle and upper classes. This social illusion resulted in a myriad of rules for visitors, including dress codes and controls. Ultimately, however, Central Park remained a park for the rich in the nineteenth century, who had time alone to visit, used it for their carriage rides and enthusiastically welcomed and promoted it as an enrichment of their elitist lifestyle.

Only today, Central Park is a park for everyone, visited by 25 million people every year, on some days more than 500,000, and at 349.15 hectares it is the largest of New York's 1700 parks. The park is first and foremost the habitat of New Yorkers, who have one of the few opportunities here for contact with nature.

Central Park has its website (www.centralparknyc.org) and its own funding organisation, the private *Central Park Conservancy* which was founded in 1980. The *Conservancy* staff maintains 250 hectares of meadows, 24,000 trees, 150 hectares of lakes and streams and 80 hectares of forest. They look after the annual plantations, 9000 benches, 26 playgrounds and 21 ball fields. All this is done with the help of donations. Since its foundation, 60 million US dollars in donations have been collected, 536 million from private sources. The highest single private donation was registered in 2012 with US$100 million from the John A. Paulson's Foundation. In 150 years, the park has been worth US$150 million to the city of New York (Central Park Conservancy 2013; Fig. 4.16) (Schwarz 2005b).

Shanghai (China) is building a new "national park city"

Hardly any other city in the world has expanded its urban green space as much in such a short time as Shanghai. The 761 ha city green in 1978 was extended to 30.609 ha by 2006. 37.3% of the space of the megacity are green spaces. In 1990 this was 3 m^2 per inhabitant, in 2006 already 22 m^2 per inhabitant. This is internationally unprecedented and shows the city's efforts to give itself a face as a modern metropolis as a "park city". The largest new green spaces are not first and foremost classic urban parks, but a network of tree plantations and forest parks in the city's surrounding area that accompany streets and waterways (Fig. 4.17, 4.18 and 4.19).

New parks were created in urban expansion areas such as the Pudong district (e.g. Century Park 140 ha). But also in the densely built-up city, space was found

Fig. 4.16 Central Park New York. (Photo © Zepp 2011)

Fig. 4.17 Area of the future urban park Yangzhong Greenery, Yan'an Road in Shanghai, state 2000 (display board on site)

for urban greenery. The solution here was the demolition of old residential buildings to make space for parks. The Huangpu section of the city park on Yan'an Road was completed after a one-year planning and construction period in 2001 at 11.85 ha. Previously, 17.07 ha had to make way for old residential buildings and 4837 families who were resettled in other parts of the city. With a stock of old trees transplanted there, it does not give the impression today that it is only thirteen years old on Fig. 4.18 (Shanghai Municipal Statistics Bureau 2006).

Fig. 4.18 Yangzhong Greenery City Park, Yan'an Road in Shanghai, the state in 2001 (display board on site)

Fig. 4.19 Yangzhong Greenery City Park, Yan'an Road in Shanghai. (Photo © Breuste 2011)

4.2.4.2 Allotment Gardens

In the last quarter of the nineteenth century organized allotment gardening developed in Central European cities. The allotment garden sites were mostly leased land for a limited period of time, which was located close to the residential areas with multistoried houses and rented apartments and often built on later. Only in unfavourable locations, unsuitable for building development did the gardens of the initial period last longer.

The origin of the allotment garden and the allotment garden association is the industrial society. At the same time, the allotment garden is a part of the pre-industrial country life, which has been preserved until our time and has thus also grown out of the industrial society. This persistence of individual urban allotment gardens testifies to a special significance of this "second urban nature type" (Kowarik 1992a). Many accents of the allotment garden have changed in the course of its development, its core, the creative interaction with nature, have remained and is as relevant to modern urban life today as it was in the past. From the point of view of ecologically oriented urban development, the maintenance of human health, leisure activities in the urban space and especially in the big cities, the allotment and leisure garden system is still of great importance at the beginning of the twenty-first century (Breuste 2007). With the *Urban Gardening movement,* the spectrum of design and appropriation of urban green spaces has expanded.

In many cities, especially in northern and central Germany, allotment gardens were created in particularly large numbers between the two world wars and still characterise the green structure of the cities today. In some former industrial cities, they now occupy as much space as all other urban green spaces (except municipal forests) combined (e.g. Halle, Leipzig) (Breuste 2007).

Allotment gardens in Germany are about 300–400 m^2 in size and have fruit trees, vegetable beds, flower beds, lawns and a summer hut. In recent decades, there has been a marked change from a pure utility garden to a recreational garden (less labour-intensive vegetable beds, more lawns) and a nature meeting place (Breuste 2007).

Many older allotment gardens are now located in the middle of the city and part of the district like other facilities. At present, however, it is precisely here that a process of displacement is taking place in favour of building uses.

Allotment gardens are important green elements of the city and living spaces (Gilbert 1991). They are the last links between the urban and the countryside life. Mostly the allotment gardeners in allotment garden estates (from a few dozen to several thousand allotments) are organized as associations. The allotment garden is an important green space, cultural factor, place of learning, recreation and meeting. Allotment garden estates in the city are green spaces that make the built-up areas habitable (Schiller-Bütow 1976). Considerable parts of the urban population spend their leisure time as tenants or their family members in allotment gardens. A study by the BMVBS (2008) assumes 4.5 users per allotment garden. The majority of allotment gardeners are pensioners with a relatively large amount of free time. Co-users are their younger family members. No other public green space is only remotely as intensively visited and used as the allotment garden. On weekends in summer, 7–9 h a day are spent here.

As part of the green system of large cities, allotment gardens can, among other things, a. improve the urban climate and air hygiene, increase biodiversity through habitat provision and provide more contact with nature (see also Wittig et al. 1998, pp. 347–348; Endlicher 2012, pp. 197–199; Table 4.11).

Table 4.11 Allotment gardens organised by associations in Germany. (Breuste 2010)

	Number of allotments	Number of allotment garden estates	Area in km^2
Germany BDG	About 1,000,000	14.000	466,40
1. Berlin	67.363	738	31,37
2. Leipzig	40.000	290	9,63
3. Hamburg	36.000	311	14,00
4. Dresden	23.400	366	7,67
5. Hanover	20.063	102	0,94
6. Frankfurt am Main	16.000	115	0,80
7. Magdeburg	16.000	236	0,85
8. Rostock	15.559	155	0,66
9. Chemnitz	15.100	181	0,54
10. Bremen	13.900	160	4,79

4.2.5 Urban Brownfields

Urban brownfields are areas in the city that are temporarily (a few years to decades) unused but previously used. They can be found in industrial areas or on railway sites, but also as independent areas due to the abandonment of use. War destruction, reserve land provision and socio-economic reasons (e.g. de-industrialisation, demographic change, land speculation etc.) are the causes of abandonment. Brownfields are found worldwide, especially in the context of urban-industrial shrinkage (e.g. in Germany, Great Britain, USA, Korea).

Urban brownfield sites have primarily urban-industrial prior uses. Agricultural wastelands on the urban territory are often found on the outskirts of the city as “farmland”. They are rather untypical urban wastelands.

Some brownfields are designated according to their previous uses - for example, Housing, agriculture, industry, etc. (e.g. Rebele and Dettmar 1996).

Urban brownfield sites are habitats of intensive anthropogenic changes (e.g. industry), which have often come to a sudden standstill. They are therefore often relatively undisturbed areas for years, on which a natural secondary succession can take place via pioneer stages to pre-forests. They are therefore among the few urban habitats where no management takes place and where their natural development can be scientifically observed. Early on, this has turned urban wastelands into an experimental field for ecology and objects of scientific investigation (Gilbert 1991; Sukopp and Wittig 1998; Rebele and Dettmar 1996; Wittig 2002). Urban brownfield sites are valuable habitats with plant and animal species often only found there.

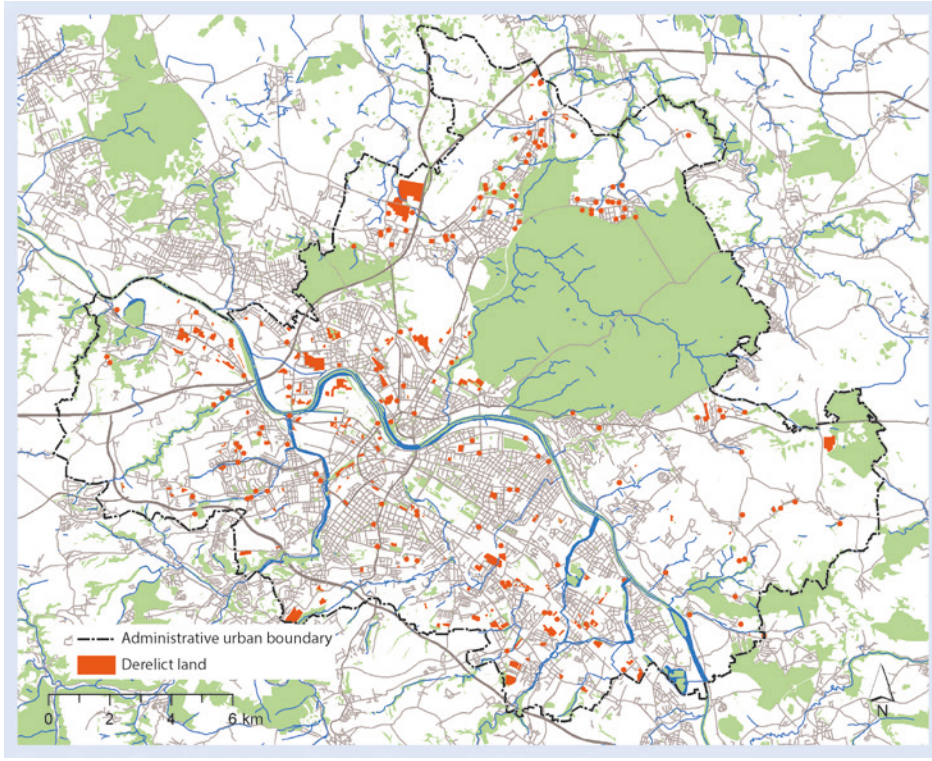

Fig. 4.20 Brownfields in Dresden 2004 (in red), total 1550 ha. (Korndörfer 2005)

On the other hand, nature observations can be made on them and experiences of nature gained that would not be possible anywhere else in cities. This importance of urban wastelands will increase, but it is still not sufficiently recognised and appreciated. Instead, the reuse of brownfield sites is the focus of efforts almost everywhere. This is quite understandable in view of a large number of urban wastelands in some cities (e.g. in Dresden 2004, 1550 ha) (Fig. 4.20).

Particularly long-standing undisturbed brownfields, brownfields in different stages of succession, as well as easily accessible and accessible brownfields in residential areas must be at least partially preserved as a natural experience area and are developed in a targeted manner. To this end, necessary agreements can be made with the owners (in some cases, especially in eastern Germany, these are the municipalities themselves) on temporary (co-)uses simple infrastructural accessibility and exclusion of risks of use (risk of injury).

The acceptance of the "forth nature type" (Kowarik 1992a) and its new possibilities for the experience of nature and the possible integration of succession areas into traditional parks will depend to a large extent on whether it will be possible to overcome existing reservations about "unkempt", "messy" and "unattractive" natural succession

Fig. 4.21 Thüringer Bahnhof district park, developed since 1991 on former railway brownfields. The railroad gardens depicted here show the industrial traces of previous use. (Photo © Breuste 2008)

nature and to make people familiar with this specific nature. This requires more efforts in environmental education, especially in kindergartens and schools. Banse and Mathey (2013) were able to show in a study that the initial stages of succession with herbaceous pioneer vegetation and the final stages with less penetrating dense woody vegetation are least regarded as pleasant and inviting to use, but the intermediate stages with perennials and single trees are certainly better accepted. It is, therefore, possible that the use of urban brownfields for nature experience or as part of public green spaces may require design intervention in order to control succession in a targeted manner.

Brownfield revitalisation refers to the efforts of municipalities to make reuse possible by demolishing buildings and eliminating the risks of use. For this purpose, public funds are used via subsidy programmes. The reuse of brownfield sites as public open spaces often has the aim of establishing public parks on their areas, sometimes as a new type and with reference to previous use (e.g. parks on railway lines - e.g. Eilenburger Bahnhof in Leipzig or Thüringer Bahnhof in Halle/Saale, Fig. 4.21). As a rule, the new parks allow for a considerable upgrading of residential areas in the densely built Wilhelminian-style neighbourhoods that were associated with industries that have since been closed down (Hansen et al. 2012).

Ecological Parks in London – Brownfields as Public Urban Parks

Ecological parks are intended to enable nature development of all kinds on urban sites and the use of these by people for recreation and experiencing nature (*enjoy nature*). Neither traditional park designs nor costly management is necessary.

Citizens design their parks themselves or receive gardening support while respecting urban nature.

Max Nicholson was a visionary who proclaimed as early as 1976 that he wanted to bring nature conservation into the cities through nature experience and he put this into practice. Nicholson and the Trust for Urban Ecology (TRUE) first realized this idea in 1976 at an old truck park near London Bridge in London with the William Curtis *Ecological Park*. In 1986–88 *Stave Hill Ecological Park* was built in the London Docklands. Further parks as *urban wildlife habitats* in London, other cities in the UK and abroad have since been added. Stave Hill is a nine-meter high mound of rubble and debris from the London Docks with 2,1 ha surrounding land in various stages of natural succession, preserved by management.

TRUE manages Stave Hill, *Greenwich Peninsula Ecology Park, Dulwich Upper Wood* and *Lavender Pond Nature Park*. In 2012 TRUE became part of *The Conservation Volunteers* (TVC).

The TRUE *Ecological Parks* take a new approach to urban conservation by introducing people to the not especially spectacular urban nature. They create new *habitats* for plants and animals (*habitat for urban wildlife*), enable urban ecology research, introduce urban citizens, especially children, to urban nature through their own experience (environmental education) and demonstrate creative urban nature conservation off the beaten track, involving citizens as volunteers in management. The *Ecological Parks* on urban wastelands with natural succession and use-related management has proven to be a new idea to value urban nature (TCV 2013).

4.2.6 Structure and Dynamics of Urban Habitats

Through the urban expansion, the urban nature of first and second type has been displaced to the periphery. The nature of the third type, the parks and green spaces, were created together with the new residential areas and urban expansions in interrelated mixed structures. The large urban parks were either created on the outskirts of the city on former agricultural land or in forests. The dense inner-city development allows only little green space in inner courtyards or as front gardens. The belt of low-density, low-density, loose buildings adjoining the inner cities to the outside is much more diverse, with plenty of garden greenery in individual and terraced housing. In the mixture with commercial and industrial areas, there are also more frequently urban brownfields with nature of the fourth type, and a small-scale structure of nature used with varying intensity leads to a wealth of species in the outskirts of the city, which is caused by the structural richness and often exceeds that of the intensively used inner cities and even that of the intensively agriculturally used surrounding area. It is primarily thanks to these spatial patterns of urban nature and biodiversity that cities are often richer in species than their surrounding areas. Despite this general spatial structure of decreasing building density and increasing natural

endowment from the inner city to the outskirts, cities generally have a mosaic structure of the four natural types in accordance with their development and land use. Although the total number of vascular plants in the city is high, there are considerable differences between the individual biotope types and also within the same biotope type (Chapter 1).

Urban habitats were and are subject to dynamic change, determined by changes in land use and intensity of use. The abandonment of land use leads to successions and creates new habitat characteristics and structures. The surroundings of urban natural areas often lead to the isolation of the habitats and the endangerment of their populations due to building development and traffic routes. This influence can be mitigated by networking the habitats in the city. The changing habitat structures in the city require ongoing monitoring in order to be able to carry out protection and development within the framework of complex urban nature conservation. Additional challenges arise from climate change, which will especially affect cities. For example, it is expected that the number of tropical days (average temperatures above 250 °C) in Essen will increase from 22 to 76 days in the years up to 2100 (Kuttler 1998). This, combined with summer drought, will lead to changes in the urban flora, the planting of other ornamental plants and the irrigation of parks. Plants that are better adapted to higher temperatures and drought will gain competitive advantages (Chapter 1 and Sect. 5.3; Sukopp and Wittig 1998).

Urban nature is unevenly distributed in the urban area. Some districts have very few and small green spaces; others have large parks, urban forests or private gardens. In every city, the majority of living space is privately owned (agricultural land, private gardens) and is subject to private decisions in design and management. In built-up urban areas, two-thirds of green spaces are often private. Just like public open spaces, they are living spaces, but are given far less consideration in analysis, evaluation and planning. The public and publicly accessible green spaces of cities are also unequally distributed. Depending on location and distance, not all citizens have equal access to them. While this is a design goal in European cities, it is often ignored or accepted in other countries. The green districts are inhabited by the “richer”, the less green by the “poorer”.

Distribution of Urban Parks in Tabriz, Iran

In a study (Breuste and Rahimi 2015), all 132 city parks of Tabriz (Iran) were examined with regard to their accessibility in distance zones, differentiated by park size and category (from urban green spaces to large urban parks) and their social environment. While the provision of urban green spaces is comparable for all districts and all social groups in the city, this is not the case for the larger regional and urban parks. The larger and better equipped the parks are, the more often they are located in a residential environment with higher social status. In the vicinity of the large urban parks, the well-off middle classes dominate over low-income groups with over 75%. The park environments are at the same time characterised by higher land prices and rents. Public green spaces in Tabriz are far more accessible and accessible to the richer classes of the population than to the poorer classes, who, however, make up the majority of the urban population (Fig. 4.22).

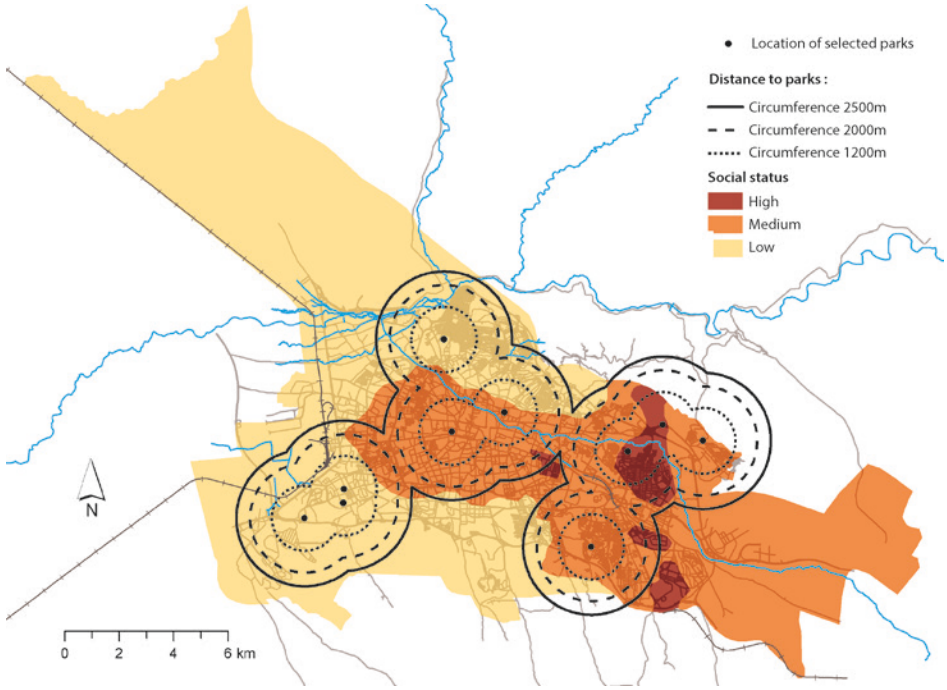

Fig. 4.22 Catchment areas and social status of the residential environment of urban regional parks in Tabriz, Iran (Breuste and Rahimi 2015)

4.3 Management of Urban Nature

4.3.1 Tasks and Objectives of Urban Nature Conservation

Urban nature conservation has special tasks. It protects nature for people in the city. This includes first and foremost making this nature accessible to people and understanding and preserving it as a place for recreation, learning and experiencing nature.

> Nature conservation in the city does not primarily serve the protection of endangered plant and animal species; its task is rather to specifically preserve living creatures and biotic communities as the basis for the direct contact of city dwellers with natural elements of their environment (Sukopp and Weiler 1986, p. 25).

Urban nature conservation can not only make use of scientific approaches and methods, but must also include social science issues, and often even put them in the foreground.

Among the new, urban tasks of nature conservation were

- Recreation,
- Environmental protection and landscape management (water balance, water hygiene, climate, air hygiene, noise protection),
- Educational use as a model and experimental areas,
- Unregulated child's play,
- Identification with the area (“sense of home”),
- Production of agricultural and ornamental plants,
- Bioindication of environmental changes and pressures,
- Ecological research (Sukopp and Weiler 1986; Breuste 1994a).

The urban land use structures are a general, spatial analysis instrument for nature conservation in the city. On their basis, interpreted as biotype types, plant and animal species and their biotic communities are often recorded. Nature conservation management also refers to this urban approach in species and biotope protection programmes.

> In the populated area, it is primarily the uses that shape the distribution pattern of the organism species. The basis of nature conservation work in the city is therefore to systematically record the most important types of land use and to describe their species population and their ecological conditions of existence. The final result shows the extent to which individual uses of certain characteristics contribute to the conservation of species in the populated area. It also becomes clear which uses are characterized by pronounced species poverty and may, under certain circumstances, require measures for 'renaturalization' (Sukopp et. al. 1980, p. 565).

The land use-related biotope survey became in Germany the standard procedure with the 1986 basic programme for area-wide biotope mapping in populated areas (Arbeitsgruppe 1986). This basic programme was revised again in 1993, but in principle corresponds to the methodological approach of 1986 (Arbeitsgruppe 1993). With this basic programme, between 1978 and 1986, area-wide biotope mapping in populated areas had become established as the standard procedure for developing ecological programmes for nature conservation in cities in Germany (Breuste 1994a, b).

Although the “flow chart of biotope mapping in populated areas” (Schulte and Voggenreiter 1986; Schulte et al. 1993; Frey 1999) can also be clearly emphasized as areas of evaluation of the mapped biotope types “experience of nature and nature experience” and “townscape/village/landscape”, this area has only recently been dealt with more intensively (Reidl et al. 2005).

In contrast to the scientifically exact recording of plant and animal species and their evaluation according to rarity and endangerment, the social sciences are required here as an important component of urban nature conservation. Biotope mapping, however, is usually done by biologists and landscape ecologists. Social science studies should be involved in nature conservation investigations and justifications right from the start.

Trepl (1991) points to the need to expand the justifications for nature conservation, which also makes nature conservation research an object of social science:

- Importance for urban design (aesthetics, preservation of tradition, etc.),
- Importance for recreation,
- Importance for the "free" use of "open spaces", especially by children and young people,
- Importance for education, training.

Accepted nature can be protected for the urban dweller, unaccepted nature only against the urban dweller. To protect nature in the city against the urban dweller should be the rare exception with special justification (e.g. protection is not possible elsewhere) (Breuste 1994a). The exclusion of humans from nature to be preserved should be the rare exception in the city. What consequences does this have for nature conservation? Which nature should be protected and for what reason?

> In the built-up area ... the focus is not on the identification and preservation of natural vegetation and the fauna associated with it, but rather of those biocoenoses that have spread over large areas with the urban development of the last 100 years (Sukopp 1982, p. 60).

For all urban areas, spatially differentiated nature conservation objectives specific to settlements are to be determined. The same structure, or the same species spectrum of a biotope outside and in areas enclosed by buildings, cannot lead to the same nature conservation objectives applying to them. Even near-natural habitats in the settlement area cannot be treated according to the general objectives for such areas from the outside (Plachter 1990, 1991).

The answers to the questions

- What is the value of a tree in a street?
- From what point of view are small green structures important?
- Can this value be compared with that of a rare insect species in the city's alluvial forest?
- Does rarity increase the worthiness of protection?
- Why do rarities enjoy special protection?

can only be found by taking into account the specifics of development, location, use and functions of nature in the settlement area.

The definition of generally applicable, settlement specific nature conservation objectives has not yet been completed. Ecosystem services and thus the usefulness of nature for humans now seem to provide orientation for urban nature conservation.

4.3.2 Practical Nature Conservation in the City - Worldwide

For urban nature conservation, all levels of scale, from the house and garden plot to the urban landscape, are equally important. They are part of the nature conservation concepts of the cities. Many small changes in use, for example, more near-nature management in a public park or garden or the felling of trees in an avenue, also bring about ecological changes at the level of the city as a whole. Such changes can be essential for animals that operate on this larger scale. Habitat loss and isolation as well as the emergence of new habitat structures must be considered in nature conservation concepts. In a complex habitat mosaic, natural patches can complement each other, unusual ones can be replaced in their function by others, and some are irreplaceable. This eco-functional consideration of habitat patterns and networking of urban habitats is of great importance for practical urban nature conservation.

Auhagen and Sukopp (1983) made the first attempts to define urban nature conservation objectives using the example of Berlin (West) at the beginning of the 1980s (principles of ecotope and species protection).

Guidelines for the implementation of nature conservation in urban planning

In 1987, principles were developed for the "Guidelines for the implementation of nature conservation in urban planning" (Sukopp and Sukopp 1987, pp. 351–354), which are still fully valid today.

Principle of.

1. Priority areas for environmental and nature conservation,
2. Zonally differentiated priorities of nature conservation and landscape management,
3. Consideration of the development of nature in the city center,
4. Historical continuity,
5. Maintaining large continuous open spaces,
6. Networking of open spaces,
7. Preservation of differences in location,
8. Differentiated intensity of land use,
9. Maintaining the diversity of typical elements of the urban landscape,
10. Preventing all avoidable interference with nature and landscape,
11. Functional integration of structures into ecosystems,
12. Creation of numerous channels for air exchange,
13. Protection of all life-supporting factors.

> In short, almost every attempt to protect 'nature' in the city has paradoxical effects. The only sensible way to protect nature in the city is to let the 'weeds' grow where and as long as they do not really interfere with everyday activities (Hard 1998, p. 41).

This drastic formulation by Hard (1998) at least indicates that nature development in the city has an intrinsic value and should not be formally destroyed for reasons of order and cleanliness alone. This way of thinking is slowly beginning to take hold in green spaces and municipal nature conservation administrations, not least with the support of numerous NGOs. Less intervention means more nature development and this without costs, for example, urban forest. What is also missing is the acceptance of spontaneous nature by the urban dwellers, a process that should be promoted in the long term through environmental education.

Species and Biotope Protection Programme Munich

The Species and Biotope Protection Programme (ABSP) in Bavaria is a nature conservation concept. Based on biotope mapping and species protection recording, it analyses and evaluates all areas of importance for nature conservation. It derives from the results goals and proposed measures, which have been developed and applied for more than twenty years for districts and cities. The Bavarian State Office for the Environment coordinates this work. The ASBP is carried out according to a uniform standard by independent planning offices and specialists on its behalf. The results of the ABSP are used for the preparation of landscape and green space plans or in contractual nature conservation. They are an important basis for nature conservation authorities and local authorities.

The dynamic development of the city of Munich in recent decades has led to the designation of new commercial and residential areas. Ecologically significant areas potentially important of nature conservation (e.g. parts of the open forest Allacher Lohe, the railways' yard area or parts of the Panzerwiese heartland) were also taken up by construction measures. Instead of using ecologically significant areas on the outskirts of the city, priority for building developments should be given to (already built-up) areas that are no longer used. Wetlands, rough meadows and dry habitats in the city are legally protected by several nature reserves. 44 areas with a total of approx. 155 ha have been designated as protected landscape components (various types of forest, litter meadow remnants, heath land remnants, hedges and field shrubs, fallow and succession areas, old tree populations and old parks). Since 1964, 18 landscape protection areas (approx. 5150 ha) have been designated. Sealing is to be reduced. In particular, the preservation of historically developed biotopes has priority over a new establishment. For this purpose, conceptual cooperation with the surrounding communities (e.g. regional pool of compensation area) is practiced.

Munich is striving to develop a biotope network system in the settled area with a focus element:

- Development of a dry biotope network,
- Conservation and optimisation of wetland habitats,
- Development of a network of woody biotopes,
- Conservation and development of all forests and woodlands in the urban area, especially those of special importance for avifauna, deadwood-populating insect species, cave breeders, bat quarters,
- Preservation and optimisation of the running water system including the springs with spring streams of the city (Bayrisches Landesamt für Umwelt 2014).

Protection of urban biodiversity—the example of Singapore

The 712 km^2 large island city-state Singapore had 5.7 million inhabitants in 2018 with a very high population density of 7126 inhabitants/km^2. The National Park Board is responsible for four nature reserves (3347 ha), 2269 ha urban green spaces (59 regional and 255 district parks) 2664 ha street green spaces, including more than one million trees and 1679 ha used open land. Only 200 years ago, the island was completely covered in forest (82% tropical forests, 5% swamp forests and 13% mangrove forests). In 1992, a first *Singapore Green Plan* was drawn up, which was continued until 2011. It has since been supplemented by the *Singapore Blue Plan* (Fig. 4.23). Singapore has adopted a *National Climate Change Strategy*, a *National Biodiversity Strategy* and an *Action Plan*. In addition, there are ten-year *concept plans* and five-year *master plans* for urban development, which include the protection of biodiversity. The "City In A Garden" concept envisages the embedding of the city in a natural environment managed by different parties and the protection of the remaining tropical forest. The *Singapore Index of Cities Biodiversity*, which was developed in 2012, is intended to encourage other cities to evaluate and monitor their natural environment and nature management themselves. More than fifty cities around the world are already applying the evaluation concept. Twenty-three quantitative indicators will provide information on urban biodiversity, ecosystem services (water regulation, climate regulation, recreation, education) and their management. Since 1992, Singapore has thus been one of the pioneers in the protection of urban biodiversity worldwide (Davisson et. al. 2012) Fig. 4.24.

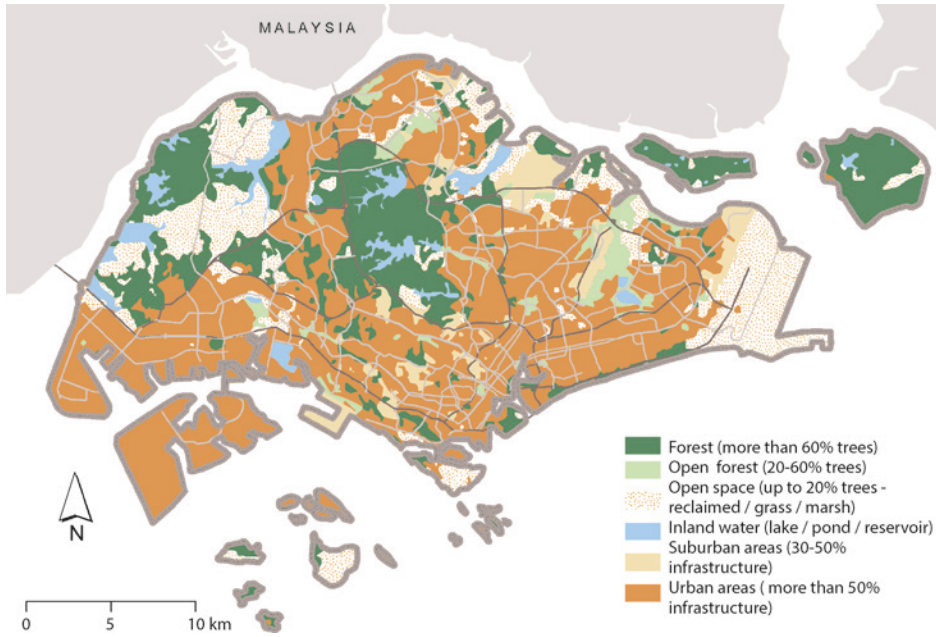

Fig. 4.23 Urban nature as part of the urban structure in Singapore. (© Design: J. Breuste, cartography: W. Gruber; source: Davison et al. 2012)

Fig. 4.24 Table Mountain National Park, Cape Town, South Africa. (© Breuste 2006)

National Park in the City - Example Table Mountain National Park (TMNP) Cape Town, South Africa

The Table Mountain National Park (TMNP) was established in 1998 after earlier conservation efforts (1963 Table Mountain Nature Reserve) to protect the unique endemic flora of the Cape Floral Region (UNESCO Cape Floral Region World Heritage Site), but also because of the special landscape of the Cape Peninsula. On three sides it is surrounded by the growing city of Cape Town with its 3.7 million inhabitants, to whose 2455 km^2 urban area it belongs with 221 km^2 (9%).

The efforts of the park administration consist of organising the large streams of visitors and in the preservation and development of the particularly rich biodiversity (2200 mainly endemic flowering plants, in comparison the whole of Great Britain has 1492 flowering plant species). The National Park is a globally important biodiversity hot spot. Invasive plants are reduced by deforestation (e.g. of commercial *Pinus pinaster* plantations) or fire management to give indigenous flora (fynbos and afromontane forest) development opportunities (Fig. 4.24).

With its educational opportunities, the park plays an important role in nature education for the population of Cape Town. More than one million people visit it every year, many of them international tourists. The National Park in the city is easily accessible through a variety of trails, but especially through the cable car to the 1067 m high Table Mountain (since 1929). The majority of the inhabitants of the large black townships see the mountain every day, but most have never visited it (Yeld and Barker 2003).

4.4 Conclusions

Urban nature is complex, diverse and determined by man. The changes in natural conditions lead to special habitat characteristics that do not occur in the surrounding area. These include more fragmentation, warmer and drier habitats, changing intensity of use and much more. In cities, humans also provide substitute habitats for species that often have few habitats left in the intensively used agricultural landscape of the urban surrounding. This also explains the relative species diversity in cities. Ubiquists, but also specialists, find habitats in cities.

The diversity of urban habitats can be divided into four easily describable nature categories (“nature types”; Kowarik 1993). They all have their justification in the nature spectrum of cities. Urban trees along streets, on squares and in urban forests, for example, enable a wide range of ecosystem services that help people to improve human living conditions in cities (shade, temperature reduction, increase in humidity, light attenuation, habitat for many animals, etc.) They allow an aesthetic and creative enhancement of urban spaces without requiring a lot of space in the competition for space. Especially

the self-developing urban-industrial succession nature is still not a valued part of urban nature in the consciousness of the urban dwellers. This urban nature manages without planting and care, is optimally adapted to the conditions of the location and can be an enrichment of the spectrum of habitat spaces in cities. Animals are often less noticed in cities or only perceived when they become pests (health, buildings etc.) or appear as spectacular species (wild boars, foxes, moose etc.). They are, however, permanent inhabitants of our cities.

The habitats are in a constant state of change due to changes in land use and urban expansion. Climate change will also be a particular challenge for flora and fauna. Cities are the first experimental fields to show how flora and fauna react to these changes. The dynamics of urban habitats must be given special consideration in urban nature conservation. Urban nature conservation is not only the continuation of nature conservation efforts from outside the city into the city. It must also take into account a paradigm shift that consists of protecting nature for the urban dwellers and not against them. The task of bringing nature in the city closer to the people in the city and turning urban nature into places of learning and nature experience alongside recreation is of particular importance. For the majority of people in many countries, the city is the most important space for dealing with nature and learning from and about it.

Urban nature is neither primarily fragile nor is it a risk space for people. In this area of conflict, however, it is often perceived in cities. Maintaining nature for the protection of urban nature is only necessary where we have good reasons for wanting to enforce and preserve a very specific nature against its natural development and where we aim for accessibility and risk reduction. Nature maintains itself, even in the city, independently if it is allowed to do so. Nor does it need to be perceived per se as a risk space (dense, dark, confusing). It is a space for recreation, inspiration, relaxation and learning. For this, it is needed as a green infrastructure like other important parts of the urban structure. We need more nature of all kinds in cities, in a better distribution, accessible to all, in order to make their services available to every urban dweller. Species and biotope protection concepts, but also the commitment of the many individual urban citizens to nature in their city helps to achieve this.

Questions

1. What are unfavourable site conditions for plants in the city in comparison to the urban environment?
2. What are the reasons for the richness of species and the attractiveness of cities as habitats?
3. What characteristics do animal species favour when settling in the city?
4. Why in urban ruderal black locust forests only 50% of the woods are indigenous?
5. Why are brownfield sites valuable habitats?
6. What is the main task of urban nature conservation?

Answer 1

- The chemical milieu of the soil is often unfavourable.
- The chemical milieu of the air is usually less favourable (gases, dust etc.).
- The enjoyment of light is reduced at many locations.
- The water balance is usually more difficult. Higher temperatures cause water losses. Soils are often reduced in their water storage capacity (low soil moisture content due to compaction).
- Soil sealing and compaction impede the colonisation by plants.

Answer 2

- Structurally diverse urban landscape,
- Nutrient-poor, dry and warm biotopes/habitats,
- Protected and safe habitat.

Answer 3

- Short escape distance,
- Adapted to small structured areas,
- Adaptation to richly structured, rocky terrain,
- Similar food requirements as humans (omnivores),
- Specialisation in certain foods or materials that are part of human needs,
- High reproduction rates,
- Small body size,
- No great competition or disturbance to humans,
- Independent of high air or soil moisture,
- Not dependent on water or clean water,
- Not very sensitive to immissions.

Answer 4

The pioneer woody plants of the tree and shrub layer are too weak in competition with black locust (*Robinia pseudoacacia*) to displace it.

Answer 5

- High species diversity, especially in the pioneer stage,
- Special site conditions with plant and animal species often only found here,
- Observation of natural processes (succession) is possible (nature experience).

Answer 6

They preserve living beings and communities as a basis for the direct contact of urban dwellers with natural elements of their environment in a targeted manner.

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