UBC Social Ecological Economic Development Studies (SEEDS) Student Report

Examining the Sustainability of Lawns on Campus

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Executive Summary

This report explores whether lawns can be considered a sustainable landscaping option in a campus setting. This was completed through an analysis of each of the three spheres of sustainability: environmental, social, and economic, in addition to a consideration of the use of lawns at specific universities. The following conclusions were generated:

i. **Campus lawns can be considered sustainable if they are managed in an environmentally conscious and sensitive manner at low levels of maintenance.**
   - Recommendation: Manage lawns at a Level 4: "Open Space/Play" maintenance level as defined by the B.C. Landscape Standards.
   - Recommendation: Conduct future research to determine the balance between sustainable management practices and optimal lawn health.

ii. **Lawns provide an important environmental benefit through the sequestration of carbon. However, their low biodiversity and high water consumption must be considered in maintenance practices.**
   - Recommendation: Allow dormancy in summer months or implement a rainwater collection program to supplement irrigation.
   - Recommendation: Use lawns in conjunction with pockets of trees and native vegetation to support biodiversity.

iii. **Socially, lawns are very sustainable because of their canonical place in campus landscaping.**

iv. **Economically, lawns can be considered sustainable because of their longevity and the low level of maintenance complexity they require.**

v. **The use of lawns at the University of Washington and Simon Fraser University provides insights as to the environmental and social benefits of lawns.**

- Recommendation: Consider the environmental benefits that lawns provide in terms of stromwater filtration and the impact of this at the University of British Columbia.

Introduction

Throughout the history of university campuses, lawns have been a canonical aspect of their landscapes. However, as concepts of sustainability are becoming of increasing concern to modern society, the environmental impacts of different landscaping features are being questioned. Sustainability is of paramount concern to universities such as the University of British Columbia (UBC) and is even encoded within many campus development strategies (UBC 2010; City of Seattle, 2013). Thus it follows that the landscaping of the UBC campus is subject to intense scrutiny over its sustainability: environmentally, economically, and socially. This research project seeks to determine the sustainability of lawns in campus landscaping, with a comparison against the currently popular native landscaping options, as well as to generate recommendations as to the use of lawns. This will involve a literature review and the consultation of landscaping professionals at UBC. Sustainability will be analyzed in the three spheres of environment, social, and economic, with a particular focus on the environmental sustainability as of dominant concern to UBC. Furthermore, the use of lawns at other comparable campuses, such as Simon Fraser University and the University of Washington will be considered in formulating conclusions.

Methods

This research project consisted mainly of a literature review to determine the environmental and social values of lawns in a campus setting. A variety of sources, including peer-reviewed articles, consultant reports, and provincial and campus-specific landscaping standards were utilized to generate a broad and thorough understanding of

the many views on lawns. This literature review identified native landscaping as the most popularly supported alternative to lawns, a type of landscaping that is lauded as an environmentally sustainable alternative in popular thought. The economic sustainability of lawns for UBC was determined through a qualitative analysis based on a combination of literature review and expert consultations. Obtaining quantitative costs proved to be outside the scope of this project due to the complexity of comparing lawns, which can be managed at a variety of service levels and costs with native vegetation in general, for which specific types and maintenance regimes would have to be tried before discerning any direct data. Recommendations were generated based on the information synthesized through the process outlined above.

Environmental Sustainability

The impact that lawns have on their environments is the topic of much scholarly debate. Moreover, there are many different types of environmental effects that turfgrasses have which must be considered, ranging from the potential for carbon sequestration to issues of biodiversity. This project identified carbon sequestration, water consumption, and biodiversity as the key environmental issues of lawns. Wherever applicable, these issues were weighed against native landscaping to determine whether lawns can be considered sustainable in relation to its most popularly supported opposition. Native landscaping, for the purposes of this project, can be defined as soft horticultural landscaping using plants native to Vancouver, B.C., that occurred prior to European contact (Native Plant Society of B.C., n.d.).

Carbon Sequestration

One of the most significant positive environmental effects that lawns provide is the potential for carbon sequestration by turfgrass. Any surfaces that can potentially absorb carbon from the atmosphere, thereby reducing local carbon dioxide levels, are acting favourably for environmental sustainability by counteracting the greenhouse effect. There have been a number of recent studies conducted on the carbon sequestering capabilities of turfgrasses, most of which conclude that the carbon absorbed by turfgrasses is significant (Milesi et al. 2005; Sahu 2008; Selhorst & Lal 2011; Qian & Follett 2012; Selhorst & Lal 2012).

In his literature study, Dr. Sahu claims that well-managed turfgrass can sequester between four and seven times the amount of carbon that is emitted by a lawn mower for that unit of turfgrass area (2008). Sahu based his conclusions on calculations considering the shoot, root, and first few inches of soil underlying a unit of lawn (2008). However encouraging his findings may be for lawn surfaces, it is important to note the potential biases in his findings, having created a report for the Outdoor Power Equipment Institute, who would want lawns to remain popular options to foster business. Despite this issue, Sahu's findings are repeated in a number of other scholarly sources (Milesi et al., 2005; Selhorst & Lal, 2011; Qian & Follett, 2012). Selhorst and Lal determined that on average in United States residential lawns, turfgrass soils are sinks for 2.8 (±0.3) Mg of carbon per hectare per year (2011). Furthermore, it was demonstrated that the amount of carbon released to the atmosphere by fertilizer application and mowing would not negate the carbon sunk by lawns until between 66 and 199 years after turfgrass establishment, depending on the intensity of management (Selhorst & Lal, 2011; Qian & Follet, 2012).

This was proven to be highly dependent on management practices, specifically the practice of leaving clippings on lawns, which increased the carbon sequestered in all management scenarios, even when nitrogen fertilizer application was reduced by 50% (Qian & Follett, 2012).

Thus, it can be seen that lawns indeed provide effective carbon sinks. In comparison to other landscape types, looking at unmanaged forests, shrubs, and herbaceous plants, Falk (1976; 1980) and Pouyat et al. demonstrated that lawns are comparable in the amount of carbon they sequester (2008). Native plants, for this comparison, fall under the category of herbaceous plants and shrubs. Interestingly, studies suggest that although turfgrass itself does not sequester as much carbon as a tree, shrub, or herbaceous plant, the soils underlying the turfgrasses act as substantial carbon sinks (Jo & McPherson, 1995; Pouyat et al., 2008). Furthermore, it has been proposed that the faster growth rate and high root density of grasses causes them to sequester more carbon in the soil than slower growing plants with lesser root systems, such as herbaceous plants and shrubs (Charles, 2012). Therefore, it can be seen that lawns do act as net positive carbon sinks, even considering management emissions, and can be compared to other vegetation types in their sequestration benefits. However, it would be enlightening to undertake a study on the sequestration potential of specific native vegetation types at UBC to more definitively address the question of whether lawns sequester carbon more successfully than native vegetation landscaping.

Biodiversity

One of the least sustainable aspects of lawns as landscape surfaces is the loss of biodiversity. Overall, turfgrasses do not support nearly the same degree of biodiversity as

native landscaping does (Kermath, 2007; Brown, 2009; Schultz et al., 2009). Lawns are uniform surfaces of a single exotic species of turfgrass, most commonly Kentucky blugrass (*Poa pratensis*) or Perennial ryegrass (*Lolium perenae*) in the Pacific Northwest (Stahnke et al., 2010). Any other plants or purported 'weeds' that may establish within the turfgrass are eliminated. Thus, fundamentally, lawns lack the plant diversity that native landscaping promotes through the encouragement of natural establishment of native species (Kermath, 2007). The spread of suburban lawns into natural habitats has reduced biodiversity, replacing animal species with a smaller number of species suited to living in close proximity to humans and plant species with one turfgrass species (Bormann et al., 2001). Considering, however, that UBC is already a built, urbanized environment, the use of lawns will not be destroying a natural landscape of high biodiversity. McKinney suggests that to increase biodiversity, a variety of native plant species should be cultivated, which has been shown to positively correlate with native bird species richness in Australian and North American studies (Munyenyembe et al., 1989; Sears & Anderson, 1991; McKinney, 2002). Therefore, supplementing lawns with pockets of native species would be a more sustainable option for UBC. As Beard and Green have shown, turfgrasses can support a "diverse wildlife population," when used in conjunction with native plants and trees (1994, p. 456). Ultimately, however, the environmental sustainability of lawns is greatly reduced when the impacts to biodiversity are considered: native landscaping would better facilitate biodiversity on campus than lawn surfaces.

Water Consumption

The irrigation of lawns consumes vast amounts of water. For example, on the west coast of the United States, lawn irrigation accounted for 60% of available water use in 2001 (Brown, 2009). However, it is important to realize that the UBC campus is located in a seasonally wet climate; on average it receives over 1200 mm of rain per year, ranging from 39 mm in July to nearly 200 mm in November (Environment Canada, 2013). Milesi et al. found that lawns acted as successful carbon sinks when irrigated with 25.4 mm of water per week, including inputs from rainfall (2005). This means that within a climate such as Vancouver's, lawns at UBC would not require irrigation for most of the year (see Table 1).

Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**
Rain (mm)	146.5	125.2	118.7	89.0	68.3	55.5
Month	Jul	Aug	Sept	Oct	Nov	Dec
Rain (mm)	39.3	48.1	58.6	113.3	196.1	167.9

Table 1. Rainfall at UBC by month (Environment Canada, 2013).

As an alternative to lawn surfaces, native landscaping would eliminate the need for irrigation, because native plants have evolved to support themselves using what the climate provides (Brown, 2009). Therefore, purely in terms of water consumption, lawns are not the most environmentally sustainable option for landscaping at UBC. However, at the University of Washington, a system of rainwater and stormwater runoff collection

that would provide enough water to fulfill irrigation requirements for the entire campus has been proposed (Way et al., 2012). UBC could initiate a similar project to meet water needs. Alternately, if allowed to go dormant in the drier summer months, the need for irrigation would be eliminated. Turfgrasses are capable of ceasing growth and becoming dormant for the summer months, then recovering easily to a healthy, growing, and aesthetically pleasing green colour when rainfall returns (Beard & Green, 1994). Therefore, it can be concluded that with careful management, the water consumption of lawns at UBC would not be a significant environmental issue.

Other Maintenance Factors Affecting Environmental Sustainability

Fertilization. Many studies have demonstrated that the carbon sequestration potential of lawns can be increased when they are supplemented with fertilizer application (Milesi et al., 2005; Selhorst & Lal, 2011). The application of fertilizer causes a large influx of nitrogen into the lawn ecosystem, potentially resulting in nitrate contamination of groundwater supplies (Beard & Green, 1994). However, studies have also found that leaving the clippings from lawn mowing on the grass to act as a natural fertilizer can benefit lawns and render the need for fertilization significantly less (Milesi et al., 2005; Sahu, 2008; Qian & Follet, 2012). Potentially, managing the lawn at a Level 4 “Open Space/Play” maintenance level as defined by the B.C. Landscape Standards would be an option whereby the lawn could be sustained without the use of fertilizers, supplementing the limited fertilization with clippings (B.C. Society of Landscape Architects and Landscape and Nursery Association, 2012). Further research would have to be conducted to determine the viability of this specifically on the UBC campus and to

discover the best balance between optimal carbon sequestration and sustainable management.

Mowing. Lawn mowing can be a source of fossil fuel emissions and a significant consumer of gasoline. However, the studies I have consulted conclude that the emissions from the operation of lawn mowing equipment do not amount to enough to negate the positive carbon sink that turfgrasses provide (Sahu, 2008; Selhorst & Lal, 2011; Qian & Follett, 2012). Specifically, Selhorst and Lal demonstrated that if mowed once or twice a week from April through October using a gasoline powered mower, up to 265 years would have to pass before the lawn mower emissions (totalling approximately 189.7 kg of carbon equivalent per hectare per year) would surpass the amount of carbon that a lawn absorbed (Selhorst & Lal, 2011). It is important for this project to note that UBC utilizes diesel-powered rotary mowers, not typical homeowners' gasoline powered mowers. Diesel fuel was calculated by Selhorst and Lal to emit 0.94 kg of carbon equivalent for each litre combusted, slightly more than the 0.85 kg of carbon equivalent emitted per litre by gasoline (2011). The values for gasoline emissions were utilized because determining the effects of the exact emissions from UBC lawn mowers is outside the scope of this study. Further research into the emissions of different types of lawn mowers would provide beneficial insights into enhancing the sustainability of this aspect of lawn management. Additionally, it has been suggested that allowing grass to remain at a longer length that typical lawns can increase the amount of carbon sequestered, through a deeper root system (Selhorst & Lal, 2011). If adopted, this practice could help to reduce the amount of mowing required and therefore, the amount of emissions.

Social Sustainability

The social sustainability of lawn surfaces on campus will be examined in this next section with the aim of concluding whether lawns can be considered socially sustainable at UBC. Dober contends that lawns are an integral part of university landscapes, iconic and definitional of a typical campus (2000). They are a fundamental component of traditional university life and of traditional North American landscaping design overall, as is repeatedly emphasized in a variety of sources (Jenkins, 1994; Dober, 2000; Bormann et al., 2001; Steinberg, 2006). Aesthetically, lawns provide blank reprieves from the built environment, presenting a "counterpoint to the verticality" of the surrounding environment (Bormann et al., 2001). Furthermore, lawns serve an important social function encouraging "informal participation in campus life [and as] an anodyne for electronically induced anomie" (Dober, p. 10, 2000). Lawns are a place for socialization, mental relaxation, and studying in the fresh air; they are a classic component of university life (Dober, 2000). For example, the University of Virginia has a famous expanse of turfgrass known as "The Lawn" which is iconic of the school and is recognized as one of the campus' most important architectural features (Bormann et al., 2001). Lawns are also recognized for their safety as a landscape feature. The unimpeded visibility of lawns deters intruders and vandals and is an important feature around the entrance to buildings for easy and safe access (Beard & Green, 1994). The social sustainability of lawns can be brought into question however, as issues of globalization and sense of place become increasingly prevalent in modern society. Lawns are homogenous, generic landscapes that can cause "experiential, aesthetic impoverishment," robbing us of our sense of place (Schultz et al., 2009, p.2). With lawns dominating

landscapes all over the world, there are no longer ties to the land that establish a sense of belonging (Schultz et al., 2009). However, seeing as they are such iconic components of campus landscapes in North America, lawns potentially could be seen as creating a sense of place of being at a higher learning institute. To maximize the social sustainability of lawns then, utilizing them in conjunction with pockets of native vegetation would provide the benefits of both arguments by establishing a sense of place while maintaining their essential function in campus life.

Economic Sustainability

In determining the economic sustainability of lawns at UBC, I analyzed a series of variables related to landscape labour at the UBC campus. At UBC, 20-30% of landscape labour time is generally allocated to lawn care depending on the season, comparable to the industry average of 25.7% (Van Yahres, 2000; Nulty, 2013). Alternately, horticultural work typically consumes about 20% of a campus' landscape labour time, arboriculture about 8.6%, and flowers about 5.7% (see Figure 1).

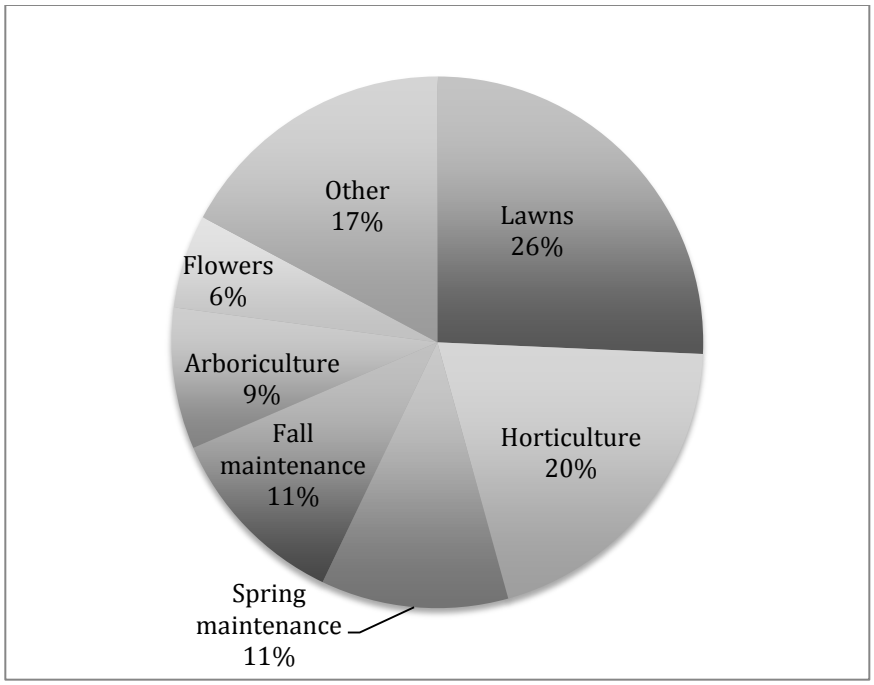

Figure 1. Campus landscaping labour time requirements (Van Yahres, 2000).

Thus, superficially, it would appear that lawns are more costly and therefore less economically sustainable than other landscape types. However, it is important to consider the overall economic sustainability, not simply the economic cost. Lawns do require more time resources in labour, however, they are also the least complex form of landscape to maintain (Van Yahres, 2000). In contrast, arboriculture, which involves the smallest time investment, requires the most skilled labour and experts for long-term management (Van Yahres, 2000). Experts and skilled labour would cost substantially more in salary, for a lesser amount of time, than the labourers required for lawn maintenance. Aside from labour costs, lawns can be considered more sustainable economically because they do not require replanting every ten years, as do shrubs and flowers. The life cycle of turfgrasses is at least 100 years on average, which is ten times as long as shrubs or flowering plants (Van Yahres, 2000). Additionally, there are many expanses of turfgrass on campus that

are virtually unmanaged, requiring a negligible amount of labour resources (Nulty, 2013). In considering the use of native plantings as compared to lawn in terms of management, it is important to realize that although promoted as 'wild' plants that will effortlessly thrive in their natural environments without consuming labour resources, native plants indeed require an amount of maintenance that can be equal to horticulture in some cases (Nulty, 2013). Additionally, native plantings would require edging work and seasonal clean-ups, which accounts for approximately 22.8% of labour time on a typical campus (Van Yahres, 2000). Therefore, although a direct cost comparison was not possible within the scope of this research project, it can be seen that lawns can be considered economically sustainable because of their long life cycle and low management complexity.

Simon Fraser University and the University of Washington: Insights from Other Institutions

Through a review of the land use plans published by Simon Fraser University in Burnaby, B. C., and the University of Washington in Seattle and Tacoma, Washington, I was able to compare the universities' views on lawns. Simon Fraser University does not focus much on landscaping in their land use plan, although they do emphasize the importance of enhancing and blending in with the natural beauty of the surrounding mountaintop environment, including the forest and native vegetation (Simon Fraser University, 2010). They also state the importance of large, horizontal, open spaces for leisure and recreation, as well as the importance of maintaining a green network cleared of forest to maintain the impressive views (Simon Fraser University, 2010). Thus, Simon Fraser University would best fit a combination of lawns and native plants or forest. In

contrast, the University of Washington includes much on their views of landscaping land use for the University District. They promote focusing on open public spaces for the safety and enjoyment of the public, such as green streets and parks, as well as landscaping that is pedestrian-friendly (City of Seattle, 2013). Additionally, since 2009, green stormwater infrastructure (GSI) is required in all redevelopment projects for stormwater mitigation, specifically to clean and slow runoff (City of Seattle, 2013). The land use plan discusses the application of rain gardens and green roofs for this, but neglects to consider the effective filtration systems that turfgrasses are (City of Seattle, 2013). Lawns could thus help to meet the GSI requirements for the University of Washington. Lawns would also fit the insitution's desire for open, public, pedestrian-friendly green spaces.

Limitations

Unfortunately, to fit within the limited time and scope of this project, only a subset of the myriad of environmental variables that affect landscaping sustainability could be considered. Carbon sequestration, water consumption, and biodiversity were chosen from a combination of literature review and the project objectives laid out by UBC SEEDS. Additionally, it is difficult to compare the qualitative aspects of sustainability against one another, as no sphere can be objectively identified as more important than another. As such, future research should focus on establishing a more quantitative measure through which sustainability can be gauged.

Conclusions and Recommendations

Through this study, I have determined that lawns can be considered sustainable environmentally, socially, and economically. Although they have been demonstrated to be less supportive of biodiversity than other landscaping options, considering their carbon sequestration benefits, lawns can be considered environmentally sustainable if they are managed sensitively and intelligently. Options for such management include leaving clippings on lawns to reduce fertilizer need, using areas of lawns in combination with native plants and arboriculture, and some combination of rainwater collection for irrigation and allowing dormancy in the driest months of the year to reduce water consumption. Managing lawns at a level four or five maintenance level as defined by the B. C. Landscape Standards would fit some of these recommendations, ensuring that lawns are primarily maintained for ecosystem functioning, are adapted to high pedestrian traffic, and are mowed as infrequently as possible. Finally, implementation of some other institutions' innovative ideas for sustainability practices regarding lawns, such as the stormwater collection and green filtration proposals from the University of Washington, would further foster the sustainability of lawns at UBC.

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