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The role of native species in urban forest planning and practice: A case study of Carolinian Canada

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ABSTRACT

In recent years, many North American municipalities have adopted urban forest management plans. These plans typically include ambitious tree planting goals, with a focus on increasing native species' presence. Having a high percentage of native species can increase ecological integrity, but there are also benefits associated with planting non-native trees in urban forests. The possibility of using assisted migration as a way for cities to respond to climate change raises additional questions about the importance of managing for native species. This study explores the ways native tree species are treated in urban forestry planning and practice in light of on-going debates around ecological integrity, non-native benefits, and assisted migration through a case study of municipalities in Carolinian Canada (Ontario, Canada). In particular, we (1) examine the role of native species in urban forest management plans, (2) explore municipal foresters' attitudes and actions related to native tree species, and (3) determine if municipalities with and without formal management plans are making different decisions regarding native tree species planting. The objectives are addressed by examining management plans and interviewing urban foresters from municipalities with and without formal plans. We found all of the municipalities with management plans emphasize native species, and many justify their planting as a way to increase ecological integrity. These municipalities are also considering more of the managerial aspects associated with native species than municipalities without a plan. However, only a fraction of species native to the region are available through nursery stock, meaning many native species are not planted by municipalities. Most municipalities are also passively practicing assisted migration without considering the ways it can be used as a climate change adaptation tool. The gaps between municipal plans and practice are discussed, as well as future research needed to help guide treatment of native species in urban forests.

1. Introduction

Throughout North America municipalities are adopting strategic plans and ambitious tree planting goals based on the numerous ecological, social, health and economic benefits ascribed to the urban forest. This parallels recent foci of urban environmental research exploring sustainable management of urban forests (Clark et al., 1997; Kenney et al., 2011; Mincey et al., 2013; Vlek and Steg, 2007; Young, 2013) and documenting their ecosystem services (Alvey, 2006; Bolund and Hunhammar, 1999; Nowak and Dwyer, 2007). With the aggressive planting goals many municipalities are pursuing, species selection today will have a lasting impact on the composition, health, and function of the urban forest.

Urban forests typically have relatively high species richness as compared to the surrounding countryside (Alvey, 2006; Bertin et al., 2005; Miller and Hobbes, 2002; Stewart et al., 2004). However, this richness is often the result of numerous non-native species while many native tree species are not regularly planted (Clemants and Moore, 2003; Hitchmough, 2011; Kendle and Rose, 2000; Schaelpfer et al., 2012). The importance of maintaining native species within urban forests is unclear, as there is a knowledge gap surrounding the tolerance of many tree species to urban stressors (Alpert et al., 2000; D'Antonio and Meyerson, 2002; Davis, 2012; Sagoff, 2005). The current understanding of ecological integrity, measured as the wholeness and proper functioning of an ecosystem, suggests that native species should be prioritized (Alvey, 2006; Ordoín˜ez and Duinker, 2012; Raupp et al., 2006), but the benefits of planting at least some non-native species, and the potential of assisted migration in urban forests as a response to climate change raise questions about the value of a native-only (or native-first) approach to tree planting.

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To guide urban forestry, municipalities are increasingly adopting urban forest management plans (UFMPs), which typically outline management goals and objectives over a twenty-year timeframe. Ordoín˜ez and Duinker (2013) found the one commonality among all of the existing Canadian UFMPs was an emphasis on planting native species. It is unclear if and how debates associated with assisted migration, defined as the intentional translocation of species outside of their historic ranges in order to ameliorate actual or anticipated biodiversity losses (Hewitt et al., 2011; McDonald-Madden et al., 2011; McLachlan et al., 2007; Ordoín˜ez and Duinker, 2014; Sax et al., 2009; Zhu et al., 2012), and the potential benefits of planting non-native species, including tolerance for urban stressors and provision of desired ecosystem services, have influenced the goals in these plans, or the impact such debates and UFMPs themselves have on actual planting practice.

Given the gaps in our understanding of the formulation and implementation of UFMPs and on-going discussions about ecological integrity, non-native species benefits and assisted migration, the objectives of this study are to (1) examine the role of native species in UFMPs; (2) explore municipal foresters' attitudes and actions related to native tree species, and (3) explore if municipalities with and without formal management plans are making different decisions regarding native tree species planting. These objectives are addressed through a case study of municipalities in Carolinian Canada (Ontario, Canada), a region with relatively high native tree richness, by examining UFMPs and interviewing urban foresters from municipalities with and without UFMPs. The following sections outline debates around native and non-native species in urban forests, present our methods and results, and provide a broader discussion of the implications of current practice and recommendations for future urban forest management.

2. Ecological integrity, assisted migration, and non-native trees in the urban forest

The recent urban ecology and urban forestry literature debates the value of native trees in cities, in part, because of the unique conditions associated with urban forests (Hitchmough, 2011; Kendle and Rose, 2000; Kowarik, 1995; Rotherman and Lambert, 2013). In particular, the importance of and potential pathway to achieve ecological integrity, the useful role of planting non-natives trees, and the use of assisted migration as a tool to mitigate and adapt to climate change have all been discussed (Camacho, 2010; Davis, 2012; Hewitt et al., 2011; Ordoín˜ez and Duinker, 2014; Zhu et al., 2012).

Ecological integrity depends upon a high ratio of native biodiversity (Bolund and Hunhammar, 1999; Clemants and Moore, 2003; Hermoso and Clavero, 2013; Landry and Chakraborty, 2009; Ordoín˜ez and Duinker, 2012). When ecosystem functions are lost due to an absence of native diversity, the system becomes less resilient, so the capacity to resist damage and recover from a disturbance is reduced (Folke et al., 2004). The current composition of species in most urban forests means that some functions (e.g. provision of food, maintaining biodiversity, nutrient cycling, reduction of wind damage, regeneration of soils and the maintenance of organisms within them) do not occur at the same rate, suggesting lower resilience and reduced integrity (Ordoín˜ez and Duinker, 2012).

In order to improve the ecosystem function and resilience of urban forests, it is important to plant not only a diverse assemblage of Trees – which often already exists – but a diversity of native trees. More specifically, native specialist and rare species must be present in order to support a high degree of ecological integrity (Ordoín˜ez and Duinker, 2012). However, while generalist species can often survive the many stressors present in urban ecosystems, specialized and/or rare native species frequently cannot (Ordoín˜ez and Duinker, 2012). The unique challenges of managing such a system – typically including high levels of impervious surfaces, variable amounts of shade/sunlight, highly compacted soils, lower air quality, and other molestations – creates complications for prioritizing native tree species, such that tree species tolerant of urban stressors are preferred for planting even if they are not native (Escobedo et al., 2011).

Furthermore, municipalities are tasked with not only maintaining and enhancing ecological integrity, but also typically need to reduce tree-related risks while increasing the ecosystem services provided by the urban forest (Kenney et al., 2011). Risks are reduced, in part, by planting trees without large fruits/nuts, avoiding the use of softwood and coniferous trees as street trees, and using small trees to avoid utility conflicts (City of Burlington, 2010), thus potentially excluding a number of native species.

Ecosystem services are defined as the goods or services provided by ecosystems that contribute to human well-being (MEA, 2005). The well-documented ecosystem services provided by urban forests include storm water retention, erosion control and microclimate regulation (Ostoić and Konijnendijk, 2015). Managing for ecosystem service provision and risk reduction is often achieved by planting trees that are assured to grow quickly with minimal need for maintenance and other capital expenditures, regardless of their native status (Dobbs et al., 2011; Sjöman and Nielsen, 2010). For instance, *Acer platanoides* (Norway maple) and *Gingko biloba* have been frequently planted in urban areas outside their native ranges due to their relatively fast growth; resistance to pests; and ability to withstand urban stressors, such as soil compaction and particulates. In at least some cases non-native species are better at providing desired ecosystem services in urban environments (Escobedo et al., 2011), including providing habitat and food sources for native species (Gray and van Heezik, 2016). Given the novel assemblages of species already present in most cities, some have argued that exotic species should not be avoided simply because of their non-native status (Kowarik, 2011).

While some non-native trees may be more tolerant of certain urban stressors and survive better as a result, individual trees are part of the larger urban ecosystems. The resilience of these ecosystems to recover from disturbances, as well as the provision of food for other parts of the food-web, nutrient cycling, and soil creation are dependent on native trees. Thus, a dilemma exists regarding an appropriate emphasis on native species, whose planting can increase ecological integrity, while planting select non-native species may ensure a better survival rate in stressed situations, reduce risks to people and property, and quickly provide key ecological services.

Further complicating the appropriate ratio of native species in urban forests is the likely inability of many tree species to rapidly adapt to the changing climate (Zhu et al., 2012). Given the long life span of trees, planting decisions today will influence urban forests' species composition for years to come, but some native species may not be able to survive in their current ranges in the coming decades. Assisted migration is one way to maintain healthy urban forests into the future in light of anticipated climate change (City of Halifax, 2012; Kowarik, 2011; Ordoín˜ez and Duinker, 2013; Peel, 2011).

The term assisted migration is discussed in the literature in a variety of ways (Hewitt et al., 2011; Pedlar et al., 2012; Ste-Marie et al., 2011). In this study, we focused on assisted migration as the intentional translocation of species outside their historic ranges (typically shifting northward) in order to ameliorate actual or anticipated biodiversity losses caused by climate change, similar to the way the term is used in the forestry sector (Pedlar et al., 2012). This may entail moving individuals to locations with species assemblages that have coevolved with the relocated species or to locations with non-coevolved species assemblages (Hewitt et al., 2011). In Carolinian Zone urban forests, there is the potential for