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Tree Wardens and public grounds management in North America: Overseeding athletic fields with perennial ryegrass to promote safe playing surface

Richard W. Harper^{a*}, Wesley R. Autio^b, John T. Finn^a and Frank S. Rossi^c

^aDepartment of Environmental Conservation, University of Massachusetts, Amherst, MA, USA; ^bStockbridge School of Agriculture, University of Massachusetts, Amherst, MA, USA; ^cSchool of Integrated Plant Science, Cornell University, Ithaca, NY, USA

Responsibilities of the municipal/urban forester, or Tree Warden as the position is known in parts of the United States, may extend to a variety of widely used community green spaces that include gardens, landscapes and athletic fields. In recent years, the application of non-chemical, cultural methods pertaining to the management of publically accessible athletic fields has garnered growing interest. This is especially true as it relates to weed control and the maintenance of desirable turfgrass cover and safe playing conditions. Based on previous research, a demonstration field study was conducted over four growing seasons (2005–2008) to determine the effectiveness of weekly, repetitive (8×), late summer – early fall overseeding with varying rates of perennial ryegrass: 0, 1, 3 and 6 lbs 1000 ft⁻². Overseeding at the highest rate (6 lbs 1000 ft⁻²) appeared to generate the greatest increase in desirable turfgrass cover during growing seasons that received adequate, well-distributed rainfall. The relationships between amenity and sports grass management and adjacent trees are considered.

Keywords: athletic field; overseeding; perennial ryegrass; PRG; Tree Warden; turfgrass; urban forest

Introduction

In the six New England states that comprise the north-east region of the United States, the position of the municipal urban forestry official is titled “Tree Warden.” Tree Wardens are practically identified as the individuals with the “greatest responsibility” for the maintenance and care of public trees in municipalities (Ricard, 2005). The first state Tree Warden law was passed in the Commonwealth of Massachusetts in 1896 (Ricard, 2005). Pursuant to the Statutes of Massachusetts (MA Gen. Laws, Ch. 87, Sec. 2–5), Tree Wardens are responsible for the “care and control” of community public shade trees, and may enforce laws, make regulation, establish fines and appoint subordinates, known as Deputy Tree Wardens (MGL, 2016). They may also plant shade trees, hold public hearings pertaining to municipal tree removals, or may remove trees without a hearing based on their determination that a tree “endangers” public well-being (MA Gen. Laws, Ch. 87, Sec. 2–5). Though a sense of professionalism, and even community, is fostered among Tree Wardens through formal associations (i.e. the Massachusetts Tree Warden’s and Forester’s Association; the Connecticut Tree Warden’s Association) and through vocational interaction, the title “Tree Warden” is not a formalised professional

*Corresponding author. Email: rharper@eco.umass.edu

designation (Ricard, 2005). Therefore, there is great community-specific variation affiliated with this position that often expands beyond the scope of caring for municipal street trees, to encompass the management of parks, public greenways, gardens, landscapes, community pools and athletic fields (A. Snow pers. comm.).

Though Tree Wardens may find themselves working in varied and complex environments, it is also widely accepted that the trees growing in the urban environment themselves, face a complex of challenges that include lack of available space, pest pressures and exposure to pollution (Nowak, McBride, & Beatty, 1990). These factors often underlie urban tree morbidity and early mortality (Jutras, Prasher, & Mehuys, 2010), yet one important conflict often given little regard, is the struggle between trees and grass (i.e. turfgrass). In natural settings, grass-dominated communities and tree-dominated communities typically don't co-mingle – in fact, they generally comprise different biomes, often with geographical distinction. Thus, when trees and grass are established in close proximity with one another – as is all too often the case in the urban environment – they are known to compete vigorously for the same limited resources like light, water and essential elements. The presence of turfgrass has been shown to reduce the number of fine roots produced by trees in upper soil layers (Day, Wiseman, Dickinson, & Harris, 2010) potentially impacting tree health. Additionally, the use of turfgrass management equipment (i.e. lawnmowers, string-trimmers, etc.) may be injurious to portions of the tree including the lower stem and roots. Fortunately, a number of strategies may be employed to aid and protect tree health in relation to reducing turfgrass, and the need for its maintenance in the immediate vicinity of tree roots, including the application of mulch (Fini, Degl'Innocenti, & Ferrini, 2016). In addition to diminishing turfgrass around trees, the use of mulch may also enhance soil biological, chemical and physical attributes (Ferrini et al., 2008).

Though simple strategies like the use of mulch, may help to promote tree health, at the expense of reducing populations of turfgrass, Tree Wardens may be tasked with managing a variety of non-woody plants and forced to look instead, for strategies related to the care of other plant types. Thus, in situations where a healthy population of grass is desired, it may not be unusual that a Tree Warden may be asked to prioritise the care of lawns and turfgrass in public parks and athletic fields.

Many public parks and athletic fields receive intense, widespread recreational traffic. In the United States, it is estimated that 3.5 million children incur sports-related injuries each year; on grass-covered athletic surfaces it was estimated that upwards of 300,000 children ages 5–14 were treated in hospital emergency rooms for football and soccer-related injuries in 2009 alone (University of Rochester, n.d.). To help provide safe-playing conditions, these athletic surface areas on which these sporting events are played should feature a thick-growing, dense, healthy turfgrass (Harper, n.d.). In addition to being aesthetically appealing, this thickly grassed surface may help young athletes to obtain better footing, and offer a more cushioned surface relative to impact (Orchard, 2002) resulting in potentially fewer, less severe injuries. This is important to landscape professionals – including Tree Wardens – who manage such facilities, as concerns related to liability and public safety continue to escalate in North America.

Grass selection and athletic surfaces

Perennial ryegrass (*Lolium perenne*) (PRG) is a very commonly used cool-season grass in the US and throughout the world. It is known to offer numerous benefits including high traffic-resistance and fast germination, making it especially suitable as a turf

species and forage grass (Hoffman, DaCosta, Ebdon, & Zhao, 2012). In part, because of its popularity, resilient and high-performing turf types are widely marketed and available to professional and residential end users (Morris, 2013). PRG is often touted as a surface-feeding insect-resistant, low-thatch-producing grass (Sherratt, Street, & Holdren, 2008), and it is often included as part of the renovation or establishment of a grassy-covered site or used as part of a turf-maintenance programme, which may include spot seeding and/or overseeding. Because of its appearance, PRG often blends well with other turfgrass types, making it suitable for overseeding, especially when compared to more popular turf types like Kentucky bluegrass (*Poa pratensis*) (KBG) (Beard, 1973). Though KBG is the dominant cool-season turfgrass on North American athletic fields, thanks in part to its rhizomatous growth which allows it to withstand heavy wear/foot-traffic, it is largely unable to establish under normal wear conditions due to the excessive germination time, making it generally ill-suited for selection as part of an overseeding programme (Dodson, Lyons, Jordan, & Tardif, 2011). Furthermore, when compared to other aspects of KBG, PRG features a lower shoe-surface traction and if cut higher, is considered to offer a safer playing surface with more cushion for the end-user (Orchard, 2002). In fact, a trend toward a decreased risk of anterior cruciate ligament (ACL) injury was noted with play on PRG athletic surfaces compared to other types of grass-covered surfaces (Orchard, 2001).

Pesticide use and risk reduction

In addition to health concerns about injury on athletic fields, health-related concerns associated with exposure to chemicals like pesticides have also become more prevalent in recent years (Robbins & Sharp, 2003). Exposures may occur in a variety of manners on grass-covered surfaces, including the acute on-site exposure to a pesticide on recently treated areas, or the more subtle “tracking” of a pesticide to another location, including a home (Nishioka, Burkholder, Brinkman, & Lewis, 1999). Specifically, concerns regarding these types of exposures may be related to the possible (and/or perceived) underlying relationship between pesticides and an increase in cancer rates (Zahm & Blair, 1992), as well as environmental persistence (Robbins & Sharp, 2003). In short, the demand for low-input turf-care practices that emphasise only minimal uses of fertilisers and reduced-risk/organic pesticides continues an upward trend (Tukey, 2006). This is relevant to Tree Wardens who may manage parks and athletic fields, as many of them hold a pesticide applicator’s licence and are knowledgeable about plant care products (MA Gen. Laws, Ch. 87, Sec.5).

The demand for sports played on these grass-covered surfaces continues to grow also, with Americans aged 12–24 now ranking soccer as their second favourite sport behind professional football (Bennett, 2014). A record of 391,839 boys and 356,116 girls participated in soccer in 2009–2010, and the sport has continued to enjoy steady growth since the 1970’s (Anonymous, 2011). Due to this increased consumer concern regarding the human and environmental health risks associated with chemical exposure, as well as increasing regulation relative to the use of pesticides (Sandberg & Foster, 2005), the options for maintaining and improving turf density and quality continue to diminish. Thus, many of the professionals who manage turfgrass, including Tree Wardens, are searching for alternative, integrated ways to suppress weeds while promoting overall turf density, especially on high-use athletic fields. Unfortunately, few successful management regimes of this type currently exist.

The practice of overseeding

Turfgrass overseeding has long been acknowledged as an important non-chemical practice employed to improve desirable plant density and resilience under heavy traffic conditions (Bornino, Bigelow, & Reicher, 2010). Typically, recommendations for an overseeding regime incorporate the use of mechanical and cultural practices including core aeration and irrigation (Larsen, Kristoffersen, & Fischer, 2004). While beneficial, these practices require time and resources and may be cost prohibitive or even impractical for professionals that are managing low-input sites on a limited budget. Spring overseeding is regularly employed to repair areas of turfgrass damaged from salt, snow ploughing or grub feeding and to improve desirable-plant density before annual weeds germinate. Spring overseeding, however, features a number of challenges including aggressive weed competition, cool soils that may foster poor seed germination, and erratic weather conditions (D. Chinery, pers. comm.).

Earlier work (Rossi, 2004) examined the ability to improve turfgrass density on low-input sites with repetitive overseeding at varying rates, initiated throughout the spectrum of the growing season months (June–October) of a single year (2003). This regime did not include the implementation of mechanical or other cultural practices like core aeration, irrigation or fertilisers. The field research component of this manuscript expands upon that work to encompass a time period of four growing seasons (2005–2008), with a focus of seed application having occurred in the latter portion of the growing season. Specifically, PRG was overseeded at three rates: 0, 1, 3 and 6 lbs 1000 ft⁻² weekly, for a total of eight applications. These applications took place from 18 August 2005–05 October 2005; 23 August 2006–13 October 2006; 31 August 2007–02 November 2007; 29 August 2008–18 October 2008.

The specific objectives were to:

- (1) Determine if there was an increase in turfgrass density achieved by repetitive late summer – early fall overseeding, without the implementation of other cultural practices.
- (2) Determine if there was a corresponding notable decrease in annual weed populations.
- (3) Consider implications for associated urban tree populations and tree managers.

Methods

In the spring of 2005, the Fox Meadows Elementary School soccer field in Scarsdale, NY (Westchester County) was identified as a suitable site for a multi-year fall overseeding study on a publically accessible athletic field. This location offered historically lower populations of perennial lawn grasses and higher populations of annual weeds. The Fox Meadows Elementary School soccer field did not receive supplemental fertiliser or irrigation during the study. Each individual plot within this site was 100 ft⁻² (25 ft × 4 ft). Untreated plots were also maintained between treated plots to minimise possible overseeding interference/contamination. A Gandy drop spreader (Anertec & Gandy Company, Owatonna, MN) was used to apply a total of eight repeated PRG applications per year of the trial. Within each year, each of the four treatments was replicated three times (Figure 1).

A 40" × 40" weed-square was used to quantify (%), using a randomised point quadrant method) approximate desirable turfgrass populations, weed populations and



Figure 1. Overseeding strip (25 ft × 4 ft overseeded PRG, 6 lbs 1000 ft⁻²).

bare soil (i.e. no vegetation). Initial readings were taken after the first weekly application of PRG, mid-way through the series of applications, and after the final (8th) application of PRG. Readings consisted of taking two separate, random visual assessments on each side of the 12 plots.

Literature and approaches pertinent to urban tree management were reviewed and considered.

Experimental design and statistical analysis

Each year of the study, 12 new research plots were selected. Since this research featured a publically accessible, demonstration/extension component, treatment strips were arranged in a consistent order: 0, 1, 3 and 6 lbs. That order was repeated three times. It was concluded that directional bias would not be a meaningful factor due to the

inherent, relative uniformity associated with a constructed athletic field pertaining to variables like grade, soil type and drainage. All dependent variables were subjected to analysis of variance with overseeding treatment and sample date as fixed independent variables and replication as a random independent variable using SAS statistical software V.9.4 (SAS Institute, 2012). When necessary, per cent data were transformed to approach normality. Mean separation among overseeding treatments was conducted with orthogonal polynomial contrasts.

Implications for trees and tree managers were reviewed.

Results

According to visual assessment at the end of the first season of study, the repeated applications of PRG seed yielded little germination, and turfgrass density did not appear to have significantly increased. While unfavourable, this was not an unexpected result. The growing season of 2005 featured temperature levels much higher than normal with very little consistent rainfall throughout most of the growing season. Seasonal (30 September) growing degree-day (GDD) accumulation equated to 2937 accrued heat units, with 16 days reaching at least 90°F. Only 9 days reach 90°F in Westchester County (Spaccio, 2015) in a typical growing season. Rainfall was limited to only 0.3" (18–31 August), 1.62" (1–30 September) and 0.4" (1–5 October) during the time of seeding (Spaccio, 2015).

At the end of the second season of study (2006), the repeated applications of PRG yielded evident germination and improvement of desirable turfgrass density. Weekly overseeding of PRG over a period of 8 weeks at 1 lb 1000 ft⁻² resulted in 54.8% desirable turfgrass cover, 3 lb 1000 ft⁻² resulted in 67.5% turfgrass cover and 6 lb 1000 ft⁻² resulted in 85% turfgrass cover. The unseeded control resulted in approximately 45.2% desirable turfgrass cover. Rainfall occurred at a much more even (and abundant) rate during the time of seeding in 2006: 5.36" (23–31 August), 4.69" (1–30 September) and 3.22" (1–13 October). Additionally, only 8 days featured temperatures at or above 90°F (Spaccio, 2015). There is little doubt that the cooler (2900 GDD), wetter weather of the second growing season contributed greatly to the increased germination rates of the PRG seed (Figure 2).

At the end of the third season of study (2007), the repeated applications of PRG again yielded apparent germination and improvement in desirable turfgrass density. Weekly overseeding of PRG over a period of 8 weeks at 1 lb 1000 ft⁻² resulted in 72.2% desirable turfgrass cover, 3 lb 1000 ft⁻² resulted in 87.5% turfgrass cover and 6 lb 1000 ft⁻² resulted in 94.3% turfgrass cover. The unseeded control resulted in approximately 62.3% desirable turfgrass cover. In 2007, Growing Degree Day summaries totalled 2935 GDD units, and the research site had received routine rainfall of 2.46" (31 August–30 September) and 5.38" (1 October–2 November) during the time of seeding. The growing season of 2007 was not acutely hot with only 6 days experiencing temperatures at or above 90°F (Spaccio, 2015) (Figure 3).

At the end of the final season of study (2008), the repeated applications of PRG again yielded obvious germination and improvement in desirable turfgrass density. Weekly overseeding of PRG over a period of 8 weeks at 1 lb 1000 ft⁻² resulted in 54.8% desirable turfgrass cover, 3 lb 1000 ft⁻² resulted in 57.3% turfgrass cover and 6 lb 1000 ft⁻² resulted in 78.5% turfgrass cover. The unseeded control resulted in approximately 40.3% desirable turfgrass cover. Accumulation of GDD units totalled 2875 (30 September) and rainfall occurred at a much more even rate during the time of



Figure 2. Desirable turfgrass density (unseeded control).



Figure 3. Desirable turfgrass density (overseeded PRG, 6 lbs 1000 ft⁻²).

seeding: 0.22" (29–31 August), 6.72" (1–30 September) and 0.36" (1–18 October). The growing season of 2008 was not an acutely hot one, with only 8 days experiencing temperatures at or above 90°F (Spaccio, 2015).

The overall effects of year and sample date varied significantly for most parameters. Overseeding treatments differed for turf quality, clover density and the per cent bare

soil, and in all cases, these differences varied with sample date. For these three parameters, the interaction of overseeding treatment and sample date was consistent across the four years of this trial. The interaction was partitioned as treatment within each sample date (Table 1).

Consistent with their life cycle as annual weeds, crabgrass (*Digitaria* spp.) and prostrate knotweed (*Polygonum aviculare*) populations declined as individual growing seasons progressed, but statistically, there was no significant effect of overseeding.

Implications for urban trees and tree managers

Though effects concerning tree root populations were not formally measured, there would likely have been an inverse relationship between increasingly dense turfgrass populations generated from repetitive overseeding, especially at the 6 lbs 1000 ft⁻² rate, and a decreasing number of tree roots (Day et al., 2010), were they in the vicinity of the site. These factors would be important considerations for professionals like Tree Wardens, concerned with managing a variety of plant communities that extend beyond that of trees, to include turfgrass.

Discussion and conclusions

In 2006, overseeding efforts resulted in up to 85% desirable turfgrass cover by seeding 6 lbs 1000 ft⁻² at 8 weekly intervals. Since unseeded control plots featured 45.2% desirable turfgrass cover, the desirable turfgrass density almost doubled. In 2007, overseeding efforts resulted in up to 94.3% desirable turfgrass cover at the overseeding rate of 6 lbs 1000 ft⁻². Since unseeded control plots had only 62.3% desirable turfgrass cover, the increase in desirable turfgrass density was well over 30%. Finally, in 2008, overseeding efforts resulted in up to 78.5% desirable turfgrass cover by seeding 6 lbs 1000 ft⁻². Since unseeded control plots featured only 40.3% desirable turfgrass cover, the increase in desirable turfgrass density was over 37%. It is important to note that not only was the proliferation of desirable turfgrass noted at the end of each of the individual growing seasons, but that a reduction in bare soil was informally noted at the commencement of the following growing season's research in the previous year's plots. Though outside of the purview of this study and not formally measured, this does suggest that a cumulative benefit may be observed in compounding measure as seasons of overseeding ensue on an athletic field surface. This would also corroborate the findings of other researchers (Elford, Tardif, Robinson, & Lyons, 2008), as bare soil and less-desirable plants would continue to be displaced by desirable turfgrass cover over time.

It is important to note that due to inadequate frequency of precipitation, 2005 PRG overseeding efforts appeared to avail insignificant germination of a desirable turfgrass species. A lack of response from overseeding was also noted by Elford et al. (2008) that same year due to a "dry growing season." It is possible that a region-wide drought negatively influenced overseeding results at both locations. Thus, perhaps it may be more appropriately qualified that while this study strongly suggests that overseeding PRG at 6 lbs 1000 ft⁻² at 8 weekly intervals may be an effective way of increasing desirable turfgrass cover on a low-input athletic field, most favourable results are most likely contingent on suitable weather conditions, namely adequate rainfall. This would be a topic worthy of further research.

If a repetitive PRG overseeding programme was implemented on an annual basis, eventual displacement of a majority of the original grassy athletic field covering would

Table 1. Relative effects of overseeding on turfgrass quality, clover cover and bare soil at three different sample times.

Overseeding treatment (lbs/1000 sq. ft.)	Turfgrass quality (% desirable turfgrass)			Clover (% cover)			Bare soil (%)		
	Sample 1	Sample 2	Sample 3	Sample 1	Sample 2	Sample 3	Sample 1	Sample 2	Sample 3
0	33.6	39.6	42.0	11.0	13.8	15.3	1.6	5.1	26.6
1	26.0	41.0	48.8	12.9	17.4	18.2	1.9	4.2	18.5
3	32.0	43.1	57.9	10.0	13.5	13.3	1.5	3.9	13.4
6	33.6	45.6	68.7	13.5	14.8	7.4	2.0	2.5	9.3
Significance ^z	ns	ns	Linear**	ns	ns	Linear**	ns	ns	Quad**

^zSignificance: ns = nonsignificant, Linear** = highly significant linear relationship between overseeding rate and parameter, Quad** = highly significant quadratic relationship between overseeding rate and parameter.

likely take place (Gruttadaurio, 2008). Though there are many merits associated with PRG, its presence as *the* dominant athletic field grass may be cause for further questions. PRG is known, for example, to demonstrate poor low-temperature tolerance (Ebdon & Gagne, 2002). Would large sections of a PRG-dominated athletic field *regularly* succumb to winter cold-injury (Elford et al., 2008; Lyons & Elford, 2009)? PRG is also known to be susceptible to fungal organisms of importance including crown rust (*Puccinia coronata*) (Muyllé et al., 2002) and the highly destructive grey leaf spot (*Magnaporthe grisea*) (Curley et al., 2005). Would the presence of these diseases make the management of widespread numbers of PRG-dominated athletic fields prohibitive? Certain types of grasses – like fescues – are known to exude allelopathic chemicals that may injure the roots of other plants including trees (Bertin, Senesac, Rossi, DiTommasa, & Weston, 2009). Would a field dominated by PRG exude similar toxins? These are topics worthy of further consideration and research.

As with any input, there would be resources required to commence and maintain a repetitive overseeding programme. Gruttadaurio (2008) has estimated weekly costs for PRG seed on a typical soccer field, administered at the 6 lbs 1000 ft⁻² rate to equate to \$6.00 per 1000 ft⁻² of area, and total \$132.00 per week. These estimates should be carefully considered by practitioners and further studied by researchers, since limitations associated with municipal budgets are widely known (Stobbart & Johnston, 2012), especially relative to the maintenance of publically accessible grounds, parks and athletic fields. Findings may then be compared to costs associated with current management practices to determine if the purchase of large quantities of additional grass seed may be feasible. Since overseeding has been referred to as an “essential” component of a successful integrated pest management programme (Lyons & Elford, 2009), especially where there is interest in reducing pesticide use, it is important to understand how costs associated with other inputs, like herbicides, also would be affected over the long-term.

Turfgrass overseeding has indeed been long acknowledged as a key non-chemical practice that may be employed to improve desirable plant density on high-use, low-input sites. Its application as part of a repetitive regime may be a viable option for those landscape professionals – including Tree Wardens – whose responsibilities include turfgrass management, who wish to reduce their reliance upon traditional pesticides and provide safe playing surfaces for end users. Of course, knowing that trees have been identified by some experts as the single most important obstacle to growing healthy turfgrass (D. Otis, pers. comm.), Tree Wardens may ultimately be faced with a choice in some public settings: healthy municipal trees, free from the competition of turfgrass or healthy grass-covered parks and playing surfaces free from the detrimental shade of their woody counterparts. This speaks to the increasing multi-dimensionality of the role of the Tree Warden in the USA. Individuals in this position will need to be able to competently manage a broad spectrum of urban land uses, even when interests – and plant-types for that matter – are inherently competitive. This is especially the case in an era where our urban green spaces and resources continue to be under mounting environmental and social pressures, from factors like climate change and human population increase.

Finally, it is clear that the relationship between trees and amenity or sports turf is a two-way interaction and trees will subject turf to water stress, nutrient stress, shade and deposition of leaf litter. This is worthy of further work.

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Disclosure statement

No potential conflict of interest was reported by the authors.

Notes on contributors

Richard W. Harper is an extension assistant professor of Urban and Community Forestry in the Department of Environmental Conservation, University of Massachusetts, Amherst, MA. He administers an applied integrated research and extension programme aimed at addressing both emergent and long-term needs of urban forest managers. He currently teaches courses in urban forest management and urban plant health care.

Wesley R. Autio is a professor and director of Stockbridge School of Agriculture, University of Massachusetts, Amherst, MA. Autio has extensive experience involving research concepts, experimental design and statistical analysis. He is leading current efforts to strengthen educational, research and outreach programmes.

John T. Finn is a professor and systems ecologist at the Department of Environmental Conservation, University of Massachusetts, Amherst, MA. Finn's scholarly interests include development of modelling and analysis techniques, statistical methods for ecological data, GIS, remote sensing and application of modelling and theory to environmental assessment and resource management.

Frank S. Rossi is an associate professor and extension turfgrass specialist at Cornell University, Ithaca, NY. Rossi orchestrates a broad-based research and education programme focused on ecological aspects of turfgrass science. He also instructs numerous courses including "Plant Science and Systems" and "It's Just Grass; Grassing the Urban Eden."

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