

# Spontaneous Urban Vegetation: Reflections of Change in a Globalized World

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## ABSTRACT

Urban habitats are characterized by high levels of disturbance, impervious paving, and heat retention. These factors, acting in concert, alter soil, water, and air conditions in ways that promote the growth of stress-tolerant, early-successional vegetation on abandoned or unmaintained land. In most urban areas, a cosmopolitan array of spontaneous plants provide important ecological services that, in light of projected climate change impacts, are likely to become more significant in the future. Learning how to manage spontaneous urban vegetation to increase its ecological and social values may be a more sustainable strategy than attempting to restore historical ecosystems that flourished before the city existed.

## KEYWORDS

climate change, disturbance, globalization, preadaptation, ruderal vegetation, urbanization, wasteland

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Urban ecology can be distinguished from its natural systems counterpart by the inseparable blend of human culture and natural history. Mastering the discipline requires dealing not only with issues related to the quality of air, water, and soil as modified by humans, but also with the complex economic, social, and cultural systems which dictate the flow of energy and raw materials throughout metropolitan areas (Alberti et al. 2003; Gilbert 1989; Grimm et al. 2000). In cities, human values—driven mainly by socio-economic considerations—typically trump biological factors such that people encourage the presence of organisms that make the environment a more attractive, livable, or profitable place to be, and vilify as weeds and pests those that flourish in contradistinction to these goals.

From a strictly functional perspective, most vegetated urban land can be classified into one of three broad categories: remnant native landscapes, managed horticultural landscapes, and abandoned ruderal landscapes (Kowarik 2005; Kühn 2006; Whitney 1985; Zipperer et al.



1997). These landscape types can be distinguished from one another on the basis of 1) their past land-use history; 2) the types of vegetation they contain; 3) the characteristics of their soils; and 4) the levels of maintenance they require in order to preserve their integrity (Table 1). The least studied of these types, and the focus of this paper, is the abandoned ruderal landscape which consists of marginal or degraded urban land that receives little or no maintenance and is dominated by spontaneous vegetation—a cosmopolitan mix of species that grows and reproduces without human care or intent. Ruderal landscapes are typically associated with the margins of transportation infrastructure, abandoned or vacant residential, commercial, and industrial property, and the interstitial spaces that separate one land-use function from another.

While ruderal landscapes are often referred to as “wastelands,” advancements in urban ecology warrant a fresh look at this neglected resource. European ecologists have been analyzing the historical development and spatial distribution of spontaneous urban vegetation for many decades (Chocholoušková and Pyšek 2003; Pyšek et al. 2004; Sukopp 2002) and have recently begun documenting the extent of its coverage in urban ecosystems using GIS technology (Herbst and Herbst 2006; Rink 2009). In comparison, North American ecologists have been slow in embracing the subject of urban ecology and did not begin to seriously focus on the subject until the 1990s (Alberti et al. 2003; Grimm et al. 2000; Zipperer et al. 1997).

In the search for models of urban ecosystem management that go beyond the restoration of historically native landscapes, this paper argues that spontaneous urban vegetation can effectively achieve many of the ecological goals of traditional restoration with less financial investment and a greater chance of long-term success (Choi 2004; Sagoff 2005). This paper challenges urban ecologists, planners, and landscape professionals to take a non-judgmental look at the totality of the biological resources of cities and to recognize that ruderal landscapes have the capacity to make significant contributions to the ecological functionality of many cities, particularly those struggling to adjust to the reality of negative economic growth and population loss.

## **The Urban Environment**

Perhaps the most obvious distinguishing aspect of urban environments is the ubiquitous physical disturbance associated with the construction



**Table 1** ■ A simple taxonomy of urban landscapes

	<i>Remnant Native Landscapes</i>	<i>Managed Horticultural Landscapes</i>	<i>Abandoned Ruderal Landscapes</i>
Land-use Category	Minimally disturbed woodlands, wetlands and coastal habitats	Large and small parks, cemeteries, lawns, ball fields, street trees, residential gardens, commercial landscapes, corporate and educational campuses	Post-industrial land, vacant lots, infrastructure edges, railroad and river corridors, degraded wetlands, abandoned parks, successional woodlands
Primary Vegetation	Native plants and associated invasive species	Cultivated plants and associated weeds	Spontaneous native and exotic species
Soil Characteristics	Native soils with minimally disturbed profiles	Nutrient rich and highly manipulated; often manufactured or relocated from off-site	Disturbed and/or compacted; often mixed with subsoil or construction rubble
Maintenance Requirements	Low to moderate	Moderate to intensive	None to low

and/or maintenance of their infrastructure. Such disturbances drastically alter existing soil and drainage characteristics, thereby changing the growing conditions for the associated biota (Byrne 2007; Godefroid et al. 2007). In economically vibrant cities, a significant portion of the urban fabric is always in the process of being torn up and rebuilt, which tends to create a constantly shifting mosaic of opportunistic plant associations dominated by disturbance-tolerant, early-successional species (Gilbert 1989; Kowarik 2005). In economically depressed cities, where a large percentage of the urban core has been abandoned for significant periods of time, plant succession often proceeds without interference (i.e., maintenance) from people and comes closer to achieving a “stable,” multi-layered structure than it does in more prosperous cities (Figure 1) (Muratet et al. 2007). Casual observations in a number of cities suggest that the amount and maturity of



**Figure 1** ■ A functional wetland—dominated by common reed (*Phragmites australis*) has developed in this abandoned factory loading dock in Detroit.



spontaneous vegetation they contains is inversely proportional to their economic prosperity (Rink 2009). In New York City, for example, Manhattan—with its sky-high property values—has relatively little spontaneous vegetation while the less affluent boroughs of Brooklyn and the Bronx are filled with it.

While landscape disturbances play key roles in the cycle of vegetation succession in most cities, the intensity of such disturbances is highly variable and driven by large-scale shifts in socioeconomic patterns and technological innovations. In the past hundred and thirty years, local ground transportation in North American cities has changed from draft animals and wagons to trains, trolleys, and subways, and finally to bicycles, automobiles, and trucks—totally transforming the supporting infrastructure with each technological shift (Bottles 1987; Mühlenbach 1979; Warner 1978). Such population- and transportation-linked changes typically destabilize existing vegetation patterns and promote the formation of entirely new plant associations (Chocholoušková and Pyšek 2003; Pyšek et al. 2004).

A second distinguishing characteristic of urban areas is the abundance of concrete buildings and asphalt paving. Because such structures absorb and retain heat—to say nothing of the cars, air conditioners, heating units, and electrical equipment that generate heat—the annual mean temperatures of large urban areas can be up to 3° C warmer than the surrounding nonurban areas, and on extreme occasions the temperature difference between the city and the countryside can be as high as 12° C (Sieghardt et al. 2005). The abundance of buildings and impervious pavement in cities can also have a profound effect on hydrology by decreasing water infiltration, increasing runoff, and compacting the soil, all of which tend to reduce water availability and create stressful drought conditions for plants (Arnold and Gibbons 1996; Paul and Meyer 2001). For urbanized riparian habitats in eastern North America, the abundance of moisture-adapted native species relative to the numbers of exotic species declines in direct proportion to the abundance and proximity of impervious surfaces (Pennington et al. 2010).

While increased temperature is probably the most ecologically significant factor that distinguishes the city from the surrounding countryside (George et al. 2007; Ziska et al. 2004), several other climatological factors associated with urbanization can have profound impacts—*often significantly positive*—on the growth of plants. These factors include elevated levels of carbon dioxide, altered solar radiation regimens, altered wind patterns, decreased humidity, increased

or decreased ozone levels, increased soil and air temperatures, and extended growing season length (George et al. 2009; Gregg et al. 2003; Sukopp 2004; Ziska et al. 2003).

## Spontaneous Urban Vegetation

The origin and global dispersal of the spontaneous vegetation that dominates abandoned urban land is as much a cultural phenomenon as it is a biological one (Kowarik 2003; Mack and Erneberg 2002). This vegetation consists of a cosmopolitan array of species that are: 1) native to the area; 2) formerly or currently cultivated for agricultural or horticultural purposes; and 3) unintentionally introduced, disturbance-adapted weeds. European ecologists have traditionally had a much stronger interest in the subject of urban vegetation than their American counterparts, mainly because Europe has a much longer history of both agriculture and urbanization (Knapp et al. 2010; Kowarik 2005). By combining sophisticated archaeological work with modern ecological research, European scientists have been able to reconstruct the complex history of their urban flora and subdivide it into three main categories: 1) native species; 2) non-native *archaeophytes* which were introduced with agriculture into a given area from other parts of Europe, Asia, or Africa prior to 1500; and 3) non-native *neophytes* which were introduced after 1500, mainly from Asia and North and South America (Wittig 2004). Interestingly, there is a fourth category of urban vegetation—mainly annuals of European origin—that seem to have no known natural habitats. These *anecophytes*, as they are known, have mainly arisen through the process of hybridization and show specialized adaptations to habitats associated with agriculture, urbanization, and/or industrialization (Kowarik 2003; Meerts et al. 1998; Salisbury 1961; Wittig 2004).

An exhaustive literature review of the vegetation of 54 central European cities determined that the proportion of non-natives they contained, including both *archaeophytes* and *neophytes*, varied between 19.7 and 59.7%, with a mean value of 40.3%. The fact that this figure is 13.7% higher than the ratio of non-native to native plants in the surrounding countryside is indicative of a “remarkable concentration of aliens in urban areas” (Pyšek 1998: 159). Other vegetation surveys of European cities have concluded that 1) the ratio of non-native to native species increases as one gets closer to more highly disturbed parts of the city (Kowarik 1995); 2) within the category of non-native



species, the ratio of neophytes to archaeophytes rises in direct relation to the intensity of human disturbance (Pyšek et al. 2004); 3) “the flora of the city differed from that of the surroundings in higher demands for light, temperature, nitrogen and soil reaction and lower demands for moisture” (Chocholoušková and Pyšek 2003: 366); and 4) plant diversity in urban areas is often surprisingly high because of a number of factors, including past land-use history, habitat heterogeneity, shifting patterns of socio-economic activity, changing climatic conditions, horticultural and agricultural activity by people, and the abundance of disturbance-generated establishment opportunities (Knapp et al. 2010; Sukopp 2004; Wittig 2004; Zerbe et al. 2003). In recent years, a number of European researchers have gone so far as to propose that certain inner-city areas with relatively old patches of spontaneous vegetation be actively conserved because of the role they play in generating and maintaining urban biodiversity (Kowarik 2005; Maurer et al. 2000; Muratet et al. 2007; Rink 2009; Savard et al. 2000).

## North American Urban Vegetation

The spontaneous vegetation of North American cities has not been studied as extensively as that of European cities. Based on published floras for eight large urban areas in the Northeastern and Midwestern United States, Clemants and Moore (2003) found that the percentage of non-native species varied from a low 19.3% (Minneapolis) to a high of 45.7% (Boston), with an average of 34.9%, numbers that are comparable to those of the smaller European cities reported by Pyšek (1998). The authors concluded that the non-native species richness of urban areas in the U. S. is probably more influenced by historical and socio-economic factors than by climate or latitude.

The cultural history of the vegetation of North American cities is significantly different than that of Europe. For one thing, the concepts of archaeophyte and neophyte have little relevance given that the importation of plants from Europe into eastern North America began abruptly with the founding of Plymouth colony in 1620. In order to survive, the early settlers of the “new world” transported their entire lifestyle across the ocean—not only their own personal belongings and the food necessary to sustain themselves for at least their first year—but also seeds of their crop plants, livestock and the fodder to feed them, and medicinal plants (Cronon 1983; Josselyn 1672). In addition

to intentionally cultivated species, the colonists inadvertently brought along weed seeds either embedded in the hay they brought for their animals or mixed in with the grains they sowed on the land they cleared and plowed (Mack 2003). As early as 1672, John Josselyn documented at least 22 uncultivated plants that had “sprung up since the English planted and kept cattle in New-England” (p. 85).

While English-speaking people dominated the initial settlement of northeastern North America, immigrants from other western European countries were quick to follow, driven by difficult economic or political conditions in their homelands. And just as the members of each successive wave of immigrants came with their own language and culture, they also brought their own traditional crops and associated weeds, some of which eventually escaped from cultivation to become part of the spontaneous flora that dominates today’s unmanaged urban landscapes (Mack 2000; Mack 2003; Mack and Ernberg 2002).

In stark contrast to the large numbers of European plants that have naturalized in North America, comparatively few North American species—mainly those native to disturbed, early-successional habitats—have managed to “cross the pond” and naturalize in Europe (Marks 1983; Wittig 2004). The asymmetry of the biological exchange between the two continents is partly a reflection of the lopsided nature of the cultural exchange between the two continents and partly a result of the fact that Europe, for reasons relating to both cultural and evolutionary history, seems to be unusually rich in disturbance-adapted herbaceous species (Weber 1997). That being said, however, most of the native North American neophytes that have become established in European cities—such as box elder (*Acer negundo*), black cherry (*Prunus serotina*), black locust (*Robinia pseudoacacia*), ragweed (*Ambrosia artemisiifolia*), horseweed (*Conyza canadensis*), goldenrod (*Solidago spp.*), annual fleabane (*Erigeron annuus*), and evening primrose (*Oenothera biennis*)—are also important components of North American urban flora (Del Tredici 2010; Kowarik 1995; Kowarik 2003; Kunick 1990; Sukkop and Wurzel 2003; Wittig 2004).

With relatively few exceptions, the influence of Asian plants on the urban flora of North America began with the forced opening up of Japan to the West in 1853. From this date and continuing through 1920, new plants from Asia poured into North America with minimal regulatory restrictions on importation (Pauly 2008). At first only wealthy estate owners and commercial nurseries could afford to import these exotic species—especially woody plants—but with time and government support for plant exploration, large numbers of both wild and





cultivated Asian plants were eventually introduced into the horticultural and agricultural landscapes of America.

Similar patterns of importation were repeated with plant introductions from Australia, South Africa, Southern Europe, and Central and South America into subtropical Florida, seasonally dry parts of California, and arid regions of the Southwest. Many of these plants are extremely adaptable and were used extensively for reforestation and ornamental purposes in both urban and rural areas during the first half of the twentieth century, from whence they subsequently escaped into the surrounding countryside (Pauly 2008). In a recent book describing 222 common urban plants in the northeastern United States, 32.5% are native to North and Central America, 47.5% are from Europe and Central Asia, 12% from Eastern Asia, and 7.5% are native to both Eurasia and North America (Del Tredici 2010). In much the same way that American cities have been open to human immigration from all parts of the world, they have also been open to biological immigration from all corners of the globe—resulting in a truly cosmopolitan vegetation that mirrors the “melting pot” character of its human population.

## Climate Change and Ecosystem Functionality

The notion that self-sustaining, historically accurate plant associations can be restored to urban areas is an idea with little credibility in light of the facts that 1) the density of the human population and the infrastructure necessary to support it have led to the removal of the original vegetation; 2) the abiotic growing conditions of urban areas are completely different from what they were originally; and 3) the large numbers of non-native species that have naturalized in cities provide intense competition for the native species that grew there prior to urbanization. Certainly people can plant native species in the city, but few of them will thrive unless they are provided with the appropriate soil and are maintained to the same level as other intentionally cultivated plants (Del Tredici 2007). Experience has shown that without on-going management, the default vegetation of the vast majority of urban landscapes is a cosmopolitan assemblage of early-successional, disturbance-tolerant species that are *preadapted* to the conditions of the urban environment (Larson et al. 2004; Lundholm and Martin 2006).

The question of urban ecological restoration is immeasurably complicated by the issue of climate change which, as many scientists have pointed out, can be viewed as a massive, uncontrolled experiment on

the impact of increased atmospheric carbon dioxide concentrations on the earth's ecosystem (Fox 2007; Hobbs et al. 2009). After 200 plus years of burning fossil fuels these impacts are both wide-ranging—they have affected every corner of the globe—and, at the local level, unpredictable. Cities have a particularly important role to play in the study of climate change because urbanization has caused their core areas to heat up to levels predicted for the surrounding countryside in the coming decades. In a very real sense, urban areas can provide a “preview of coming attractions” because, from an ecological perspective, they have already arrived at the future (George et al. 2007; George et al. 2009; Grimm et al. 2008; Ziska et al. 2003).

It is a foregone conclusion that the global environment will continue to deteriorate over the next few decades as humans continue to pump more heat-trapping carbon dioxide into the atmosphere and more acid rain falls back to earth to pollute the water and the soil. The worldwide migration of people from the countryside into cities is also contributing to environmental degradation because land that was once covered with vegetation is being covered by buildings that generate heat and pavement that retains it (Grimm et al. 2008; Sieghardt et al. 2005). The confluence of climate change and urbanization, together with the globalized spread of non-native species, makes it likely that spontaneous vegetation will play a significant role in the future development of urban and rural ecosystems across the globe (George et al. 2009; Hobbs et al. 2009; Ziska et al. 2004).

To date, most of the studies that attempt to calculate the economic value of the ecosystem services provided by vegetation have focused their attention on either native plant communities or intentionally cultivated landscapes (Bolund and Hunhammer 1999; Chen and Jim 2008; Tyrväinen et al. 2005). Only recently have ecologists come to realize that a measurable degree of ecological functionality can be achieved with a cosmopolitan assemblage of species (Hobbs et al. 2009; Pickett et al. 2008). Extrapolating from the published literature on cultivated plants, one can construct an impressive list of ecosystem services provided by spontaneous urban vegetation, including: temperature reduction; food and/or habitat for wildlife; erosion control on slopes and disturbed ground; stream and river bank stabilization; excess nutrient absorption in wetlands (mainly nitrogen and phosphorus); soil building on degraded land; improved air and water quality; sound reduction; phytoremediation of contaminated soil (Porebska and Ostrowska 1999); and carbon sequestration. At the functional level, spontaneous urban vegetation can be considered sustainable in the sense



that it is performing a wide range of quantifiable ecosystem services on marginal land with a minimal input of maintenance resources (Del Tredici 2010; Rink 2009).

The recent downturn in the global economy has the potential to intensify this trend by causing cutbacks in the maintenance of publicly funded park systems. In this regard, experience in Germany since the end of World War II has demonstrated that spontaneous vegetation, given adequate time to develop into “wild urban woodlands,” can make important contributions to the ecological and social fabric of cities and their surrounding regions (Körner 2005; Rink 2009).

## Managing Spontaneous Vegetation

While it is relatively easy to enumerate the ecological value of spontaneous vegetation, it is considerably more difficult to quantify its social and aesthetic value (Körner 2005). Many of the people who live in cities tend to interpret the presence of spontaneous urban vegetation in their neighborhood as a visible manifestation of dereliction and neglect, even though they may view the same plants growing in a suburban or rural context as “wildflowers” (Rink 2005). Clearly, the context in which a plant exists can have a major influence on the way people feel about it. The common reed (*Phragmites australis* var. *australis*), for example, is widely distributed in river deltas throughout Europe and serves as both an important water filtration agent and a major bulwark against coastal erosion. The fact that the plant is dying throughout much of its native European range is viewed as an ecological crisis (Armstrong and Armstrong 2002). Yet this same subspecies growing in the same type of habitat in North America is widely seen as a noxious weed that is disrupting native ecosystems (Saltonstall 2002). Such relativity is perhaps best explained by the fact that people are looking at the plant through the subjective lens of a cultural value judgment which places a higher value on the nativity of a given plant than on its ecological function (see Figure 1). While this privileging of nativity may be appropriate and necessary for preserving large wilderness areas or the localized habitats of rare native species, it seems at odds with the realities of urban systems, where social and ecological functionality typically take priority over the restoration of historic ecosystems (Kowarik 2005; Rink 2005; Sagoff 2005).

Unfortunately, the social and aesthetic values of spontaneous, ecologically functional urban landscapes often leave something to be de-

sired. This raises the question of whether or not there is a way to harmonize the ecological functionality of spontaneous urban vegetation with people's desire to live in a safe and beautiful environment. *The Dynamic Landscape*, edited by Dunnett and Hitchmough (2004), presents current European research on ways to manipulate meadow-type vegetation through the judicious addition and/or deletion of species. The book does an exemplary job of combining solid ecological information on natural grasslands and agricultural fields with the horticultural goal of creating aesthetically pleasing urban landscapes using a cosmopolitan array of low-maintenance perennials. Such landscapes fit the definition of *sustainable* in the sense that they 1) are adapted to the site; 2) require minimal maintenance; 3) are ecologically and socially functional; and 4) are cost-effective (Kühn 2006).

For urban landscapes dominated by woody plants, the biological and social questions surrounding their management are more complicated than they are for herbaceous plants because of their larger size and longer life spans. Research presented in the groundbreaking book, *Wild Urban Woodlands*, edited by Kowarik and Körner (2005), makes it clear that design approaches which integrate the ecological functionality, aesthetic appearance, and recreational potential of spontaneous urban woodlands are more likely to succeed than those which focus on ecology alone. Numerous contributors to the book also make it clear that 1) people are an integral part of the urban habitat and that their preferences need to be part of the management plans; 2) careful manipulation of natural successional processes can dramatically enhance the aesthetic qualities of urban woodland; and 3) the insertion of well designed landscape features—such as pathways for access and art installations for interest—will facilitate their use by people, thereby generating political support for their preservation (Dettmar 2005; Grosse-Bachle 2005; Keil 2005; Körner 2005; Kowarik and Langer 2005; Rink 2005). Perhaps the most famous example of the successful integration of spontaneous vegetation into a designed landscape is Peter Latz's *Landschaftspark* in Duisburg-Nord, in the Ruhr area of Germany, which transformed the contaminated ruins of an abandoned steel mill into a dynamic, heavily visited cultural center (Körner 2005; Weilacher 2008).

## Conclusion

The interacting forces of urbanization, globalization, and climate change have led to the formation of novel associations of plants that are not



only adapted to a city's environmental conditions but also reflect its past socio-economic history. It is imperative that ecologists, land managers, policy makers, conservation activists, landscape architects, garden designers, nursery owners, and maintenance contractors get beyond the divisive arguments over the relative value of native versus exotic species and focus on the ecological functionality of spontaneous urban vegetation. The task we face is not how to eliminate these plants, but rather how to manage them to increase their ecological, social, and aesthetic values.

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