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Urban Naturalization: An Approach Towards Sustainable Cities

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Abstract: Naturalization is a relatively new management strategy for green areas within urban environments. It presents a great opportunity for urban centers to integrate native species into the landscape. A successful naturalization strategy can significantly reduce city management costs, promote preservation of local species, restore environmental services and encourage more members of these communities to embrace naturalization as a desirable strategy to follow. The information on naturalization that is available for decision makers is very limited; usually based on previous experiences of urban planners. The most common approach to urban naturalization is to establish species native to the region. Native species have specific adaptations to thrive and survive in their natural habitat. By limiting human intervention and reintroducing native species, an area is eventually naturalized, meaning no further management of the area is needed for it to become an assemblage of the naturally occurring landscape. Soils are expected to have a significant role in successful establishment. The experimental approach undertaken in this research was to stop mowing and to plant with native species. The current study is assessing how successfully woody native plant species established in an urban setting using naturalization as a management approach. Soil treatments included soil tillage and no tillage combined with compost and topsoil amendments. Plant species were four shrubs and four trees.

Keywords: Naturalization, Topsoil, Compost, Herbicide, Tillage, Native Species, Urban Environment, Woody Species

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1. Introduction

Naturalization is an alternative landscape management technique where natural processes of plant colonization and growth are less restricted, allowing the landscape to return to a natural state. Environmental benefits include increased biodiversity and wildlife use, soil stabilization, improved ground water recharge, provision of windbreaks for snow capture and dust reduction, reduction of atmospheric greenhouse gases and cleaner air [12, 3, 6]. Economic benefits include a significant reduction in maintenance costs such as mowing, irrigation and herbicide use. Quality of life benefits include landscape beautification, increased green and shady areas for recreation, increased community awareness of environmental issues and noise reduction by mature plantings [3]. Potential challenges to naturalization are mainly related to community engagement and education regarding issues with non native plants in initial stages and increased wildlife.

Naturalization historically focused on planting trees to restore urban forests. However, naturalization can also occur in urban grasslands and wetlands. It requires careful selection of plant species for development of an appropriate plant community and to utilize specific soils [11, 9]. Management strategies must be developed to augment natural successional processes of plant community development.

While planting native species is an important component of naturalization, it must also address inherent soil limitations [10, 9, 13]. Compacted soils can prevent root growth and therefore successful plant establishment and long term development [7]. Naturalization can reduce soil compaction, through root expansion, increased biological activity and frost heave [1, 8]; subsequently increasing infiltration rates [2, 6]. Naturalized sites retain leaf litter and woody debris, which decomposes, adding organic material, which is positively correlated with increased plant available soil water [4, 5]. Naturalization can result in unrestricted growth of herbaceous understory plants and increased root density in upper soil horizons [7].

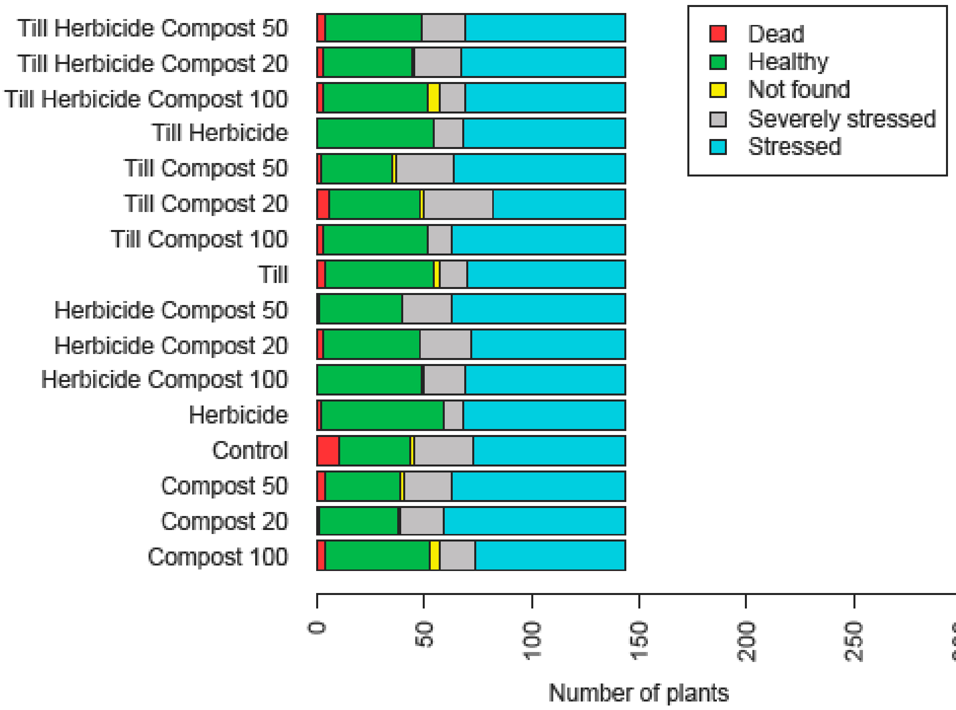
Little scientific research has been conducted on methods to achieve naturalization of urban parklands. Many of these sites require reclamation to address soil issues and all require revegetation to facilitate development into a naturalized ecological community. Results of naturalization efforts to date have been inconsistent.

2. Results and Discussion

After one growing season, most plants were alive and either healthy or stressed; dead and severely stressed individuals were sparse (Figure 1). Highest mortality occurred in the control treatment and lowest in the till herbicide and herbicide compost treatments. The highest number of severely stressed plants were in the control, till compost 20 and till compost 50 treatments.

Death and stress of the plants were attributed mainly to lack of water, anthropogenic disturbance or wildlife predation. Dead plants were not removed from the site as due to the hardy nature of the native species used, there is a possibility they may regenerate the next growing season. Stress and severe stress are considered transitioning stages for the first growing season due to the short period of time since the planting date and the assessment date.

Figure 1. Number of plants in each soil treatment that were dead, healthy, stressed, severely stressed or not found.



Plant performance was visibly affected by soil treatment (Figure 2). Highest numbers of healthy plants were found on the herbicide treatment; second highest numbers on till herbicide; and third highest numbers on compost 100, herbicide compost 100, till, till compost 100 and till herbicide compost. Lowest numbers of healthy plants were on the control, till compost 50, compost 50 and compost 20. The highest number of dead plants were clearly found in the control, followed by till compost 20 treatment (Figure 3). Fewest dead plants were found in the till herbicide and herbicide compost 100 treatments.

The top three treatments for healthy plants directly interfere with the prevailing vegetation on site prior to new seedlings establishment, either by using herbicide, tillage or a seedless amendment like compost. This suggests that to establish native species in urban environments, species competitive attributes need to be taken into consideration to decide which species to plant, and what type of soil preparation treatment can be adopted to improve establishment.

Individual plant species were affected differently by the soil treatment (Figures 2 and 3). Healthy spruce, willow, snowberry and balsam poplar plants were least affected by soil treatment, doing equally well in all of them. Aspen survived best in till herbicide and least in the control and till compost 100. Healthy chokecherry plants were small in number; growing best in herbicide and least in compost 50, compost 20, till compost 20 and till herbicide compost 20. Cranberry did best in herbicide and till. Rose had fewest surviving plants in till compost 50, compost 20 and till compost 20. Health, survival and mortality were mainly affected by water stress and health of the planting stock at planting.

Figure 2. Number of healthy plants per species in each soil treatment.

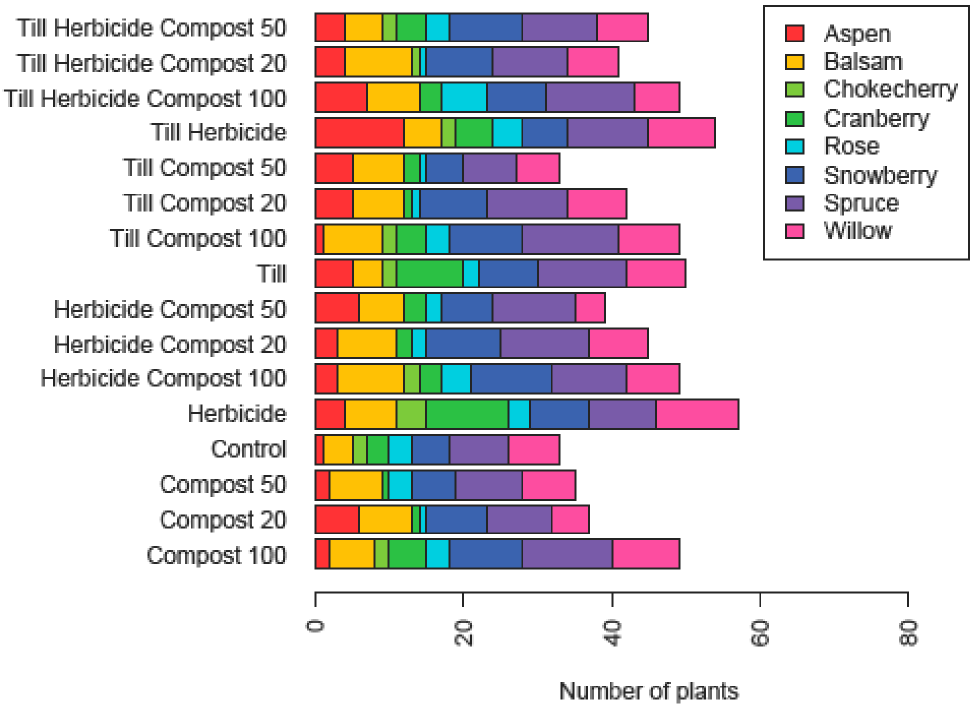
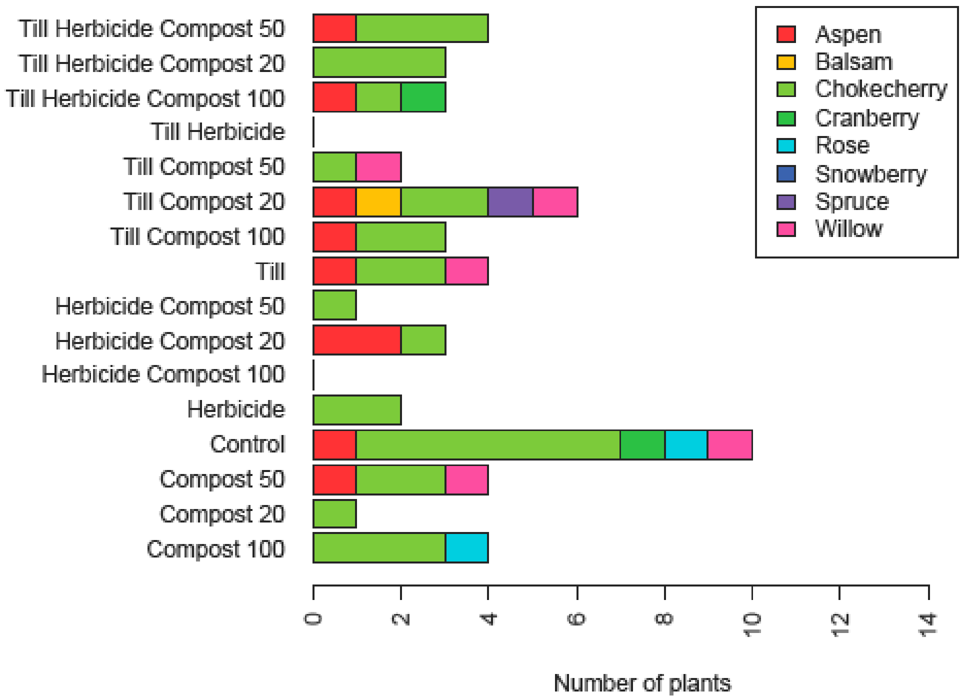


Figure 3. Number of dead plants per species in each soil treatment.



3. Methods

In May 2014 six research sites representing the variety of locations where naturalization is adopted within the City of Edmonton were established. The research sites reflected variability in topography, management and exposure to urban disturbance. Three flat and three sloped sites were selected.

Each site contains three replicate 10 x 10 m plots, each divided into sixteen randomly allocated 2.5 x 2.5 m subplots. Site preparation consisted of soil tilling, foliar herbicide application, a combination of tilling and herbicide and no site preparation. Soil amendments were compost (compost 100), a 50:50 mix (by volume) of topsoil and compost (compost 50), an 80:20 mix of topsoil and compost (compost 20) and no amendment.

Rototilling was to a depth of approximately 15 cm with a rear tined, 9 HP hydraulic drive, Power Dog 209. A 1 % solution of Roundup Transorb (540 g L-1 glyphosate) was applied to herbicide plots. A week later, amendments were applied using a mini steer loader and/or wheel barrow. Amendment was added to the surface of each plot and spread with shovels to create a 15 cm deep layer.

Planting was conducted the first two weeks of July. Planting stock comprised 4 tree species *Picea glauca* (white spruce), *Populus tremuloides* (trembling aspen), *Populus balsamifera* (balsam poplar) and *Prunus virginiana* (chokeberry); and 4 shrub species *Rosa acicularis* (wild rose), *Symphoricarpos albus* (snowberry), *Viburnum trilobum* (highbush cranberry) and *Salix exigua* (coyote willow). Individual subplots received one plant of each species, for a total of 2304 plants. Plants were randomly located within subplots, away from the edges and at least 15 cm apart from each other.

Watering was with an irrigation truck, 24 to 48 hours post planting, followed by every 2 to 3 days for the next two weeks, twice per week for the next four weeks, then once per week until the end of the growing season. The sites were selectively hand weeded.

Plant health assessments were conducted four times in the growing season, starting two weeks following planting. They were conducted July 23, August 7 and October 9. Due to differences in phenology of the plant species a plant health assessment was conducted on August 7. A five point health scale was used for dead, healthy, not found, stressed and severely stressed plants.

4. Conclusions

After one year, influence of soil treatments is evident on woody species health and mortality. Direct planting without tillage, herbicide and soil amendments led to highest mortality and severe stress. Competition from existing vegetation must be controlled to facilitate transplant establishment.

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Conflict of Interest

The authors declare no conflict of interest.

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