The Case for Fruit Trees in the City

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Summary

Food production systems meet a critical human need, but have today developed into what are often extremely resource-intensive and unsustainable systems. Recent global awareness of sustainable development, use of natural resources, rising fossil fuel prices, and carbon emissions have placed conventional agriculture systems under criticism.

The reintegration of urban agriculture in urban infrastructure could be a vital strategy in creating a more sustainable food production system. Urban agriculture is a key component of developing livable and sustainable cities. The urban forest, in particular, is a key element of urban infrastructure that provides a number of benefits, including ecological, recreational, aesthetic, health, and infrastructure services. While urban agriculture has become a buzzword in recent years, the debate has focused on traditional gardening in small urban plots, or futuristic trends such as vertical farming. Less attention has been paid to fruit trees, which, as a critical intersect point between urban forests and urban food production, can potentially provide the key for improved integration of local food production in cities.

Along with potential and opportunities, there are many drawbacks and barriers to fruit tree planting in cities including land availability, soil contamination, pests and maintenance. Understanding the drawbacks and barriers to urban fruit production is critical for assessing feasibility of fruit-tree integration and creating municipal regulations, public-private partnerships, appropriate community engagement as well as

different socio-cultural perceptions, all of which are key to fostering the integration of fruit trees in the urban environment.

This report assesses the importance of integrating urban forestry with urban fruit production, the potential for urban fruit production within cities, and potential barriers and benefits. A fruit-tree planting study was completed to assess potential planting and fruit production capacity in an urban residential neighbourhood in Halifax, Nova Scotia. Further feasibility and potential opportunities for fruit-tree integration are analyzed with existing urban fruit tree and urban fruit orchard case studies around the world. Overall, the analysis points to high potential for fruit tree integration within urban environments. The report addresses some of the existing barriers to this integration, and provides recommendations for further research, municipal programs, bylaws, and incentive programs that can overcome these identified drawbacks and barriers.

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1. Introduction

Cities are places of continuous change, development, and growth. In the second half of the 20th century, a major global migration from rural areas to cities occurred (Mougeot, 2006). Today, more than 50% of the human population resides in urban areas and this number is expected to increase to 60% by the year 2025 (Carreiro, Song & Wu, 2008; Toronto Food Policy Council, 1999). In Canada, more than 80% of the total population resides in cities (Statistics Canada, 2008). Although cities take up less than 2% of the earth's land surface, they use 75% of the earth's resources (Toronto Food Policy Council, 1999). In modern settings, most resources are grown, extracted, produced, processed and manufactured in rural areas, and then transported to cities (Nordahl, 2009).

Food production systems fulfill a critical human need, and yet are also one of the most resource-intensive and unsustainable systems in the world today. In Canada, the agriculture sector accounts for $87.9 billion or 8.8% of the country's GDP, but is also the fourth largest water user as a sector, and accounts for 8.8% of national greenhouse gas emissions (Kittson, Bonti-Ankomah, Zafiriou, Gao, Isma, 2007; Agriculture & Agri-Food Canada, 2008; Environment Canada, 2011; Environment Canada, 2008). Modern industrial and conventional agriculture consists of large-scale production systems that are highly reliant upon resource inputs such as fertilizers, pesticides and fossil fuels (Nordahl, 2009). It relies on fossil fuels in almost every stage of the food system, from the manufacture of chemical fertilizers and pesticides, to the powering of machinery for harvesting, tilling, washing, sorting, processing and transporting food (Nordahl, 2009).

Such a heavy reliance upon fossil fuel-based resources, as well as its high outputs of greenhouse gases, makes the agriculture industry one of the top contributors to global greenhouse gas emissions (Environment Canada, 2011). The resulting effects of climate change, including changes in weather patterns and water availability, and the high costs of agricultural inputs at times of high oil prices, have highlighted the vulnerability of our centralized agriculture production systems (Nordahl, 2009).

Modern industrial food production occurs primarily in rural areas and as a result, city dwellers are increasingly distanced and disconnected from food sources and production. With the recent international focus on sustainable cities, resource scarcity, rising fossil fuel prices and climate change, conventional agriculture systems have come under criticism (Nordahl, 2009; De La Salle & Holland, 2010). The shift to high-density city centres, growing food demand and industrial agriculture, amongst other factors, have led to the decline of urban agriculture in city planning and infrastructure during the second half of the 20th century (De La Salle & Holland, 2010).

Urban agriculture - the raising, processing and distribution of agricultural products within and around a city - has been practiced for thousands of years across the globe (Mougeot, 2006). Urban agriculture can take many forms including community gardens, private backyards, rooftops, allotment gardens, fruit orchards, and commercial production sites. It is part of a survival strategy for the urban poor throughout the world and its contribution to food security is substantial in many developing-world cities (UNDP,

1996). In contrast, urban planning in developed nations and cities rarely includes urban agriculture infrastructure.

Recently, urban agriculture has also been growing in popularity alongside local food procurement, sustainable food production and food security movements in cities across the world (De La Salle & Holland, 2010). The reintegration of urban agriculture in city planning and infrastructure is a key component of developing sustainable cities: local food production is critical for regional and community food security as well as community health and resilience (Nordahl, 2009; De La Salle & Holland, 2010).

The urban forest is another critical component of urban infrastructure. Current urban forest planning and management encompasses ecological and wildlife components as well as recreational, cultural, and aesthetic factors, but seldom include food provisioning from trees (Carreiro et al., 2008). This paper argues that fruit trees are the intersecting point between urban forests and urban food production and can potentially provide the key for integration of these two critical urban systems. They could be an important and useful part of developing community food security, sustainable food systems and ecological services. The report assesses the potential for urban fruit production through the integration of fruit trees within the urban forest, and identifies potential barriers and benefits.

The objectives of the study are to:

A) Examine the importance of integrating urban forestry with urban fruit production, therefore redefining the urban forest;

B) Determine the potential of urban fruit production within integrated urban forestry and urban food strategies (using case studies);

C) Identify the benefits and barriers of integrating urban forests with urban fruit production; and

D) Examine potential enablers for scaling up urban fruit production

2. The Urban Forest and Urban Food Production: Two Solitudes?

2.1 Forests as a Food Source

Since the development of the first urban centres and cities, forests in and near these settlements have been a primary food and fuel source for residents (Kuchelmeister & Braatz, 1993; Konijnendijk, 2008). From ancient Roman cities to medieval European settlements, the urban forest has played a critical role in resource availability, socio-cultural influences, and economics (Konijnendijk, 2008). City forests provided timber, firewood, fruit, nuts, mushrooms, and meat from hunting (Konijnendijk, 2008; Kuchelmeister & Braatz, 1993). The critical provisions that city forests supplied dictated how urban forests were managed. The first known city forest management activities began during the Middle Ages with the establishment of private hunting grounds and timber harvests for royal families (Konijnendijk, 2008).

Beginning in the mid 19th century, public parks become more prominent in cities as places for leisurely activities of the wealthy and prestigious (Konijnendijk, 2008). Today's city and urban forests encompass many types of vegetation and green spaces and are valued as recreation areas, wildlife habitats and ecologically valuable sites. As a result of this evolution and shift in urban forest management and the evolving socio-

cultural and economic context, the urban forest is no longer perceived as a major or primary food and fuel source.

2.2 New (Renewed) Interest in Urban Agriculture

Within the past 5-10 years, urban agriculture has been growing in popularity (De La Salle & Holland, 2010). Urban agriculture, permaculture, and local food procurement are today recognized as important components of sustainability and food security strategies for nations and cities (Mougeot, 2006). The United Nations Development Programme (1996) reported that there are 200 million urban farmers in the world supplying food to 800 million people, or about twelve percent of the world's population. The UNDP also stated that in many Asian cities, food production is recognized as a critical urban function. For example, Hong Kong, one of the world's most densely populated cities, produces two-thirds of the poultry, one-sixth of the pigs and half of the vegetables eaten by its residents (UNDP, 1996). This is not just a developing world phenomenon: in Canada, 40% of people in the Greater Toronto Area and 44% of people in Greater Vancouver live in households that produce a portion of their own food (Canada's Office of Urban Agriculture, 2002). International organizations and agencies such as the United Nations and the International Development Research Centre have recognized that urban agriculture is a critical and comprehensive solution to many urban social, economic and environmental issues for developing countries (Mougeot, 2006). In developed nations and cities, urban agriculture has reappeared as a part of the renewed food security and sustainable development movement, rather than for survival and subsistence as in developing nations.

Urban agriculture has many diverse benefits for city residents, the local economy and to the environment. Local food production in cities provides residents with fresh food, and increases physical and financial accessibility to healthy food (De La Salle & Holland, 2010). Thus, community food security - when all community residents are able obtain safe, culturally acceptable, nutritionally adequate diets through a sustainable food system that maximizes community self-reliance and social justice - can be strengthened through urban agriculture initiatives (Hamm and Bellows, n.d.). Community gardens and urban food production can also serve to educate residents about healthy food and farming, and bring communities together by sharing knowledge, culture and physical activity. In addition, urban agriculture helps to support and develop the local economy and creates job opportunities (De La Salle & Holland, 2010).

City agriculture operations tend to be small and use fewer pesticides when compared to large-scale conventional agriculture (Nordahl, 2009). Reduced chemical inputs provide healthier food for consumers and also reduce dependence upon fossil-fuel-intensive chemicals. Urban agriculture sites increase biodiversity and habitat space, improve soils, reduce rainwater run-off and improve microclimates (Nordahl, 2009). Locally grown food also reduces the environmental impacts of food transport and fossil fuel dependence within the food system (De La Salle & Holland, 2010).

2.3 Trends in Contemporary Urban Forest Management

The urban forest usually refers to all woody plants in and around the city including street trees, yard trees, park trees and forest stands (Carreiro et al. 2008, pg 12). Current urban forest planning and management techniques encompass the entire network of trees and green spaces within a city for ecological, social, and economic services and benefits (Dwyer, Nowak & Noble, 2003). Although the definition and management of the urban forest has changed throughout time, in general, current urban forest management practices do not encompass food production (Carreiro et al., 2008; Kuchelmeister & Braatz, 1993).

In most North American cities, fruit trees and public orchards are not a planned component of the urban forest. For most urban forest plans, fruit trees are not desired or selected tree species, and in some cases may be against urban tree by-laws (ACRT INC, 1990; Nordahl, 2009). In the city of Vancouver, only flowering non-fruiting varieties of fruit trees are allowed (ACRT INC, 1990). Tree planting and species selection are usually based upon a set of criteria including pest and disease resistance, native species, canopy size, and resilience to harsh urban environments (Dwyer, Nowak & Noble, 2003; Carreiro et al., 2008). In contrast, in some European and Asian cities, fruit trees are extensively integrated within urban parks. For example, the cities of Stockholm, Prague, and Bangalore grow up to 25% fruit trees in their urban parks (Barrs, 2002).

2.4 Bringing Food and Forest Together in the City

The integration of fruit trees in the urban forest can potentially provide a critical step forward for strengthening and developing the urban food network. Fruit trees can provide local, organic and fresh food to communities and strengthen community food security by increasing physical, social and economic access to nutritious and fresh foods (Hamm & Bellows, n.d.).

Ecological principles such as connectivity, diversity and resilience are ecosystem components that also benefit communities (Dwyer, Nowak & Noble, 2003). Fruit trees, much like other trees within the urban environment, can provide critical ecological services. Planting fruit trees could potentially provide more wildlife habitat for birds, which are attracted to and feed on fruit (Foster, 2007). Because fruit trees have many small and dwarf varieties, they can be planted in locations where larger trees cannot grow, and therefore increase planting opportunities.

The relatively small size of fruit trees is also an added beneficial characteristic in regions such as Nova Scotia and Atlantic Canada where high winds and storms result in abundant tree windthrow. In general, shorter trees with smaller canopies are less likely to blow over in storms and cause damage to hydro lines, houses and properties (Clatterbuck, 2000). An urban forest with a diversity of species, tree sizes and age can be more resilient to disturbances such as storms and pest outbreaks (Balvanera et al., 2006).

Fruit trees have multiple benefits for the urban forest and city residents. Understanding the critical ecological, community and food-security benefits can help to address barriers to fruit tree planting within cities, particularly by addressing socio-cultural misperceptions of growing food in urban areas.

2.5 Fruit Tree Characteristics

Before addressing fruit tree planting potential, benefits and barriers, it is important to gain an understanding of the unique characteristics of fruit trees. Due to their long history of propagation through grafting for desirable traits, fruit trees have quite unique size, fruit yield and hardiness characteristics (Hessayon, 1990). Because most fruit trees are not self-pollinating, they do not pass down their traits but rather gain new unique traits (their true desirable characteristics can never be passed down without some modification) (Hertz, 2009). In order to be reproduced true to the original cultivar, fruit trees are propagated through grafting processes, where sections of stems with leaf buds are inserted into the stock of a tree. Without controlled grafting processes, new cultivars are developed, and unlike other tree species, fruit trees have hundreds of different cultivars or varieties. Over 7,500 varieties of apples are grown throughout the world (University of Illinois, 2011). Each cultivar is selected for specific characteristics such as disease resistance, frost hardiness and fruit flavour, colour and size. In addition to desirable fruit, fruit trees are cultivated for desirable size ranges, which are determined from root stocks (Merwin, 1999). For home gardens, dwarfing rootstocks are usually selected for compact size and earlier fruit bearing.

In Nova Scotia, many varieties of fruit trees are grown commercially including apple, pear, plums, cherries, and some peaches, nectarines and apricots (Agri-Food Canada, 2008). In the Atlantic Provinces, one of the biggest concerns and issues for apple production is the fungal disease apple scab. Because of the moist climate and wet weather of the Atlantic Provinces, apple scab is a major problem in commercial orchards (Craig, 2007). When selecting fruit tree varieties for home orchards, it is important to select a variety that is resistant to apple scab. Some disease-resistant apple cultivars recommended for the Atlantic Canada Region include Pristine and Williams Pride, Red Free, Novamac, Liberty, Crimson Gold and Gold Rush (Craig, 2007). In addition to cultivar selection for disease resistance, selecting cultivars for hardiness to cold climate is critical for the survival and productivity of fruit trees. In general apple, pear and cherry trees are hardy fruit trees that can withstand colder temperatures of minus 20-30 degrees Celsius, while peaches, nectarines, and apricots are more susceptible to cold temperatures and frost damage (Hessayon, 1990; Otto, 1993).

Another important factor to consider when selecting fruit trees and varieties is pollination. As previously mentioned, most fruit trees are not self-pollinating and require compatible partner pollinators. When selecting cherry trees for a home orchard, it is important to select self-fruiting or self-pollinating varieties because pollination partnering between cherry varieties is a difficult process (Hessayon, 1990). Cultivar selection for disease resistance, hardiness and pollination are all critical components of fruit tree establishment and success.

3. Benefits of Fruit Trees in the City

3.1 Ecological Benefits

The urban forest and its combined network of street trees, urban parks and privately owned trees provide critical ecological services for city residents, including air filtration, carbon storage, storm water management, soil improvement and microclimate control (Dwyer, Nowak & Noble, 2003; Carreiro et al., 2008). Although usually smaller than typical canopy trees, fruit trees can provide these same vital ecological services (Hessayon, 1990). Many studies have shown that developing connected networks of trees and patch ecosystems, which allow for genetic, individual and species flow, increases resilience to invasive species, diseases, pollutants and weather events (Princeton UP, 2010). Additional studies have also shown that overall, ecological service and function declines with reduced ecological and species diversity as well as habitat fragmentation (Balvanera et al., 2006). By planting more fruit trees and increasing the number and varieties of trees in the urban forest network, we increase the biodiversity of the urban forest, which in turn strengthens its resilience and ecological services (Fischer, Lindenmayer & Manning, 2006).

Direct Reduction of Greenhouse Gas Emissions & Carbon Dioxide Mitigation

The extensive anthropogenic output of greenhouse gases over the last two hundred years (30 billion tonnes of global carbon dioxide emissions from fossil fuel burning in 2010) has led to increased global temperatures and climate change (Hengeveld & Whitewood, 2005; United Nations Framework Convention on Climate Change (UNFCCC), 2010). Land-use changes, deforestation, resource consumption, and other human activities result

in significant outputs of carbon dioxide and other greenhouse gases into the atmosphere (Hengeveld & Whitewood, 2005).

Although carbon uptake or sequestration rates vary by region and ecosystem, terrestrial ecosystems and forests provide a critical ecological service by sequestering and offsetting anthropogenic emissions of carbon dioxide. About one third of the carbon stored in the terrestrial biosphere is stored within living plant biomass, while the other two thirds are stored in soil (Roulet & Freedman, 2008). By increasing canopy cover, leaf area, and number of trees in cities, we can increase carbon sequestration rates of the urban forest. Carbon sequestration rates are dependant upon tree cover, trunk growth, age, species, health, weather and seasonality, and as a result, average carbon storage rates can vary significantly (Roulet & Freedman, 2008). Roulet and Freedman (2008) estimate that the 'average Canadian tree' can sequester 2.5 kg of carbon per year or 200 kg of carbon over an 80-year period within an urban environment. New York City's urban forest has a gross annual carbon sequestration rate of 38,400 tC/yr (tonnes of carbon) (Nowak & Crane, 2000). Within the Halifax urban core, the urban forest, which has a canopy cover of 40%, annually sequesters 100,000 tonnes of carbon (HRM Urban Forest Planning Team, 2011).

On average, as a result of smaller tree, trunk and canopy sizes, fruit tree carbon storage and sequestration rates are lower than large canopy trees such as oak and maple. (Nowak, Stevens, Sisinni & Luley, 2002). However, fruit trees are usually smaller than their canopy cousins and can be planted in many more locations, with the potential to increase overall carbon storage rates for the urban forest.

In addition to size, tree age has a significant influence on carbon storage rates. Although large mature trees have a significantly higher amount of carbon stored within their trunks and branches, young, growing forest stands have significantly higher carbon accumulation rates (Roulet &Freedman, 2008). The rate of carbon accumulation is lower in older trees and forest stands because there is a higher rate of decomposition in dead wood and soil, which actually results in carbon emissions into the atmosphere (Ohio State University, 2008). By planting young fruit trees within the existing network of older canopy trees, the rate of carbon accumulation will increase. In addition to higher carbon accumulation rates, planting fruit trees can provide age diversity within the urban forest, which increases resilience to disturbances and provides replacements for old and dying trees.

Indirect Reduction of Greenhouse Gas Emissions

Trees and the urban forest also indirectly reduce anthropogenic carbon dioxide emissions through microclimate control (Carreiro et al., 2008). The urban environment is mostly composed of non-permeable hard surfaces such as concrete and asphalt, and these surfaces trap and collect heat from the sun. Heating from this and other sources is called the urban heat-island effect. On average, urban environments are at least 2-3 degrees warmer, throughout the seasons, compared to rural areas (Susca, Gaffin & Dell'Osso, 2011).

Trees provide shade to reduce heat absorption and cooling through evapotranspiration,

the process by which trees transfer water into the atmosphere. A mature tree can transfer up to 378 kg of water into atmosphere through transpiration during the summer, which significantly cools the ambient air (Carreiro et al., 2008). A simulation study by Akbari et al. (2001) concluded that increasing canopy cover by 30% in the city of Toronto could reduce energy cooling costs by 10% in urban areas and 20% in suburban residential areas. Akbari & Taha (1992) also found that in cold climates, a 30% increase in urban tree cover can reduce winter heating energy use by 10%. Within the Halifax Regional Municipality (HRM), the urban forest saves $12.4 million in energy costs every year (HRM Urban Forest Planning Team, 2011). Planting fruit trees throughout the urban environment could therefore create a denser urban forest network and strengthen the positive microclimate (heating and cooling) effects of urban trees (Carreiro et al., 2008).

Storm Water Run-Off

Along with heat-retentive surfaces, cities are also mostly composed of impervious surfaces, which can lead to extensive water run-off, and sewage system and river flooding (Carreiro et al., 2008). The urban forest provides a critical function in rainwater retention and water run-off reduction in cities. Trees and soil absorb rainwater and then release it slowly (Carreiro et al., 2008). This reduces the costs of flood damage and water infrastructure provision and maintenance in cities. Estimates from studies show that existing tree canopy cover can reduce urban storm water run-off by 4-8% (Carreiro et al., 2008). In Halifax and other parts of HRM, the urban forest provides storm-water management services that are valued at approximately $2.1 million per year (HRM Urban Forest Planning Team, 2011).

3.2 Health Benefits

Air Pollution and Smog Mitigation

Along with extensive ecological benefits, fruit trees also provide various health benefits including air pollution reduction and air quality improvement for city residents. Trees help to remove air pollution by absorbing pollutants and particulates through plant tissues and stomata on the surface of leaves, branches and stems (Carreiro et al., 2008). Generally, urban areas have significantly higher concentrations of air pollutants such as sulphur dioxide, nitrogen oxides, ozone, and fine particulates (Carreiro et al., 2008). Air pollution and smog have negative effects upon the health of city residents. Health Canada estimates that in the eight largest Canadian cities, 5,900 deaths per year can be attributed to air pollution (Health Canada, 2009). Halifax and its surrounding communities of Bedford, Dartmouth, Spryfield, Sackville, Beaver Bank, Cole Harbour, Eastern Passage, Armdale and Farview have a total tree canopy cover of 43% and have an annual air pollutant sequestration rate of approximately 1,478 metric tonnes, which corresponds to approximately $9.6 million each year in pollution mitigation (HRM Urban Forest Planning Team, 2011). Planting fruit trees within the urban environment would increase air pollution mitigation, and reduce direct and indirect health-care costs that result from air pollution.

Mental and Physical Health Improvements

Stress reduction and mental and physical health improvements are another critical health impact of the urban forest. The famous 1984 Ulrich study showed that hospital patients recovered more quickly and required fewer painkillers when their windows were facing

out to nature and trees. This study and other similar studies show the positive health and stress-reducing effects of nature (Ulrich, 1984; Frumkin, 2001).

As well as faster recovery rates, interaction with nature and green spaces also improves mental health, self-esteem and mood. A study completed by a British mental health organization called MIND showed that a walk in nature, when compared to a walk in a shopping centre, significantly improved self-esteem, mood and vigor, and reduced depression, anger, tension and fatigue (MIND, 2007). Cities with urban forests and trees are vibrant and aesthetically pleasing communities, which promote physical activity. A recent Danish study found that green spaces and parks were associated with lower stress levels and lower likelihood of obesity (Nielsen & Hansen, 2007). Urban forests and green spaces are also visually appealing features in cities. Fruit trees, in particular, are colourful flowering trees that provide communities with beautiful landscapes and can help to promote outdoor activities and reduce stress (Dwyer, McPherson, Schroeder & Rowntree, 1992).

Access to Fresh and Healthy Food

In addition to the mental and physical health benefits, fruit trees also provide a healthy and fresh food source for urban residents (Nordahl, 2009). The urban environment presents unique opportunities for fruit tree and food production expansion given existing strict pesticide-use regulations, local infrastructure and local distribution networks.

Within the past 5 to 10 years, many cities and municipalities in Europe and North America have been or are in the process of banning pesticide use (Cole, Vanderlinden, Leah, Whate, Mee, Bienefeld, Wanigaratne & Campbell, 2011). Within the past eight years, the cities of Toronto and Vancouver have each established a pesticide-use bylaw that prohibits the use of most pesticides within the boundaries of the city (City of Vancouver, 2006; Cole et al., 2011). The ban of pesticides in cities means that growing and consuming food produced in cities has a positive effect upon human health, reducing risks associated with the use and ingestion of chemical pesticides: several studies, including one by the Ontario College of Family Physicians, have documented correlations between pesticide use and ingestion with negative health impacts including various forms of cancers (Bassil, Vakil, Sanborn, Cole, Kaur & Kerr, 2007).

An added benefit of fruit grown without pesticides or chemical inputs is higher nutrient content. A study by Worthington (2001) found that organically grown produce and crops have significantly more vitamins and minerals such as vitamin C, iron, magnesium and phosphorus, when compared to conventionally grown produce. With reduced or absent pesticide use, the integration of fruit trees within the urban forest could therefore provide a healthier pesticide-free food source.

With increased access to fresh food choices, community residents also receive associated benefits of healthier diets with reduced risks of chronic health problems such as heart disease and obesity (Nova Scotia Department of Health, 2004). The Healthy Eating Nova Scotia Report documented that fewer than one third of Nova Scotian adults eat the

recommended 5-10 servings of fruit and vegetables every day (Nova Scotia Department of Health, 2004). This report also identified that the cost of eating 5-10 servings of fruit and vegetables is beyond the reach of residents living on income assistance or below the low-income cut-off for the province (Nova Scotia Department of Health, 2004). Providing a local fresh fruit source that is distributed throughout community organizations, charities, kitchens and food banks could be a step towards more-accessible healthy food options.

3.3 Social Benefits

Community Involvement and Connectivity

Fruit trees can provide many social benefits for city residents and community members. In general, trees and parks provide livable, healthy and safe communities. Kuo (2003) found that the presence of trees in high-density neighbourhoods lowers levels of fear, contributes to less violent and aggressive behaviour, and encourages better community relationships. Fruit trees in particular can also be a source of community engagement and volunteer stewardship (Nordahl, 2009). Community harvesting and sharing of fruit can encourage relationship-building and community connectivity. Organizations and community groups like Toronto's Not Far from the Tree can develop networks for fresh-fruit collection days with community volunteers. With appropriate planning, fruit trees could also potentially become an income source for charity groups, community organizations and individuals through initiatives such as fresh fruit weekend markets (Centre for Education & Research in Environmental Strategies, 2010).

Fruit Trees and Education

Fruit trees and orchards are also an important education tool. School activities and healthy eating programs could be developed around fruit trees in cities. Teachers and children could help harvest excess fruit from residents' fruit trees and, in turn, students could gain an understanding of food sources and healthy eating. Additionally, school lunch menus could be developed around a weekly harvesting and fruit-picking program. For example, the Fruit Tree Planting Foundation (FTPF), a nonprofit charity dedicated to planting fruit trees, donates fruit orchards and resources to public schools and community centres across the globe (Fruit Tree Planting Foundation, 2010). In 2010, The Harriet Tubman Village Charter School in San Diego, California, partnered with FTPF to plant 25 fruit trees on its property and provide environmental education lessons for students (Fruit Tree Planting Foundation, 2010). Such integration of food education programs with fruit tree and orchard planting is a critical component of addressing socio-cultural perceptions of fruit trees and urban food production.

3.4 Economic Benefits

Economic Valuation of Ecosystem Services

The critical ecological services that the urban forest provides can also be quantified in terms of economic value to city infrastructure and services. Computer models such as the UFORE Model, which calculates and derives the value of the structure and ecological services of urban forests, are used to determine the monetary value of ecological services (Nowak & Crane, 2000). Economic valuation models have been used to calculate economic value of urban forests in many cities. For instance, the net present value of

Chicago's urban forest has been valued at approximately $3 billion annually (Nowak, Hoehn, Crane, Stevens, Leblanc Fisher, 2010). This value includes pollution removal, carbon sequestration, building energy reduction and property value increases. The City of Victoria has estimated that each tree within the urban forest is worth $2,000 and city-owned trees are worth over $80 million in total (Parks, Recreation and Community Development Department, City of Victoria, n.d.). Planting fruit trees within the urban forest can help strengthen ecological services, increasing their economic value.

Property Value

Along with extensive economic benefits through ecological services, expanding the urban forest with fruit trees can also have a significant positive effect on property value. Fruit trees are aesthetically pleasing and are often planted as ornamental trees, which can increase the appeal of neighbouring properties and their value. Various studies have shown that property values can increase by 2-15% as a result of landscaping and yard trees (Wolf, 2007).

Overall, the urban forest provides extensive monetary benefits to cities and its residents. By integrating fruit trees within the urban forest, the economic benefits of the urban forest can increase and be diversified.

4. Drawbacks of Fruit Trees in the City

Although there are many social, ecological and economic benefits of integrating fruit trees within the urban forest, there are also several physical drawbacks of planting and

caring for fruit trees that must be identified and addressed if we are to scale up fruit tree planting in urban areas. Many of these drawbacks are related to nuisance and maintenance requirements of fruit trees.

Fruit Tree Maintenance

One drawback of planting fruit trees on private lots is the added maintenance, pruning and care requirement for homeowners. Although many residents with front lawns and backyards care for their existing trees, shrubs and plants, they may feel that a fruit tree would require additional maintenance for pruning and harvesting. In order for fruit trees to bear fruit annually, they require care in the form of watering, pruning, pest prevention, harvesting and fruit thinning (Hessayon, 1990; Otto, 1993). For example, fruit trees require effective pruning on an annual or biannual basis in order to produce a bountiful harvest (Atlantic Committee on Fruit Crops, 2000). Also, correct pruning and fruit thinning techniques change throughout the lifetime of the fruit tree. They are particularly critical for young trees: the first 2-3 years of pruning for fruit trees are a training process during which a framework for fruit production is built, although reduced pruning in the early life stages of fruit trees leads to earlier fruit bearing (Wilson, 2009). Pruning is also required for tree size maintenance, which is an important factor for many homeowners.

Along with specialized pruning knowledge, many fruit tree varieties are susceptible to diseases such as apple scab and powdery mildew, and may require extra knowledge and care in the form of appropriate planting, species selection, pruning and fungicide application.

Pests

Another drawback of planting fruit trees is the issue of attracting pests such as mice, rats, and raccoons. Often fruit trees and, in particular fallen fruit, can attract a range of animal pests that may become a problem for homeowners. Fruit trees can also be significantly injured by rabbits, mice and other rodents, which usually feed on bark and exposed roots (Funt, n.d.). Any one of several solutions to this can be used in fruit orchards, which could also be implemented in residential areas with relatively little input and maintenance from homeowners. One such solution is netting and fencing set up around the trunks of fruit trees.

In addition to mammal pests, many fruit tree cultivars attract insect pests such as aphids, mites, scale insects, leaf-rollers and borer insects. Insect pests can significantly affect the health and harvest potential of fruit trees. Appropriate pest management through site and species selection, as well as specialized knowledge of local insect pests, are required for healthy fruit trees and plentiful fruit production (British Columbia Ministry of Agriculture and Lands, 2010).

Cleanliness and Fallen Fruit

Another critical drawback of planting and growing fruit trees in cities is the associated nuisance of fallen and rotting fruit. Homeowners can become weary of fruit trees within their yards because of fallen and rotting fruit, and the added work of cleaning driveways

and sidewalks as a result. In Nova Scotia, the Halifax Regional Municipality has specific nuisance bylaws that relate to sidewalk and driveway cleanliness (HRM, 2008). Such measures are indicators of the negative social perceptions and norms around urban fruit trees. Site selection when planting fruit trees is critical in reducing these nuisances. By making sure that the drip line of tree canopies does not cover driveways and sidewalks, one can ensure that fruit will not fall onto paved surfaces and create disturbances. Along with site selection, appropriate species selection for size and harvest can also reduce fallen fruit and cleanliness nuisance. Community and charity harvesting organizations are another solution to fallen fruit and harvesting nuisance. In cities like Toronto, Los Angeles and Portland, some organizations provide fruit harvesting services to residents to reduce wasted fruit, and reduce neighbourhood nuisance (Not Far From the Tree, n.d.; Fallen Fruit, n.d.; Portland Fruit Tree Project, n.d.).

Fruit Tree Pollination

In addition to homeowner maintenance and nuisance concerns, another drawback of planting fruit trees rather than non-fruit-bearing trees is the requirement of pairing of trees for successful pollination. Most varieties of apples and pears are not self-pollinating and require other individual trees for pollination. Not all varieties and cultivars are compatible in pollination and may have different flowering times (Hessayon, 1990). A basic knowledge of pollination timing by fruit cultivar and compatibility is required for successful pollination and fruit production. Selecting for self-pollinating fruit tree varieties is one approach to addressing this drawback. For example, most plum tree varieties are self-pollinating. The selection of appropriate cultivar species, pollination

pairing, and planting site selection are vital components for successful growth of fruit trees in urban areas.

5. Experiences with Fruit Trees in the City

Within the past 5-10 years, urban orchards and forest garden projects in cities along with local food movements have become more widespread (Nordahl, 2009; De La Salle & Holland, 2010). There are many examples of fruit orchard projects as well as partnership projects to utilize and distribute fruit grown in cities. The following cases are examples of successful urban fruit production in cities across the world, which demonstrate how some of the barriers outlined in the previous section can be overcome.

A. The Philadelphia Orchard Project

The Philadelphia Orchard Project (POP) is a charity organization founded in 2007 by Paul Glover. Its mission is to plant orchards in the city of Philadelphia to grow healthy food, create green spaces and enhance community food security. POP works with community-based organizations and individual volunteers, targeting low-income neighbourhoods for planting orchards and forest gardens. POP provides community groups with the materials, plants, and training, while the community groups own and maintain the orchard.

To date, POP has planted over 20 orchards in partnership with various organizations and community groups. Along with existing orchards, POP has also developed a Philadelphia food harvest map, an inventory of existing orchards and fruit trees and other edibles in

Philadelphia. POP's orchard projects effectively demonstrate the benefits of planting fruit trees in cities, particularly in terms of community health and food security (Philadelphia Orchard Project, 2010).

B. The London Orchard Project

Founded in 2009, the London Orchard Project is a UK based organization that promotes community orchards, fruit trees and urban foraging to provide healthy and local fresh produce to low-income communities. In less than one year, the organization assessed and planted twelve orchards and trained over 50 community leaders on orchard management. The London Orchard Project has over 25 sites of new and restored orchards in and around London. It also has an extensive data and map inventory of all historic and current fruit orchards in the UK. This is useful because the restoration of historic orchards can help minimize the 60% loss of England's orchards since the 1950's and will maintain unique fruit varieties and associated wildlife. The project has developed the "Rediscover London's Lost Orchard Heritage" program of orchard restoration for this purpose and, aims to restore ten London orchards over the next two years, creating food-productive community spaces (The London Orchard Project, 2009).

The Orchard Project provides training programs on fruit tree maintenance as well as fruit preserving workshops. Through this, it connects communities and helps to spread knowledge as well as understanding of fruit orchards, which in turn dispels negative social perceptions of urban food production - a critical component of addressing barriers

to urban fruit tree establishment. Similar orchard projects are sprouting across London, as a part of the growing fruit tree movement (The London Orchard Project, 2009).

C. The Millennium Orchard

Also based in the UK, the Millennium Orchard in Beverly Yorkshire was first established in 2000 by the East Yorkshire Federation of Women's Institutes. The Millennium Orchard is one of largest non-commercial orchards of northern fruit varieties in England and has over 47 apple varieties. The aim of the orchard is to preserve traditional northern apple varieties which are no longer grown in commercial orchards. An example is the Bloody Ploughman, a variety that dates back to the late 1800's. The Millennium Orchard highlights another critical benefit of maintaining and growing fruit trees, and that is the preservation of vital heritage food varieties that provide critical diversity and potential resilience against diseases and pests (Millennium Orchard, n.d.).

D. Not far from the Tree

In Toronto, Ontario, Not Far from the Tree (NFFT) has been mobilizing a group of dedicated volunteers to harvest fruit from homeowners with abundant fruit yields. It finds existing fresh fruit sources, organizes and connects residents in neighbourhoods, and effectively uses this often-ignored food source to develop local food security. The organization, established in 2008, harvests fruit from seven wards in Toronto. The fruit harvest is collected and shared equally with the homeowner, the volunteers, food banks, and community kitchens in the neighbourhood. In 2010, the NFFT volunteers and staff

picked 19, 695 pounds of fresh fruit, including cherries, mulberries, apples, plums, elderberries, ginkgo and quince (Not Far From the Tree, n.d.).

E. Portland Fruit Tree Project

The Portland Fruit Tree Project (PTFP) is a non-profit organization based in Portland, Oregon, which provides community-based solutions for food security issues through education, harvesting and distribution. PFTP registers fruit trees throughout the city and harvests the fruit with dedicated volunteers. Half of the fruit goes to the local food bank while the other half goes to harvest participants. In addition to a harvesting program, the PFTP has fruit preserving workshops and fruit tree care education programs.

The Portland Fruit Tree Project and Not Far from the Tree are both great examples of how charities, organizations and community groups can develop local fruit harvesting and distribution networks. These types of initiatives address one of the key issues or barriers of urban fruit trees: the harvesting and distribution of excess yield (Portland Fruit Tree Project, n.d.).

F. Urban Orchard Project- Melbourne Australia

In 2004, the Centre for Education and Research in Environmental Strategies (CERES) developed the Urban Orchard Project in Melbourne, Australia. This pilot project involved connecting over 200 households to join the CERES food market to share and swap excess backyard produce (Centre for Education and Research in Environmental Strategies, 2010). The project was started with a focus on making use of excess fruit from backyard

trees but now also encompasses vegetable and herb produce. Community members gather together every Saturday during the CERES Organic Farmers Market to share and exchange food, seeds, recipes and gardening tips. The weekly market provides neighbours with the opportunity to obtain local and fresh food that would otherwise go to waste. This project demonstrates the potential of local food networks to connect neighbours, reduce organic waste, reduce the need for produce transport, and build local food security (Centre for Education and Research in Environmental Strategies, 2010).

6. Opportunities for Fruit Trees in Residential Halifax: A Neighbourhood Survey

In October 2011, I completed a Halifax neighbourhood survey to identify potential fruit-tree planting sites on private front lawns. The survey was completed in a southeast neighbourhood of the Halifax Peninsula near South Street and Robie Street (Figure 1). This south-end neighbourhood consists mostly of residential properties with a variety of front lawn sizes. The aim of the survey was to quantify the potential fruit-tree planting sites on private front lawns.

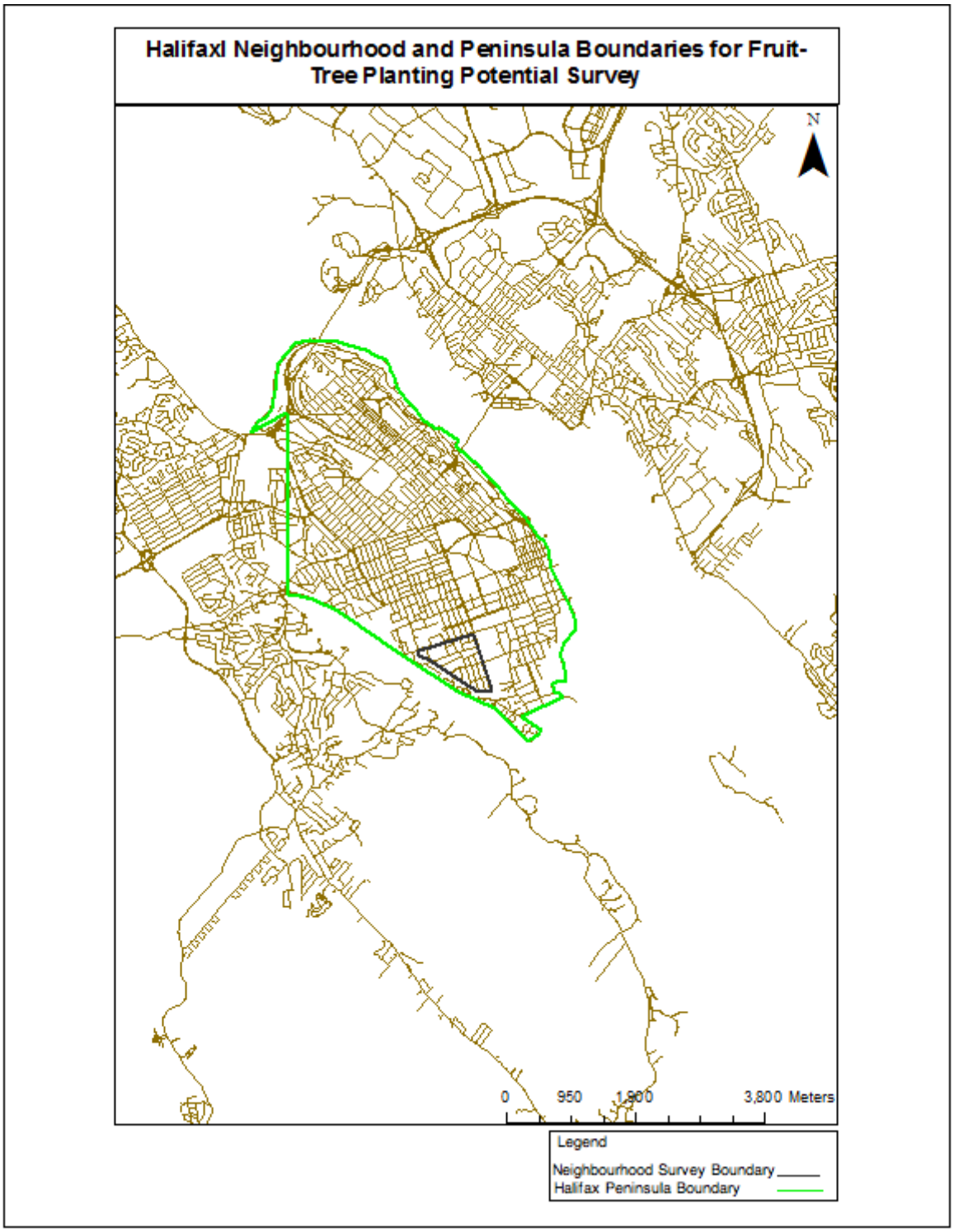

Figure 1. Halifax Neighbourhood Survey Boundaries

Survey Methods

A South Halifax Peninsula neighbourhood was selected for its residential characteristics and existing and accessible front lawns. The process of potential planting site surveying was completed using a visual assessment for open, unobstructed growing space of at least a 2m by 2m block, taking into account the relatively small size of fruit trees. Potential planting sites were marked on printed maps of the neighbourhood, as shown in figures 1 and 2 in the appendix. Visual surveys for planting sites were completed for front private lawns only as a result of the very different regulations, bylaws and barriers of public street trees. The sites were also assessed for proximity to existing trees, hydro lines, driveways and garages, and were rated as poor or good quality sites depending upon these factors. Poor quality sites had buildings, roads, trees, and hydro lines within or directly adjacent to the 2m by 2m block. The visual survey of the neighbourhood was completed over a period of 3 days in early October. Once the total number of potential planting sites was determined, street lengths were measured using the Halifax Regional Municipality Topographic Data in Arc Map from the Dalhousie University GIS Centre. The total street length of the peninsula was also calculated using the same HRM GIS map. Once the potential planting site density was determined, this value was used to extrapolate the potential fruit tree sites across the entire peninsula.

For further calculations of potential production and fruit consumption by Halifax residents, Statistics Canada data were used to determine the population of residents on the Halifax peninsula. The total peninsula population in 2006 (2006 latest population statistics for census tracts) was approximately 60,600 residents. The average fruit tree

production capacity was derived as an average from several sources including two home orchard and fruit tree books by Hessayon and Otto (1990; 1993) as well as the University of Minnesota's (2009) apple and agriculture literature. The average dwarf apple tree fruit production values are between 20-136 kg. For fruit production calculations for the Halifax peninsula, the lowest estimate value of 20 kg was used.

The neighbourhood survey and the subsequent estimates do not account for loss of fruit harvest due to seasonality, diseases and pests. The street length estimates for the entire peninsula also do not take into account industrial and commercial zones of the peninsula that would have little to no potential planting sites. And finally, the neighbourhood survey did not account for potential backyard planting space, thereby significantly underestimating potential fruit-tree planting space.

Results

Once the entire neighbourhood of 19 streets was surveyed, the total number of potential fruit tree planting sites found was ca. 1,170 (Table 1).

Table 1

Potential Fruit Tree Planting Sites in Halifax Neighbourhood		
Street	Number of High Quality Sites	Number of Low Quality Sites
Waterloo	46	
Dalhousie	32	
South	39	11
Robie	62	
Studley	31	
Cartaret	31	
Fraser	28	11
Davis	8	
Oakland	240	
Marlborough	80	
Beaufort	119	
Murray	21	
Belmont	27	
Regina Terrace	40	
Inglis	115	
Greenwood	78	
Bellevue	70	
Roxton	35	
Ritchie	47	
Total	1149	22

The total street length for the neighbourhood was 7,865 m (table 2). The average number of potential tree planting sites, given the lengths of the streets, would be equal to 15 potential planting sites for every 100 m.

Table 2

Street Lengths in Halifax Neighbourhood	
Street	Street Length (m)
Waterloo	213.081
Dalhousie	199.338
South	857.64
Robie	892.799
Studley	217.29
Cartaret	214.653
Fraser	216.626
Davis	108.591
Oakland	723.272
Marlborough	551.656
Beaufort	932.4015
Murray	128.825
Belmont	260.025
Regina Terrace	357.751
Inglis	501.904
Greenwood	524.164
Bellevue	514.214
Roxton	252
Ritchie	198.525
Total	7864.7555

Specific street characteristics such as front lawn size and proximity to roads and driveways limited the number of potential planting sites for specific streets (shown in figures 3,4 and 5 in the appendix). For example, even though South Street has a total street length of 857 m, the street's small front lawns and proximity to driveways reduced the number of potential planting sites to 39 (Figure 2).

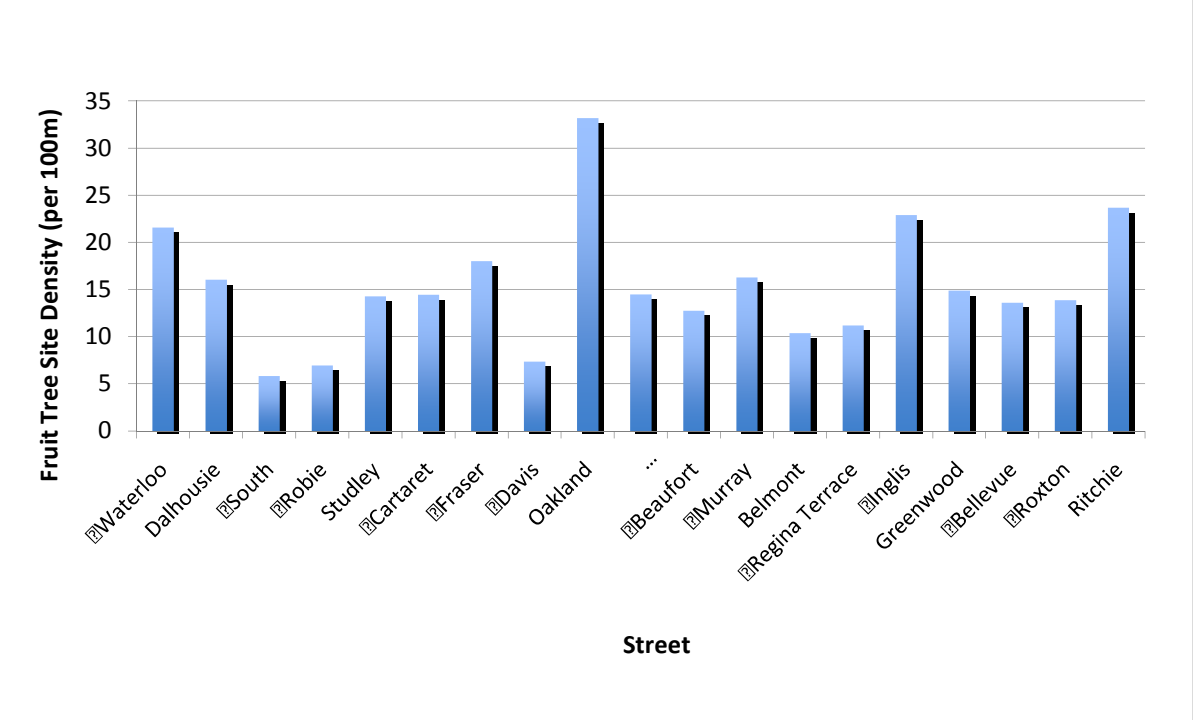

Figure 2. Potential Fruit Planting Site Density by Street Length in Halifax Neighbourhood

In contrast, Waterloo Street, which is only 213 m in length, had 46 potential high-quality planting sites due to its relatively large front lawns. Of course, this is only a rough estimate as the areas and neighbourhoods on the peninsula vary greatly in use, lot size and proximity to roads, buildings and other infrastructure. The total street length for the

peninsula is 242,616 m. Using my density value, I calculated that a total of 36, 392 fruit trees could be planted on the peninsula. With a conservative fruit production estimate of 20 kg (for dwarf and small-size trees), the total fruit production potential for the peninsula with over 36,000 fruit trees could be 727,852 kg of fruit annually (Hessayon, 1990). Given Halifax's Peninsula's approximate population of 60,600 people, this would amount to 12 kg of fruit annually per person (Statistics Canada, 2006).

Discussion

Ecological Services

The neighbourhood survey demonstrates the potential of fruit-tree planting sites within the Halifax Peninsula. The survey shows that approximately 36,000 additional trees could be planted within the Halifax Peninsula on private front yards alone, which would assist in increasing carbon sequestration rates for Halifax's urban forest. Increasing the number of trees and canopy cover in HRM's urban forest with fruit trees would also assist in microclimate control, storm water management and other ecological services.

Food Production

Fruit trees also provide the added benefit of increased food production. The Ecology Action' Centre's report on food miles titled "Are Nova Scotians Eating Local?" estimates that, on average, each Canadian consumes 10.4 kg of apples annually (Scott & MacLeod, 2010). Therefore, our annual fruit production estimate within the peninsula of 12 kg per person could potentially produce more than the apples consumed annually by residents of the Halifax Peninsula, based on average consumption data. Of course, redundant trade

must be considered with apple production and sales as an underlying issue of fruit distribution for local residents. Nova Scotia produces four times more apples than the province consumes (Scott & MacLeod, 2010). Even though there is high apple production in Nova Scotia, HRM residents are still not eating enough fresh fruits and vegetables (Nova Scotia Department of Health, 2004). An integrated network of urban fruit trees on private land in cities could provide a local-scale solution and encourage people to provide for themselves and have easier financial and physical access to fresh fruit.

The neighbourhood study has demonstrated the potential fruit production capacity for the peninsula. More-detailed analyses and studies would have to be completed to address specific productivity losses due to disease, pests, seasonality, and other interacting factors. With an approximate potential production capacity established, the next step is to address some of the major barriers to fruit tree expansion in cities.

7. Barriers to Expansion of Fruit-Tree Populations in the City

Availability and Access to Land in Cities

A major barrier to fruit-tree network expansion in cities is access to and availability of land in urban areas. From the initial data gathered for the Halifax neighbourhood case study, we found over 1000 potential planting sites or 15 potential sites for every 100 m of street on private front lawns alone. Just as in any urban area, access and availability of land is limited, but given the relatively small size of fruit trees, there are significantly more opportunities for tree planting when compared to large trees such as oaks, maples

and lindens. Also, cities have many underutilized areas and vacant lots that can become productive sites for fruit growing. On average, 15% of a city's land is categorized as vacant (Pagano & Bowman, 2000). Organizations such as the Philadelphia Orchard Project and the London Orchard Project make use of vacant and abandoned land to grow fruit orchards within cities. An important issue concerning availability and access to land in cities is the intense competition for land for commercial and residential purposes. In many cities, land within a city's core is considered prime real estate land and usually results in competition from different development companies to build multi-storey commercial or residential buildings. Predominantly, urban food production is not considered a financially beneficial or productive use of urban land (Nordahl, 2009). The influence of socio-economic norms and structures within a society govern how productivity and urban land-use is perceived. Understanding these critical interactions between socio-cultural norms and economic valuation is an essential component for addressing barriers.

Social Perceptions of Fruit Trees and Incentives for Growing Fruit Trees

An associated critical barrier to integrating fruit trees in the urban environment is the negative socio-cultural perception of fruit trees. Given that many urban trees are situated on private property, their subsequent management is highly dependant upon individual control rather than municipal-based management. Therefore, understanding the source of homeowner perceptions and opinions of fruit trees is a key component of analyzing barriers to fruit trees in cities. Cultural and social differences can affect people's perceptions of the benefits and disadvantages of growing fruit trees in cities. A study

completed in Canada by Fraser and Kenney (2000) found that cultural background had a significant effect on positive and negative perceptions of trees, lawns, and vegetable gardens. Fraser and Kenney (2000) found that British Canadians favoured shade trees over lawns and vegetable gardens for their private lawns, while Italian and Portuguese communities preferred growing fruit trees and vegetable gardens. Understanding cultural perceptions of urban trees can assist in determining whether urban fruit and food production is feasible in a community and in developing appropriate initiatives, incentives and education programs for fruit tree growing.

Municipal Bylaws

Other critical barriers to fruit tree integration with the urban forest are current municipal bylaws and guidelines regulating tree planting and urban forest plans. In Vancouver, the current street tree policy does not allow for fruit-bearing trees to be planted, only non-fruiting cultivars of fruit trees (Barrs, 2002; ACRT INC 1990). Similarly, the city of Toronto urban forestry department provides a tree planting service to residents but no fruit trees are on the list of allowed tree species (City of Toronto, 2010). Nuisance and cleanliness bylaws for residential properties are another barrier for fruit tree planting. Cities like San Francisco and Berkeley have anti-fruit tree policies that are primarily meant to address nuisance and waste fruit issues (Nordahl, 2009). With appropriate planning, site selection and support systems for pruning and harvesting, this issue could be addressed, while still allowing and promoting fruit tree planting in cities.

Soil Contamination

One of the main barriers and concerns with food production within urban areas is present and past soil contamination and subsequent health effects. Of particular concern are heavy-metal soil contaminants such as lead, arsenic, cadmium, mercury and zinc (Heidary-Monfared, 2011). The two main sources of soil metal inputs are the weathering of rocks and bedrock and anthropogenic pollution (Heidary-Monfared, 2011).

Several comprehensive studies have been completed to test the heavy metal content of soils within the Halifax Regional Municipality. The Ecology Action Centre's Community Garden Heavy Metal Study has shown that soils within certain residential areas show higher than recommended concentrations of lead, arsenic and zinc (Heidary-Monfared, 2011). The majority of Nova Scotia's bedrock (slate) naturally contains arsenic, and as a result, Nova Scotia's soils naturally contain higher than average levels of arsenic (Heidary-Monfared, 2011). Some anthropogenic sources of lead include gasoline pollution and lead-based paints.

Many studies of fruit and vegetable heavy-metal contamination have documented that fruit trees and fruit have low heavy-metal uptake rates. A study of lead levels in fruits and vegetables grown in contaminated residential soil found that the highest lead concentration was found in roots and shoots and that fruiting vegetables had lead levels below the detection limit (Finster, Gray, Binns, 2004). Similarly, Kabata-Pendias and Pendias (2001) and the Washington State University Tree Fruit Research & Extension Center (2004) also found evidence that fruit, seeds and fruit trees contain very low

concentrations of lead and arsenic compared to root vegetables such as potatoes and carrots, as well as leafy vegetables. The Tree Fruit Research & Extension Center of Washington State University (2004) published guidelines for fruit-tree planting and soil testing. The Centre recommends soil analyses if planted fruit trees are within 30 m of high-traffic roadways and parking lots, or within 6 m of buildings with lead-based paint.

Appropriate fruit-tree site selection is important for reducing risk of contact with contaminated soils. For further precautions, soil testing can be completed. The Ecology Action Centre recommends the ALS Laboratories in Dartmouth, Nova Scotia, as a local soil-testing facility (Heidary-Monfared, 2011). A typical test for heavy metals usually costs $60. Overall, the barrier of soil contaminant risks through food growing can be reduced with appropriate knowledge, testing, site selection and food-bearing species selection.

8. Overcoming the Barriers to Urban Fruit Trees: Recommendations

Education and Partnership

One of the most important barriers to the establishment of fruit trees in North American cities is the negative social perception of urban food production and maintenance requirements of fruit trees. In many European and Asian cities, fruit trees are regularly planted in back and front yards for food provisions (Fraser & Kenney, 2000). The social stigma of urban agriculture and food production is slowly shifting along with global food security movements (Nordahl, 2009). Various awareness, education and advocacy methods can be used to address the socio-cultural stigma of urban agriculture. Municipal

governments like the HRM could partner with community groups, schools and organizations to develop education programs on urban food production. The Philadelphia and Portland Fruit Tree and Orchard Projects are examples of organizations that effectively partner with municipal governments and schools for fruit tree education programs. Along with education programs, community outreach and activity programs could be developed around urban fruit picking and local food foraging. Activity and volunteer programs of fruit foraging, harvesting, and distributing to communities in need could be developed alongside municipal government programs for healthy eating and food security.

Municipal Bylaws

City urban forest and tree planting guidelines should be adapted to encourage fruit-tree planting. Developing an integrated urban-food and urban-forest management plan that allows for mixed native-tree and fruit-tree planting is a vital step towards building local food networks. Additionally, with appropriate regulations for maintenance and harvesting, nuisance regulations and neighbourhood property standards would be upheld. Key maintenance guidance should cover topics such as appropriate planning, site selection and support systems for pruning and harvesting.

Zoning is another critical municipal planning and management tool that can act as either an obstacle or support for urban fruit tree integration and food production. Municipal zoning regulations often exclude or specifically do not allow urban agriculture and food production. In many North American cities including Toronto and Vancouver, municipal

bylaws prevent homeowners or residents from selling urban-grown produce from their backyards (City of Toronto, 2011). Changing these bylaws to allow residents and community groups to sell their produce could provide new avenues for local business and organization funding. More recently, several U.S. cities have adopted new bylaws that allow for the sale of urban-grown produce. In 2010, the City of San Francisco adopted new zoning standards and bylaws that allow for three types of agriculture operations including home gardens, neighbourhood agriculture and urban industrial agriculture (San Francisco Urban Agriculture Alliance, 2011). The zoning permits all three types of operations to harvest, donate and sell produce. Urban food and fruit-friendly zoning can provide incentive and support for homeowners to plant and grow fruit trees and vegetables. They also allow for residents and community groups to sell their fruit harvests to other residents, or at farmers' markets.

Land Inventory

An important tool for addressing the barrier of access and availability of land is creating and developing an inventory of all private and public land with available planting space in cities. By obtaining accurate information on private front and backyards as well as vacant and underutilized land, we can gain an understanding of how much land is potentially available for urban fruit and food production. This database could be used to develop further studies and determine potential for fruit tree planting as well as community orchards on vacant land and in parks. The information, alongside detailed studies, could be used to promote and develop municipal and community programs for urban food production.

Incentives and Distribution Networks

Funding and potential municipal government incentives are other potential tools for addressing financial barriers to fruit tree integration into urban forests. One avenue for fruit tree planting incentives is subsidized fruit trees for city residents. The HRM, in partnership with local environmental organizations, could provide subsidized fruit trees with planting and care advice from experts. In Toronto, a local non-profit group called LEAF (Local Enhancement and Appreciation of Forests) offers Toronto residents subsidized trees for front and backyard planting, and provides advice on site selection and maintenance (LEAF, 2011). Similar programs that focus on fruit-tree planting and maintenance could be developed in cities like Halifax.

Sale of Produce and Local Job Creation

As well as increased economic value of ecological services, the integration of fruit trees within the urban forest and the development of local food networks can potentially lead to the creation of local jobs for residents. A fruit tree harvesting and distribution network, developed by organizations and community groups, can create volunteer engagement and potentially paid harvesting work for residents. In Boston, a $600,000 grant will go towards renovating a greenhouse and building 400 backyard gardens in various neighbourhoods. This grant will also create 50 temporary full-time jobs and 250 summer positions (Lee, 2010). Additionally, organizations may also be able to sell fruit at local farmers' markets, if city bylaws permit it. The Cities of San Francisco and Boston allows

community residents to barter and sell their homegrown produce including fruit at community markets (San Francisco Urban Agriculture Alliance, 2011).

Land leases are another potential tool for developing fruit-tree networks and local-food networks. Leases have been used for other urban agriculture initiatives such as SPIN farming (SPIN, 2011). SPIN farming is a form of small-scale (sub-acre) commercial and high-productivity farming (SPIN, 2011). Land leases are agreements between land-owners and other individuals for the use or rental of an owner's land, but not built infrastructure (SPIN, 2011). Land leases could be developed for organizations and community groups that are interested in growing, maintaining and harvesting fruit trees, but do not have access to land. Partnerships for land leases could be developed between homeowners and local organizations or individuals, where available land is utilized for food production. More recently, land leases have become more prevalent in Canadian cities like Saskatoon, Vancouver and Toronto for small backyard farming operations. In Toronto, a young urban farmer named Erica Lemieux has developed an urban farm by establishing land use agreements with her neighbours. She farms a variety of vegetable crops on a quarter of an acre spread across eight neighbourhood backyards (Porter, 2011). Developing municipal regulations and bylaws that promote and permit land-lease agreements may help to foster viable local urban agriculture and fruit production businesses.

9. Conclusions and Further Research

Sustainable community development has become an important priority and concern for many municipalities and cities (De La Salle & Holland, 2010). The reintegration of urban agriculture in city planning and infrastructure is a key component of developing sustainable cities (De La Salle & Holland, 2010). Fruit trees, which provide an intersection point between urban forests and urban food production, can potentially be utilized for integrating these two urban infrastructure systems for the purpose of enhancing the sustainability of urban areas.

Overall, this report has introduced and examined challenges, opportunities, and potential solutions for fruit tree planting in cities. The preliminary fruit-tree planting neighbourhood study demonstrated the potential for fruit tree harvest and production in urban areas. Further research on fruit yield and production in cities, local food security issues, regional food distribution networks, potential job opportunities, and urban ecosystems is required to address barriers in more detail. Understanding these drawbacks and barriers is critical for determining feasibility of fruit-tree integration and creating municipal regulations, public-private partnerships, and appropriate community engagement incentives and programs for fruit-tree integration in urban communities. Communities, which in the future, could benefit from diverse and expansive networks of fruit trees, public orchards, urban agriculture sites and a healthy urban forest.

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Appendix

Figure 1. Sample Neighbourhood Survey Map with Sites

Figure 2. Sample Neighbourhood Survey Map with Data

Figure 3. South Street and Waterloo

Figure 4. Waterloo Street

Figure 5. Robie Street