Literature Review for
Green Infrastructure for Ontario's Rural Communities:
Nature and its Contributions to Community Economic Development and Resilience
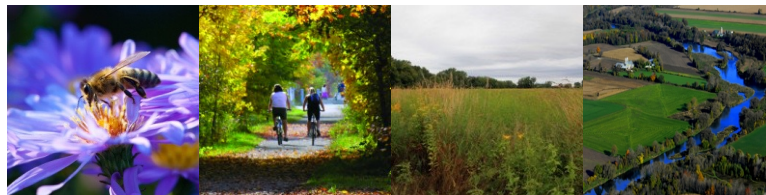
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May 2015

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Source for photos (from left): Pixfocus, Credit Valley Conservation, Wisconsin Land Trusts, St. Jacobs Country

Introduction

The purpose of the literature review is to introduce the concept of "green infrastructure".

Rather than view the natural environment as a barrier to development, it should be embraced for

the unique opportunities it can provide. The natural environment can play a role in improving

community health, resilience, and sustainability. Although our interest lies in how green

infrastructure can be implemented within Ontario, examples across North America are provided

to illustrate how nature and natural systems have been

used in unique ways as community assets. Additionally,

our interests revolve around how nature can be used in

a more holistic manner that protects the environment

and uses it to create or expand economic and

employment opportunities within rural communities.

The natural environment can play a role in improving community health, resilience, and sustainability.

Green infrastructure and its benefits will first be defined, followed by a discussion of its

importance to the Province of Ontario. Finally, an exploration of successful examples of green

infrastructure are used to raise awareness and promote techniques that embrace nature and

natural systems that contribute to a healthier environment, while simultaneously creating

economic opportunities.

Source: Ontario Nature

Green Infrastructure for Ontario's Rural Communities: Literature Review

Green Infrastructure Defined

Green infrastructure is not a new concept; rather it has been used in the European Union as a tool to lessen the impacts of its growing population on the environment, in climate change adaptation and mitigation, to enhance biodiversity, and to promote economic growth (Landscape Institute, 2013). Green infrastructure is often associated with urban settings, where it is well recognized that there is a need for green space. It is not as often associated with rural settings. Although it has gained popularity, it is necessary to provide a better understanding of what green infrastructure entails and how it can be used to address social, economic, and environmental issues.
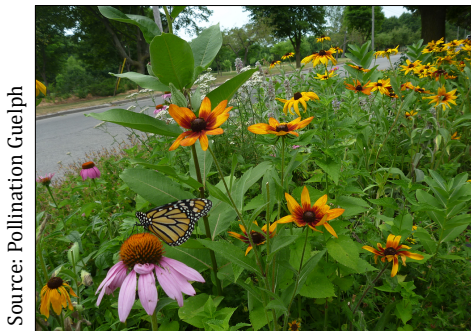
Source: Pollination Guelph

Green infrastructure can be viewed on a broader, regional scale or on a more localized, site-specific scale (Green Infrastructure Ontario Coalition [GIO], 2012). Green infrastructure can either make use of nature, or be engineered to replicate natural functions (Rutherford, 2007). It can provide services and benefits that are either similar to, or support, human-made or "grey" infrastructure. Examples of site-specific green infrastructure include stormwater management practices, such as green roofs, tree planting, rain gardens, and permeable pavement (Centre for Neighborhood Technology, 2015). Green infrastructure can also include natural areas such as open countryside, woodlands or watersheds that cross jurisdictional boundaries (Natural Economy Northwest, 2008). These provide valuable ecosystem services to humans and wildlife (Landscape Institute, 2013).

Evidently, green infrastructure can be defined in many ways. In accordance with the 2014 Provincial Policy Statement (PPS), green infrastructure can be defined as "natural and human

Not only does green infrastructure offer environmental benefits, it offers social and economic benefits as well.

made elements that provide ecological and hydrological functions and processes" (OMMAH, 2014, p. 42). Although this definition is widely recognized by Ontario's professional planners, it does not capture all of the benefits that green infrastructure has to offer. Not only does green infrastructure offer environmental benefits, it offers social and economic benefits as well (GIO, 2012). This includes education, recreation, and tourism opportunities, producing food, improving air and water quality, lowering energy use, and enabling carbon sequestration (Centre for Neighbourhood Technology, 2015). It is for this purpose that green infrastructure can be defined as "natural vegetative systems and green technologies that collectively provide society with a multitude of environmental, social and economic benefits" (GIO, 2012, p. 2).

Source: Ontario Nature
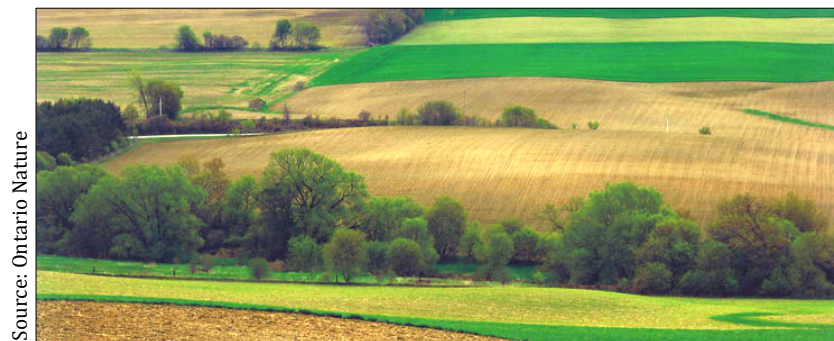
Why is green infrastructure important to Ontario?

Ontario is currently experiencing a time of change. Its population is growing, aging, and diversifying, while at the same time, climate change and a struggling global economy present environmental and economic uncertainties (GIO, 2012). Further challenges include rising health care costs brought on by the aging population and increases in obesity; increasing urbanization and population densities that put pressure on natural systems and on Ontario's aging, often

obsolete piped services; and finally, a change from industrial to post-industrial economic activities (GIO, 2012).

For all that a healthy, functioning natural environment provides, it is difficult to put a price on its worth to current and future human life. Recent efforts have been made to quantify the value of the direct and indirect benefits that southern Ontario's diverse ecosystems offer (Troy & Bagstad, 2009). These include a variety of natural resources, including agricultural lands, forests, grasslands, and all aquatic resources. In a report published for the Ontario Ministry of Natural Resources, Troy and Bagstad estimated that southern Ontario's natural ecosystems are valued at $85 billion on an annual basis (2009). By attaching an economic value to the environment and its diverse functions, the hope is that decision-making and planning for southern Ontario will take into consideration the importance of healthy natural ecosystems.

Southern Ontario's natural ecosystems are valued at $85 billion on an annual basis.

Green infrastructure is being promoted here as essential to the health, sustainability, and economic viability of Ontario (GIO, 2012). It can aid in providing employment opportunities, increasing land and property value, improving air and water quality, decreasing municipal spending on "grey" infrastructure, producing local food, improving environmental aesthetics, creating community development and education opportunities, providing recreation and tourism opportunities, and protecting wildlife habitat and biodiversity (GIO, 2012). Additionally, human health has been closely linked to environmental factors. Green infrastructure should be considered for its integral role in improving

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the health and wellness of both rural and urban human populations. For example, according to Trees Ontario (2012), forests provide diverse, healthy ecosystems that combat cardiovascular and respiratory diseases, diabetes, cancer, attention deficit/disorders, and stress. Termed "ecohealth", an ecosystem approach to health has been identified in Canada as a means to address concerns surrounding health and wellness, specifically in vulnerable populations (Webb et al., 2010). All of these examples can assist us in adapting to climate change and creating a "more livable, sustainable community that realizes savings over time" (Rutherford, 2007, p. 8).

Examples of Green Infrastructure

Although the focus of the research is on rural Ontario, the examples below have been selected to illustrate the innovative and effective ways that green infrastructure has been used across North America. These examples are by no means a comprehensive list,

Source: Grand River CA

as they provide only a glimpse into what is currently being done.

Algonquin to Adirondacks Collaborative

The Algonquin to Adirondacks Collaborative (A2A) was established to connect and maintain the diverse natural landscape between Algonquin Provincial Park and Adirondack Park (Algonquin to Adirondacks Collaborative [A2A], 2014). The area between the two parks measures 93,000 square km and links the Canadian boreal forest to the Carolinian forest of New York State.

The A2A has been identified as "one of the most important areas for connectivity east of the Rocky Mountains" (A2A, 2014). The two parks provide a variety of recreation and tourism activities for hundreds of thousands of visitors each year and rather

Source: A2A Collaborative

than develop this area, there is an ongoing effort to 'rewild' it (Hall, 2014). Additionally, it offers valuable natural habitat to a range of rare species of reptiles, amphibians, birds, and plants. The A2A does not draw a hard line between the two parks, but rather its boundaries are in flux much like the natural areas within it. The A2A has built relationships with landowners and community members and encourages good land stewardship practices that preserve, restore, and enhance this natural habitat and its biodiversity (A2A, 2014). Although it is not labeled as a 'formal' green infrastructure project, the A2A is a good example of how landscape planning can make use of ecological connectivity, offering a range of benefits to both people and wildlife (A2A, 2014).

Ontario's Greenbelt

Ontario's Greenbelt provides an example of a formalized multifunctional, regional green infrastructure system. Under the *Greenbelt Act* the farmland, forests, wetlands, and watersheds within southern Ontario's Golden Horseshoe are permanently protected as natural cultural and heritage lands (OMMAH, 2013). It is intended to protect rural areas that serve both rural and urban populations, while providing valuable natural habitats for wildlife (OMMAH, 2013). The

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green space within the Greenbelt has various functions: agriculture uses, recreation, tourism, and other cultural opportunities, and naturally protected areas (OMMAH, 2013). The agricultural land within the Golden Horseshoe produces in the billions of dollars, and provides employment for up to 35,000 people (Kubursi, Cummings, MacRae, & Kanaroglou, 2015). Both the Niagara Escarpment and the Oak Ridges Moraine are natural heritage systems that fall within the Greenbelt. They provide habitat to many important species, offer valuable hydrological functions, and provide unique recreation opportunities for the population (OMMAH, 2013).

Source: Greenbelt
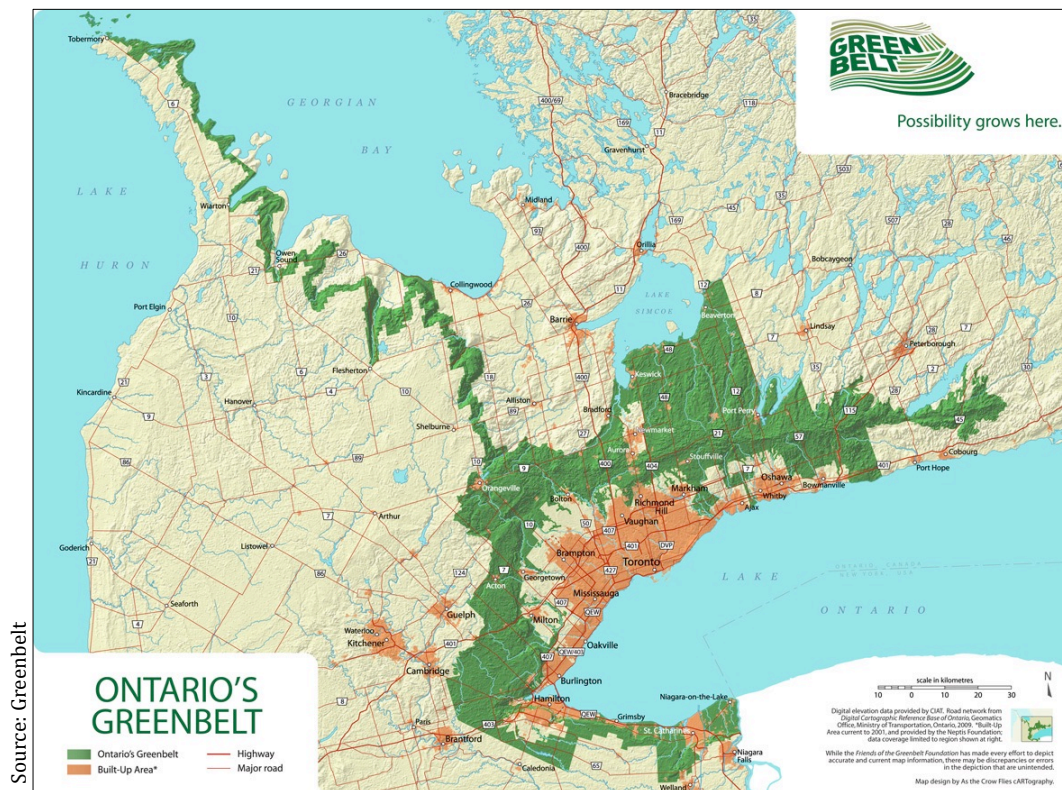
Carolinian Canada

In juxtaposition to the Greenbelt, the Carolinian Canada Coalition is a conservation civil society organization that aspires to preserve the ecosystems and landscapes within the Carolinian Life Zone, located along the north shores of Lake Erie (Carolinian Canada Coalition, n.d.). Considered to be a biodiversity 'hotspot', the Carolinian Canada mixed-wood plains eco-zone is home to thousands of unique plant, tree, and bird species. In order to protect these areas and enable transfers and linkages between the species, Carolinian Canada's "Big Picture" was devised in 2000. Compared to the formalized Greenbelt, the Big Picture is a soft governance plan, and is voluntarily participated in only. It has worked in some areas to protect and preserve the

connecting corridors between the natural landscapes (Jalava, Sorrill, Henson, & Brodribb, 2000). The Big Picture identifies natural areas and potential habitat corridors in

Source: ERCA

various counties located within the Carolinian Canada eco-zone. The Big Picture promotes environmental stewardship practices by landowners that protect, restore, and rehabilitate the natural heritage and biodiversity of the region (Jalava et al., 2000). Not only does this enhance natural habitats for native species, it sustains a healthier, higher quality environment for the human inhabitants in and around the region, offering recreation and tourism opportunities, education, cleaner air and water, providing economic benefits through all of these natural resources as well (Jalava et al., 2000).

Essex Region, Ontario

The Essex Region Conservation Authority (ERCA) has included green infrastructure in its Strategic Plan for 2011-2016 (ERCA, 2011). The Plan's goals include

Source: Tourism Windsor Essex

conservation and revitalization of natural areas, building awareness and increasing environmental education, collaboration and relationship building, and, in general, promoting a green culture (ERCA, 2011). The ERCA have included the following green infrastructure projects: greenways, restored and constructed wetlands, urban and rural woodlands, rain gardens, bioswales, green roofs, green walls, permeable pavement, and community gardens (ERCA, 2011).

Recognizing a need for an improved stormwater management system, the ERCA implemented the "Clean Water ~ Green Spaces" program (ERCA, 2011). The program provides grants to rural and agricultural landowners interested in establishing buffer strips and wind breaks, tree planting, and agricultural soil erosion control structures (ERCA, 2014a). In partnership with the Detroit River Cleanup Committee, the ERCA has included shoreline restoration to protect riparian and aquatic habitats from flooding and erosion along the Detroit River (ERCA, 2011). Rather than using traditional shoreline protection methods, they use natural

Source: Great Lakes Echo

materials and plants to combat erosion, called "soft" shoreline treatment (ERCA, 2014b). These shorelines imitate natural coastal zones, providing an improved habitat for fish and aquatic life, while offering more attractive landscapes.

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The ERCA has established native plant and community gardens in its Strategic Plan (ERCA, 2011). In partnership with the Detroit River Canadian Cleanup, ERCA have grown publicly accessible native plant demonstration gardens at two locations in the City of Windsor and the Town of LaSalle (Detroit River Canadian Cleanup [DRCC], 2015). These gardens grow wildflowers, grasses, and plants that are native to the region and provide natural habitat for wildlife, pollinators, and butterflies, while increasing biodiversity, providing natural stormwater filters, and offering attractive landscapes (DRCC, 2015). These public plantings in turn encourage residents to adopt native plant gardens on their own properties (DRCC, 2015). Finally, the ERCA have implemented a collection of community gardens including several locations in the City of
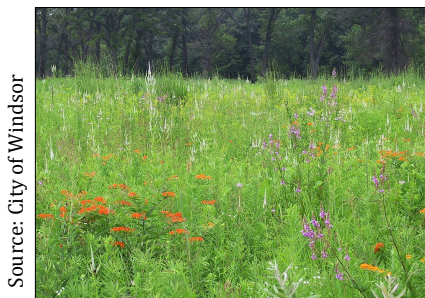
Source: City of Windsor

Windsor, one in the Town of Essex, and a planned location in the Town of Kingsville (ERCA, 2011). Other than growing fresh, healthy food for consumption, the benefits of community gardens include an increase in green space, provide social interactions, improve awareness and land stewardship, and provide education opportunities for children and youth.

Lake Simcoe Watershed, Ontario

In an effort to restore Lake Simcoe, the Lake Simcoe Region Conservation Authority (LSRCA) offers 75% off of project costs (to a maximum of $10,000) in the implementation of rain gardens (LSRCA, 2015a). The rain gardens reduce the impacts of stormwater runoff by collecting and storing it, while diverting water from storm sewer systems (LSRCA, n.d.). The rain gardens are designed to look like regular gardens using native plants suited to the Region's climate, making

them easy to maintain (LSRCA, n.d.). They provide further benefits including flood control, attractive landscapes, and offer habitat to wildlife and butterflies (LSRCA, n.d.).

Additionally, the LSRCA is currently offering 100% funding (until November 2015) for their Holland Marsh Riparian Planting program (LSRCA, 2015b). The program is directed towards property owners located along the Holland River (LSRCA, 2015b). The program involves creating a buffer zone between the streams and rivers by planting native trees and shrubs along the waterways, in an effort to prevent erosion and soil loss and to reduce anticipated flooding and drought events (LSRCA, 2015b).

Milwaukee, Wisconsin

Source: Sustain Our Great Lakes

In 2001, the City of Milwaukee implemented a green infrastructure and flood management plan called the "Greenseams" program (The Conservation Fund [TFC], 2015). The success of Greenseams has earned them the label as a "leader in green infrastructure" (TFC, 2015). The City started by acquiring flood-prone lands, mostly agricultural land, for the purpose of restoring it back to its natural wetland, prairie, and forest habitat (TFC, 2015). The newly restored land acts as a buffer in absorbing excess water and snow melt, taking up pollutants, thus protecting the City of Milwaukee's water supply (TFC, 2015). Up to 2,700 acres of land have been acquired within the region, and while it is integral as a stormwater control system, like other green infrastructure projects it provides an array of benefits including bird and wildlife habitat, and has expanded public recreation and green spaces (TFC, 2015).

Portland, Oregon

In 2008, the City of Portland, Oregon implemented the "Grey to Green" program (City of Portland, 2010). The goal of the program is to both protect and restore natural areas, while improving watershed health and protecting the City's aging sewer system (City of Portland, 2015). Portland makes use of green streets, green or ecoroofs, forests, and wetlands, to manage their stormwater more naturally. A branch of Grey to Green, the "Green Streets" program includes landscaped curb extensions to manage stormwater runoff on their city streets (City of Portland, 2015). The curb extensions allow for soil drainage and include native plantings that regulate runoff, while improving the physical beauty of the neighbourhoods and providing habitats for beneficial insects (City of Portland, 2015).

Source: Water Environment Research Foundation

Portland's "Ecoroof" program has been used to significantly decrease runoff by both capturing and evaporating stormwater on site (City of Portland, 2006). Although initial costs to build ecoroofs are more than conventional roofs, they have been proven to last twice as long and contribute to long-term savings by lowering cooling and heating costs and reducing maintenance costs (City of Portland, 2006). Additionally, ecoroofs act as a filter for pollutants, provide habitat for birds and insects, grow food, and contribute to community livability.

Delta, British Columbia

The Corporation of Delta is located 25 km. south of the City of Vancouver, B.C. Located on flat, fertile land, Delta has historically been an agriculture-based community, but recent

population growth has led to an increase in impermeable paved surfaces. Recognizing that the increase in polluted runoff has negatively impacted fish streams, the "Adopt-a-Rain-Garden" program was initiated. The program protects valuable fish habitats while improving the physical beauty of Delta's neighbourhoods (The Corporation of Delta [Delta], 2015a). The first rain garden was installed at the Cougar Canyon Elementary School in 2007, and this school currently runs education programs for young children (Delta, 2015a). Through the collaboration of neighbourhood volunteers it builds community ties, keeps pollution out of streams, and incorporates horticulture, landscaping, and design in its program.

Delta has also initiated the "Trees for Tomorrow" program, in order to increase the municipality's green canopy (Delta, 2015b). Homeowners choose their trees from a carefully selected list of tree species that can thrive in the climate, provide the best canopy, are easy to maintain, and are considered "good street trees" (Delta, 2015b). Municipality staff plant the trees and home owners are left to care for them. Trees for Tomorrow has many benefits, including providing bird and insect habitat, providing shade and wind protection, improving air quality, and aiding in water provision (Delta, 2015b).

Mapleton, Ontario

The Township of Mapleton has introduced a community tree planting initiative called "Trees for Mapleton" (Mapleton, 2014). The program provides grants to landowners that cover the cost of the trees and the planting of the trees, with the expectation that landowners will maintain the trees for 15 years (Mapleton, 2014). The primary goal of the program is to increase the amount of trees in the Township in an effort to reduce wind erosion, protect groundwater recharge, establish buffer zones along waterways, and create wildlife habitat (Mapleton, 2014).

Source: Trees for Mapleton

Additionally, it is expected to increase farm incomes, aid farmers in climate change adaptation, and increase carbon sequestration (Mapleton, 2014).

As well, the trees work to reduce municipal costs on road maintenance and snow clearance, as they provide shade protection in the summer and reduce snow drifting across roadways in the winter. Finally, the program provides the community with increased resilience, and its success can be used as an example to other communities (Mapleton, 2014).

Community Orchards

Community orchards, or fruit tree parks, take tree planting a step further and offer another innovative example of green infrastructure. Rather than planting non-fruit bearing trees, the cities of San Bernardino, California and Tampa, Florida have created orchards within community gardens and parks (Alliance for Community Trees, 2014). The orchards provide all of the same attributes that non-fruit bearing tree species do, but additionally provide healthy, fresh foods for consumption (Alliance for Community Trees, 2014). The orchards have revitalized vacant lots by creating green space, and attract community members to the parks, while providing further education to children on growing food (Alliance for Community Trees, 2014).

Source: Community Orchard

Conclusion

These examples are only a snapshot of how green infrastructure has been used in both rural and urban communities in North America. Through stormwater systems such as rain gardens and wetland revitalization, tree planting, green roofs, public green space, and community gardens, green infrastructure can aid in improving air and water quality, decrease soil erosion, increase carbon sequestration, provide wildlife habitat, offer recreation opportunities, and improve environmental aesthetics. Regional conservation through

> *Green infrastructure offers both direct and indirect savings to municipalities through its various methods.*

initiatives such as Carolinian Canada's "Big Picture" and the A2A highlight the importance of linkages between natural greenspace, while more formally recognized systems such as Ontario's Greenbelt contain policies that protect and preserve these greenways. Green infrastructure offers both direct and indirect savings to municipalities through its various methods. These examples have been initiated by municipal governments and conservation authorities, in an effort to protect and restore natural functions, and reduce human impact on the environment. These examples illustrate how green infrastructure can be used as a means to improve the health of communities through its implementation, design, construction, planting, and upkeep. The general hope in all of this is that nature can be considered for its ability to create more livable and healthy communities, while providing opportunities for employment.

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