Landscape and Urban Planning 98 (2010) 124–135

Contents lists available at ScienceDirect

Landscape and Urban Planning

journal homepage: www.elsevier.com/locate/landurbplan

Vegetation Structure and Composition within Urban Parks of Halifax Regional Municipality, Nova Scotia, Canada

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ARTICLE INFO

Article history:
Received 19 April 2010
Received in revised form 19 June 2010
Accepted 30 July 2010
Available online 9 September 2010

Keywords:
urbanization
parks
plants
ecological integrity
naturalization
fragmentation

ABSTRACT

Urban parks are important places for the conservation of biodiversity within cities, but their vegetation is affected by a number of anthropogenic stressors. This study took an exploratory approach to examining the influence of management, land-use legacy, fragmentation-related factors, and natural disturbance (by a hurricane) on compositional and structural indicators of vegetation within urban parks of the Halifax Regional Municipality, Nova Scotia, Canada. The study sites (each a particular park) were selected using a stratified random sampling procedure, based on the size of the parks. Plots of 10 m x 10 m were randomly distributed throughout the sites and used to quantify plant composition, forest structural attributes, and environmental variables. Variation in composition was described using species and plant functional groups, which were identified by combining information on growth form, life history, and biogeographical status. Plant communities within the parks varied greatly in character, and ranged from remnants of natural forest dominated by native species, to structurally simple anthropogenic habitats comprised mostly of exotics. Historical use and edge influences (from trails and stand boundaries) were significantly associated with variation in vegetative composition within semi-natural forests, particularly reflecting a higher prominence of exotic taxa. The intensity of hurricane disturbance also had a strong influence on affected communities, but was not found to promote exotics. Results of this study suggest ways to direct the design and management of urban parks in ways that help conserve native biodiversity, and thereby enhance their ecological integrity.

1. Introduction

Urbanization causes profound changes to local ecosystems, the most obvious being the destruction and fragmentation of natural habitat. The infrastructure built on the converted natural habitat is usually characterized by impervious surfaces and is subject to intense management regimes, and any vegetation that occurs is typically impoverished of native species and lacks the structural and functional characteristics of the natural ecosystems that were replaced (Kowarik, 1990; Freedman et al., 1996; Turner et al., 2005; Bryant, 2006). Moreover, ongoing horticultural management typically favors exotic species and disrupts successional processes by imposing frequent disturbance events (e.g., through activities such as mowing) (Niemelä, 1999). A consequence is that people who live in cities are largely exposed to habitats that are not "natural" in character, and this contributes to an increasingly unfamiliarity and disconnection from native ecosystems (Noss, 2004; Turner et al., 2004; McKinney, 2006).

Typically, remnants of natural habitats within urban landscapes are highly fragmented and therefore subject to the damaging effects of a reduction in area, increased isolation, and a proliferation of edges (Kupfer et al., 2006). As predicted by the theory of island biogeography, relatively small and isolated habitat patches support fewer plant species (Davis and Glick, 1978; Bastin and Thomas, 1999; Guirado et al., 2006). Edges influence vegetation by creating gradients of disturbance (Harper et al., 2005), resource availability (Gehlhausen et al., 2000), human activity (Guirado et al., 2006), and abundance of propagules (Cadenasso and Pickett, 2001). By having these influences, anthropogenic forest boundaries have been associated with an increased risk of extirpation of native species and enhanced invasion of non-forest and exotic taxa (Honnay, Verheyen, and Hermy, 2002; Godefroid and Koedam, 2003b; Guirado et al., 2006). In addition, recreational trails are well-known to influence species composition – for example, they promote synanthropic species by acting as corridors for their dispersal and by providing suitable microhabitat (Benninger-Truax et al., 1992; Parendes and Jones, 2000).

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doi:10.1016/j.landurbplan.2010.07.019

As a type of protected area, urban parks are potentially important places for the conservation of indigenous biodiversity within cities. In doing so, they contribute to increased awareness of and appreciation for native biodiversity and healthy ecosystems (Sebba, 1991; Rohde and Kendle, 1994; Noss, 2004). Despite these useful functions of urban parks, few investigations have been published of their vegetative character or other aspects of their biodiversity. Although some research has examined relationships among plant species richness and the spatial patterning of park features (Hermy and Cornelis, 2000; Cornelis and Hermy, 2004; Li et al., 2006), such knowledge has limited utility for conservation planning without accompanying information on the identities and relative abundances of the constituent species (including whether they are native or exotic). A few other studies have examined changes in vegetation of individual parks over decades (Loeb, 1992; Zipperer and Zipperer, 1992; Drayton and Primack, 1996; DeCandido, 2004). The relatively detailed information in these studies provides insight into the influences of anthropogenic stressors and management on plant communities, but they lack generalization. Although a comparative study of the flora within large urban parks of the northeastern United States was conducted by Loeb (2006), its investigation of anthropogenic influences was limited to the statistical influence of the human population in surrounding counties on species diversity. Still, where others have investigated the influence of certain stressors acting within urban parks, such as trails (Sarah and Zhevelev, 2007); there remains the need for a more comprehensive examination of the affects of anthropogenic factors on the biodiversity of vegetation.

The present study describes the influence of some dominant stressors on vegetation within a suite of urban parks in the Halifax Regional Municipality (HRM). An exploratory approach was taken to address the following questions:

1. How does vegetation composition and structure vary among habitats that have been subjected to different management regimes?
2. How is plant composition within remnants of natural forest influenced by edge-related effects?

In order to provide context for the role of the anthropogenic influences on plant communities, the effects of a natural disturbance (a hurricane) were also investigated.

2. Methods

2.1. Study Area

The study area comprises the urbanized landscape of HRM, Nova Scotia, Canada (centered at about 44º 39' N, 63º 34' W), located within the Eastern Interior Ecodistrict of the Acadian Ecozone (Neily et al., 2003). The ecodistrict is characterized by an undulating to gently rolling topography, with quartzite and slates comprising the bedrock, and soils of the Halifax, Bridgewater, and Wolfville series, composed of well-drained, often stony loams respectively derived from quartzite, slate, and shale/sandstone tills ranging in depth from < 1 m to 10 m and averaging < 3 m (MacDougall et al., 1963; Neily et al., 2003).

Forest dominates the vegetative cover of the ecodistrict. Conifer-dominated stands are most abundant, with *Picea rubens* (red spruce) and *Picea mariana* (black spruce) being dominant on well and poorly drained sites, respectively. Shade-intolerant hardwoods, such as *Acer rubrum* (red maple) and *Betula papyrifera* (white birch), along with scattered *Pinus strobus* (white pine) and an understory dominated by ericaceous shrubs, are also prominent on shallow soils. Shade-tolerant species, including *Tsuga canadensis* (eastern hemlock) and *Fagus grandifolia* (American beech), occur on deeper, well-drained sites on the crests and slopes of hills or drumlins. The dominant natural disturbances affecting forests within the ecodistrict are windstorms and wildfires (Neily et al., 2003), and much of the area is presently in a regenerative state following a hurricane (Juan) in September 2003.

2.2. Study Sites, Plot Distribution and Layout

A list of potential study sites was obtained by identifying properties that included "park" in their title (but excluding areas primarily used for fire stations, libraries, schools, the storage of equipment, or activities of the Department of National Defense) from a municipal GIS layer (Halifax Regional Municipality, 2005). These parks were overlaid with boundaries of an ecological land classification, and the list of potential study sites was limited to those located within the Eastern Interior Ecodistrict (Nova Scotia Department of Natural Resources, 2007), which is the dominant ecodistrict for the Halifax metro area. From this dataset of 157 sites, a stratified random sampling procedure, based on the size of urban parks, was used to

Table 1
Park location, size, and percent of area comprised of semi-natural habitat.

Park ID	Park name	Location	Area (ha)	% Semi-natural habitat
1	Admiral's Cove Park	44°43'06"N, 63°39'10"W	28.5	100
2	Alder Piper Park	44°40'43"N, 63°30'55"W	1	53
3	Arnold Whitworth Park	44°39'30"N, 63°32'54"W	0.5	49
4	Barrington Street Park	44°38'10"N, 63°34'11"W	0.1	0
5	Bell Lake Park	44°40'27"N, 63°30'38"W	10.5	95
6	Cogswell Park	44°38'53"N, 63°35'33"W	0.3	0
7	Conrose Park	44°38'20"N, 63°36'04"W	2.7	0
8	Cyril Smith Park	44°41'26"N, 63°34'31"W	24.5	100
9	Fort Needham Memorial Park	44°39'54"N, 63°36'03"W	5.5	15
10	Fuller Terrace Park	44°39'28"N, 63°35'42"W	0.1	0
11	Glenbourne Park	44°40'38"N, 63°40'36"W	4.2	35
12	Hemlock Ravine	44°41'24"N, 63°40'12"W	91.6	100
13	Lincoln Cross Park	44°39'53"N, 63°39'19"W	0.3	67
14	Montebello Park	44°42'06"N, 63°32'33"W	2.3	0
15	Point Pleasant Park	44°37'22"N, 63°34'07"W	76.1	87
16	Randall Avenue Park	44°39'31"N, 63°38'21"W	0.4	54
17	Remington Court Park	44°40'30"N, 63°40'11"W	0.8	70
18	Seaview Memorial Park	44°40'29"N, 63°37'07"W	5.1	0
19	Titus Smith Park	44°39'40"N, 63°38'07"W	0.9	0
20	Tremont Plateau Park	44°40'26"N, 63°39'17"W	8.2	60
21	Uplands Park	44°43'30"N, 63°44'22"W	1.8	0
22	Wedgewood Park	44°40'47"N, 63°40'13"W	1.9	95
23	Willett Street Park	44°39'29"N, 63°39'25"W	3.1	96
24	Young/Kaye Park	44°39'44"N, 63°35'55"W	0.1	0