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Urbanization and Population Growth: Projected Impacts of Growth on Ecological Resources in Ontario1

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Urbanization and Population Growth: Projected Impacts of Growth on Ecological Resources in Ontario[1]

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I. INTRODUCTION

The human population is increasing and altering the world around us at an unprecedented rate. Understanding how to balance a growing human population and the ecological integrity of the planet is a growing global concern. According to the United Nations, the global human population was estimated to be around 2.6 billion people in 1950. Today, our population sits at around 7.3 billion people even though its rate of growth has slowed substantially (United Nations). The United Nations has projected that the planet's population will increase to 9.7 billion people by 2050 and to over 11 billion by the end of this century. According to a study by Hoornweg et al, the majority of this growth will be in urban areas, which are also considered to be the major drivers of environmental degradation (567). It is important to understand that the functioning of cities is so complex that their influence on environmental degradation is multifaceted. For instance, because of their 80% share of the GDP of the global economy and a growing per capita increase in the consumption of energy and other resources (Greene and Pick, 307), cities and their residents contribute to environmental degradation in many ways. For example, they contribute to water pollution from urban runoff, air pollution from their industrial fossil fuel use and auto emissions, loss of natural land due to urban expansion, and natural resource depletion from their high consumption rates; all of which also lead to climate change. Each of the environmental issues above is accompanied by severe and catastrophic consequences for the future wellbeing of the planet.

In this research, I primarily focus on the ecological consequences of the conversion of natural habitats for urban development.

Currently, cities are home to 55% of the global population, a number that is set to increase to 66% by 2050 (Hoornweg et al, 567). This will require increased urban growth and development in order to support this growing urban population. As urban areas like cities grow, undeveloped land on the fringes is converted to urban land uses. It is important to note that cities are far more complex than simply providing areas of development for human growth. They are socio-ecological systems where human behaviors and ecological processes merge. There are environmental considerations associated with every action that occurs within the city, including development through urbanization. Unfortunately, 60% of ecological systems that exist within the urban setting are degraded or used unsustainably as natural land cover is converted to urban uses (Lam and Conway, 641). Urban areas also create negative environmental impacts from pavements and other impervious urban surfaces, high concentrations of people in small places, and increased waste discharge (and nutrient loading) into nearby water bodies (641). In each of these ways, urbanization poses serious threats to the local ecology, human population, and the economy.

To be specific, the direct impacts of urbanization on the surrounding environment include habitat loss, degradation and fragmentation, regime disturbances, modified soils, migration pattern disruptions, an increase in invasive species, deforestation and species extinction. A study by McDonald et al. showed that 5% of urban land has already been developed in protected regions across the globe (37). By 2030, urban expansion will either directly or indirectly affect 25%

of the globe's endangered and critically endangered species (Elmqvist, 140). Despite these profound threats to protected lands and endangered species, urban land only accounts for 3% of all land globally (McDonald et al, 37), which gives the impression that urban land conversion is not linked to pressing environmental issues. Yet, if we shift our focus to smaller geographic scales, the pervasiveness of environmental damage due to urbanization is evident. At the continental scale, while only 0.9% of North American land had been converted to urban land uses as of 2005 (McPhearson et al, 280); 1 million hectares of its forests are cleared for urban land use every year (Masek et al, 1).

By this mid-century, United States' urban expansion that is in close proximity to protected natural areas will increase to about 70% (Elmqvist, 140) thereby straining the health of these protected areas. It is clear that geographic scale plays an important role in modulating the environmental impact of urbanization (McPhearson, 280). This is because the intensity of urban environmental impacts is not felt the same way at all geographic scales and is often most immediately felt at the local scale (281). Therefore, to adequately show the environmental impacts of urban expansion to surrounding rural lands, this study focuses on the smaller geographic area of the Province of Ontario, Canada.

The act of rapidly converting rural land to urban land has been coined as urban sprawl. Urban sprawl is the process of rapidly converting rural lands into urban land uses as a city develops and expands uncontrollably into its periphery (Resnik). Rather than building upwards, like in urban downtown areas, urban sprawl builds outwards. The majority of North American cities have a sprawled development pattern that contains low-density, single-family homes with large

lots on the urban-rural fringe (Green and Pick, 280). As in much of North America, this form of urban development in response to rapid population growth is true of Ontario, Canada.

In order to understand how urban sprawl is capable of using such vast amounts of land, it is necessary to show how cities develop by way of urban sprawl. Typically, cities are comprised of a central, compact core, a central business district or a downtown. In North America, urban development, rather than occurring in downtown areas, typically spreads outward from the inner city in the form of new suburban subdivisions at the urban rural fringe (Green and Pick, 280). This phenomenon of residential dispersion is only the first wave of urban sprawl. The movement of industry and commercial activities towards the suburbs and the subsequent movement of many offices and employment opportunities there respectively represent the second and third wave of sprawl (288). The product of successfully integrating these three waves of urban sprawl is the formation of an edge city – "a center of employment on the outskirts of the urban area, often in the suburbs, having office and retail space and perceived as one place, usually located at a highway interchange" (288). It is typical for several edge cities to emerge around one central, inner core as more suburbs continue to grow on the urban-rural fringe. The culmination of suburban cities surrounding a central inner core manifests itself as a thickly settled urbanized area. When urbanized areas develop to the point where linkages between the neighboring counties and the central nucleus emerge, a metropolitan area is formed (43). As the proportion of the world's urban population increases to 66% (of the total) in the next few decades (Hoornweg et al, 567), the globe's metropolitan areas will

correspondingly increase in size and number and consume more rural land.

Two groups of theories, originally presented by Mieszkowski and Mills, help to explain the causes of urban sprawl in American cities (Green and Pick, 2012: 279). These are approaches focused on natural evolution and fiscal-social problems. The former suggests that development continues to move outward to open tracts of land on the edge of the city once land close to the central business district (CBD) fills up. High-income people, who are capable of affording new modern homes, take the lead in purchasing homes in the new developments at the periphery of the city because moving outwards enables them to benefit from lower housing prices and larger properties even though this increases the cost and time of their commute to the inner city. The second theory suggests that the fiscal and social stresses of the inner city, such as crime, congestion, poor school districts, and environmental degradation, drive the middle class to the suburbs. Ironically, as Mieszkowski and Mills note, suburbanization is the main cause of these social and fiscal stresses on the inner city, since the falling tax base from the loss of high-income people to the suburbs feeds the continuous cycle of inner-city decay.

In the United States, data from the National Resources Inventory (NRI) estimates that the nation's urban and built-up land increased by 40 million acres (56%) from 1982 to 2007 (Green and Pick, 2012: 280). In this 25-year period, U.S residents added an average of 1.6 million acres of urban land every year. In a more recent paper from 2014, Terando et al explored "urban sprawl changes for the next 50 years for the fast-growing Southeast U.S". They found "a future in which the extent of urbanization in the Southeast is projected to increase by 101%

to 192% [resulting in] challenging tradeoffs between ecosystem health, economic growth and cultural desires" (1). These tradeoffs occur because such high rates of urban expansion or sprawl into rural land lead to a loss of open space and a disruption of natural habitats and ecosystems (Green and Pick, 278).

Overall, North America as a whole has a very low percent of urban land conversion at 0.9% even with the rapid development of urban sprawl (McPhearson 280).

Canada, whose urban sprawl patterns are identical to those of the US, has only used 0.2% of its territory under urban development (280). With its small population of 36 million people, it is difficult to believe that urban development can be impacting the ecological wellbeing of Canada; the 2nd largest country by area in the world. However, with already densely populated urbanized areas and a population that is projected to increase well into the near-future, significant amounts of natural land will be converted to support urban development, especially around major North American cities like those in Ontario. Specifically, the province of Ontario which is home to Toronto, the country's largest and most densely populated metropolitan area, and many rare and unique ecological features (e.g., the Canadian Shield, the Great Lakes, Oak Ridges Moraine, the Niagara Escarpment, and the Hudson Bay Lowlands), will be faced with many demographic and environmental challenges in coming years.

These challenges have the potential to devastate valuable ecological lands as they get converted to urban land uses. To illustrate, in Southern Ontario, the area covered by large wetlands—those greater than 10 ha in size—decreased by approximately 72% from pre-settlement times to 2002 (Statistics Canada). It is therefore important for this research to identify the ecologically valuable area of

Ontario that could be negatively affected by urbanization.

II. THE URBAN AND ENVIRONMENTAL LANDSCAPE OF ONTARIO

i. The Urban Environment

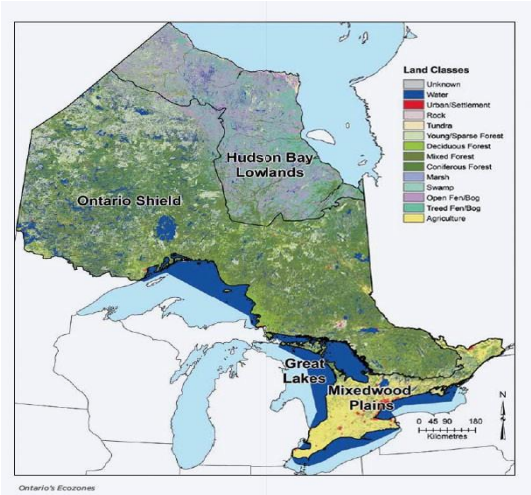

Figure 1: Ontario's 4 Ecoregions. *Source: "Ontario's Ecozones." State of Ontario's Biodiversity,*

Ontario is the second largest Canadian province next to Quebec. Having slightly more than 14 million residents, Ontario's population accounts for nearly 40% of the national population. Similar to the population distribution of the entire country, the majority of Ontarians live along the US-Canada border leaving a large portion of the province uninhabited (Statistics Canada). As is demonstrated in Figure 1, all 10 of the most populous cities in the province are located in its southern region near the US-Canada border (Lam and Conway, 644). While the population density of the province is 14.1 persons per square kilometer, 88.7% of the entire population lives within major metropolitan areas or census agglomerations (CA) while the remaining 11.3% of the population lives outside of urban areas (Statistics Canada). Furthermore,

44% of the population is concentrated within one single metropolitan area: The Greater Toronto Area (GTA), which is the sole metropolitan area in Ontario. The GTA consists of the central city of Toronto and four regional municipalities: York; Durham; Peel; and Halton. The GTA also acts as the core of the unofficial urban agglomeration that spans from the south end of Lake Erie to the north end of Lake Scugog towards Peterborough and is known as the Golden Horseshoe. The Golden Horseshoe is the most industrialized and populous area in the country, and this agglomeration is also part of the Great Lakes megalopolis which includes many US and Canadian urbanized areas. With the provincial population projected to grow by 30.2% by 2041 (Ministry of the Environment, Conservation and Parks), it will be these urbanized areas, specifically the GTA, that will experience the majority of this growth. The Ministry's report points out that the GTA will be the fastest growing region in Ontario with a population increase of 40.8% by 2041 at which point the region will hold over a 52% share of the total provincial population.

ii. The Natural Environment

The province of Ontario can be divided into four ecozones based on ecology, topography and climate: The Hudson Bay Lowlands; the Ontario shield; the Great Lakes ecozone; and the Mixedwood Plains, as defined by the Ontario Biodiversity Council (Figure 1) ("Ontario's Ecozones"). According to the Council's research, the Hudson Bay Lowlands, the northernmost ecozone, supports wetlands, boreal forests, subarctic forests, tundra, tidal marshes, rivers and lakes. The species found in this region include polar bears, gray wolves, caribou and wolverines.

This ecozone provides essential breeding and migratory habitats for other species, and its vast wetlands act as carbon sinks that sequester and store carbon from the

atmosphere. Covering 23% of the province, this ecozone holds only 0.03% of the provincial population leaving a majority of the area undeveloped. The largest ecozone is the Ontario Shield, covering 61% of the province yet only holding about 8% of the total provincial population. Its forested areas, consisting of coniferous forests (Black Spruce, Balsam Fir, Jack Pine), mixed forests and deciduous hardwood forests, make up 68% of the landscape. This region is also largely undeveloped. The Mixedwood Plains is the smallest of the four ecozones, covering only 8% of the province, yet it holds 92% of Ontario's population. The natural environments of this landscape, including wetlands, forests and prairies, have been converted to agricultural, industrial and residential urban land uses.

Although now dominated by urban activities and high population density, this ecozone remains the most biologically diverse region in the country and supports species that are not found anywhere else in the country ("Ontario's Ecozones"). The Great Lakes ecozone is the region embodying the five Great Lakes, covering 8% of Ontario. Eighteen percent of the world's freshwater supply comes from this ecozone that provides 85% of Ontario with fresh drinking water. The shores of the Great Lakes support the majority of Ontario's major industries, which, combined with high population densities, have led to a drastic decline in the region's biodiversity. However, as the Council indicates, this region still stands as one of the most ecologically diverse landscapes in North America.

The government of Ontario understands the value of its ecozones as these areas contain vast amounts of unique ecological environments, species and provide valuable ecosystem goods and services. In the Credit Valley watershed of Southern Ontario, for example, Statistics Canada has estimated the annual benefits of wetland

services to be $187 million (Statistics Canada). Thus, the government of Ontario has designated Areas of Natural and Scientific Interest (ANSI) to identify "areas of land and water containing unique natural landscapes or features" (Ministry of the Environment, Conservation and Parks). The report affirms that these ANSI areas have significant value in terms of ecological protection, conservation, scientific study or education. Two kinds of ANSI exist:

(1) Earth science ANSIs which are "geological in nature and contain significant examples of bedrock, fossils, landforms, or ongoing geological processes" (Ministry of the Environment, Conservation and Parks) and

(2) life science ANSIs which represent biodiversity and natural landscapes (Ministry of the Environment, Conservation and Parks). Throughout the entire province, over 1,000 ANSIs have been identified by the Government of Ontario as areas that provide unique value to the landscape of the province as a whole. The preservation of these areas is vital in order to maintain the overall health of the province's biodiversity and the intrinsic value of the province's ecosystem.

III. METHODS

For this study, the ArcMap 10.6* computer mapping program or Geographic Information Systems (GIS) was used to search and create different shapefiles (or map layers) of the study area.[2] The first shapefile contained data on the projected regional population percent change of Ontario from 2017 to 2032. It shows the regions of the province that will see the most significant increases in population and those that will experience a decrease. A plethora of studies show that the areas expected to have a substantial increase in population density will be mostly in urban areas (Hoornweg et

al. 567; Artmann et al. 10). The assumption can therefore be made that the areas of high percent changes in population are the areas associated with increased urbanization.

The second shapefile contained data on the locations of all the Areas of Natural and Scientific Interest across the province of Ontario. They were used to show the intersection or proximity of areas of increased urbanization across Ontario relative to areas with valuable ecological features. Together, these two map layers were used to show how the increase in urban land cover will affect the areas with the greatest ecological value in Ontario.

The projections of these maps were harmonized to avoid distortion and to improve the accuracy of the results. Once the initial map was created showing the entire province, an additional map was created to demonstrate the same information for the southern region of the province. To accomplish this, the ArcMap clip function was used to preserve the data of both layers for only the 41 regions that make up the southern region of the province. The clip function created new layers for the percent change of population density for southern Ontario and for the Areas of Natural and Scientific Interest of southern Ontario. The data that were excluded from the clip were discarded to focus the analysis solely on southern Ontario.

[2] ArcMap is a product of the Environmental Research Systems, Inc (ESRI), Redlands, CA, USA. https://www.esri.com/.

IV. RESULTS AND ANALYSIS

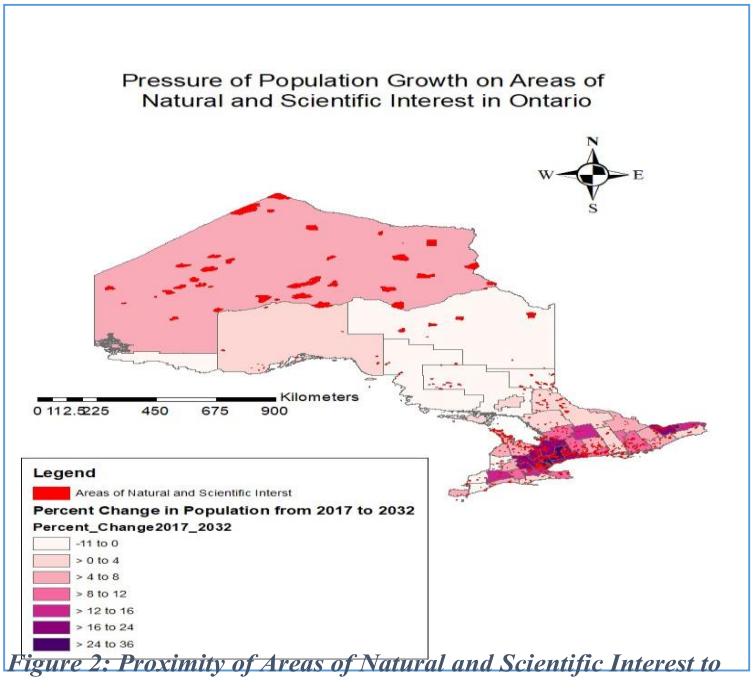

Figure 2: Proximity of Areas of Natural and Scientific Interest to Projected Areas of High Urban Population Increase of Ontario, 2017-2032

Figure 2 which shows the proximity of valuable ecological features relative to areas of future urbanization across Ontario, supports previous studies that argued that future population growth will concentrate towards the southern region of the province and that the northern region will continue to be relatively undeveloped and unpopulated. While the northern region of the province will continue to have little population growth, the central region of the province will see a population decrease (Figure 2). These results signify a minimal increase in potential urban land cover. Stress on the ANSI locations will be minimal as a result of a very low (0%-4%) population increase.

It is likely that the ecologically valuable areas of the central and northern part of the province will not be subject to the pressures of urbanization in the future - as far as

2032 (Figure 2). According to this map the region of the province where important ecological features are likely to be subject to the pressures of urbanization is concentrated in the southern region of the province (Figure 2).

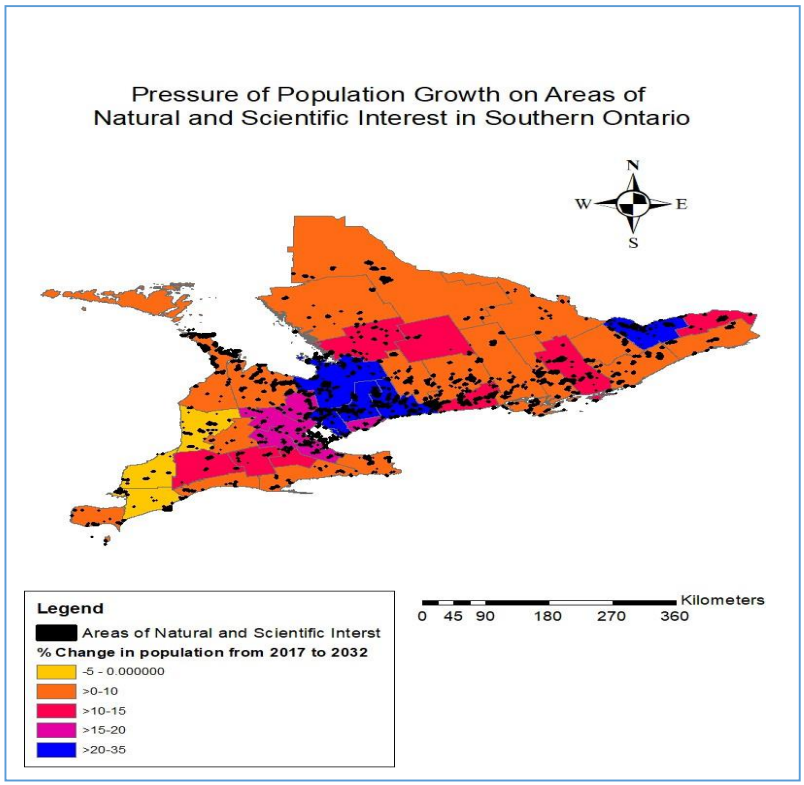

Figure 3 Proximity of Areas of Natural and Scientific Interest to Projected Areas of High Urban Population Increase of Southern Ontario, 2017-2032

As shown in Figure 3, the southern region is expected to have a population increase in all but 3 of its 41 regions. By 2032, 5 of the 41 regions in southern Ontario will experience a 15%-20% increase in percent population change, 5 of the 41 regions will experience a 20%-35% percent population increase (Figure 3). These 10 out of the 41 regions in southern Ontario are all concentrated around the GTA, thus demonstrating an expansion of the current metropolitan region into the surrounding rural land. The southern region has been shown to have the highest concentration of ANSIs, and the most heavily concentrated ANSIs are located within the three regions that are projected to have the

highest increase in population (20%-35%). In short, the area of highest population increase is the same as the area with the greatest concentration of ANSI locations (Figure 3). As a result, the southern region is shown to be the area of greatest concern for the protection of valuable ecological features from increased urbanization. This region is characterized as the Mixedwood plains and Great Lakes ecozones where already a significant decrease in biodiversity has occurred from urban activities ("Ontario's Ecozones").

V. CONCLUSION

Upon analyzing the maps that demonstrate the proximity of ecologically valuable features to areas that are projected to have increases in population between 2017-2032, it is clear that the southern region of Ontario will experience the greatest amount of pressure on its ecological resources. Since there is a positive correlation between population increase and loss of natural habitat, it can be concluded that with the significant increase in Ontario's population from 2017 through to 2032, the majority of ecological resources of the province will be put under significant stress as urban land uses encroach on ANSIs like Lynde Shores Coastal Wetlands, Shoal Point Wetlands, Rouge River Valley and, most importantly, the Greenbelt. The Greenbelt is a large provincially protected area of green spaces, farmlands, forests, wetlands, and watersheds. Although planned to be permanent, the newly elected Ontario Provincial Government has indicated a willingness to open the Greenbelt up for development (Gray)

The implications of this stress can be devastating to the biodiversity of the region which is largely comprised of the Mixedwood plains and the Great Lakes ecoregions. Both of these areas are some of the most biologically diverse regions on the

continent; containing species not found anywhere else in Canada. The Great Lakes ecoregion has already seen a drastic reduction in biodiversity as a result of the current levels of urbanization ("Ontario Ecozones"; Draaisma).

Increased levels of urban land cover as projected from the research will likely lead to the loss of unique species and a dangerous reduction in biodiversity. The projected population growth in the areas surrounding the GTA point to the spread of urbanization outwards from the center of Toronto into nearby rural, undeveloped land. There is no evidence that urbanization will be slowed in much of the southern region given the projected increase in population.

The potential increase in urbanization shown in this research points to the stress that areas of ecological value and importance will face in the future years. With the increase in urbanization as a result of population increase, the conversion of natural rural land for urban use will increase as well. As discussed earlier, land conversion for urbanization has drastic and lasting impacts on the wellbeing of the environment. The environment surrounding the GTA, where the greatest increase in population growth is projected to occur, also holds the largest concentration of ANSI locations across the entire province. In future years, the growing population and thus the growing rates of urbanization are going to spread into these critical ecological areas (Figure 3). Available evidence has shown that if the population grows as projected from now until 2032, the ecological value, health, function and importance of the southern region of the province is going to be subject to even more ecological threats. There is potential that the effects of these threats will result in the permanent loss of some of the province's species and ecosystems; many of which are vital to the functioning of the entire society and landscape of the province. Already, some researchers are warning that the "ecological collapse of

Toronto's vast ravine system has started because of invasive species" and that some of its key quintessential forest organisms such as trees, plants, and wildlife would be missing (Draaisma). Many of these invasive species are linked to human activity ("Ontario invasive Species Strategic Plan").

The conclusions drawn from this research assume that future development will follow the current method of development across the continent, that is, urban sprawl. However, the impacts can be severely lessened by use of alternative methods of development. In recent years, the approach of smart growth and low- impact development has become increasingly popular. Smart growth is a method of development that attempts to curb urban sprawl by changing the structure of cities by making them more compact and denser, revitalizing brownfields, providing mixed land uses, stimulating local economic development, improving urban aesthetics, improving the quality of urban life and increasing diversity in terms of age, race, gender and income within society (Artmann et al, 10).

The main pillars of smart growth are in fact protecting natural areas on the urban-rural fringe from sprawl and integrating ecological components within the built-up city (15). In his article published by the Toronto Star, Gray presents a study by the Neptis Foundation and the Ministry of Municipal Affairs that demonstrated that there is over "125,000 hectares (greater than the size of Mississauga and Toronto combined) of developable land within existing urban boundaries" (Gray). As such, developing outwards is not necessary and by using smart-growth principles, Ontario, in particular the GTA, can continue to grow and develop sustainably. By providing a platform for both economic and ecological prosperity, smart growth puts high importance on the protection and preservation of important ecological features and works to reduce the amount of land that

is converted to urban development.

A 2002 study performed by Northwest Environment Watch that compares the effects of smart growth versus urban sprawl across 68 cities can be used to illustrate the profound effects smart-growth techniques have on reducing urban sprawl. The study concluded that smart growth is capable of preserving significant amounts of undeveloped land from urban sprawl. In Canada's West, Vancouver is one of the most densely developed cities on the continent that adopted smart-growth strategies from as early at the 1930s. The Seattle-Tacoma metropolitan area only just began implementing smart-growth strategies in the 1990s after realizing the consequences of urban sprawl. Estimates show that if the Seattle-Tacoma urban region had the same population density of Vancouver, 233,000 acres of land would have remained undeveloped ("Sprawl and Smart Growth in Greater Seattle-Tacoma."). This example illustrates how much natural land smart-growth is capable of saving simply by changing the way in which cities are developed.

In the case of Ontario, Canada, there is potential for a significant amount of valuable ecological areas to be lost as a result of urbanization and increased population in the coming years. These consequences can be reduced or even stopped simply by changing the way in which cities are developed. Shifting from urban sprawl to smart growth has the ability to concentrate development within the already existing boundaries of the urbanized area rather than converting valuable natural land to urban land uses. Implementing smart growth requires the cooperation of citizens, government and interest groups to create regulations, habits and lifestyle changes that support the culture of smart growth.

Unfortunately, for Ontario, the current provincial government is furthering urban sprawl by passing a bill that would open the Greenbelt up for development (Rieti). The

Greenbelt was an attempt to stop the spread of development once it reached the boundary. As development is beginning to encroach on the Greenbelt's boundary, however, laws that would open all this land up for development are beginning to appear (Rieti). Southern Ontario thus not only provides a living example of how urban sprawl can threaten local and regional ecological wellbeing but also how the implementation of smart-growth principles could significantly reduce these threats. Smart growth can also improve the economic conditions of the area as well as increase the quality of life for the residents. Consequently, future population growth in Ontario does not have to result in the drastic ecological losses in the Province's Greenbelt or the Oak Ridges Moraine regions, for example. By implementing smart-growth techniques at the provincial, regional and local levels, both economic development and ecological preservation can coexist in Ontario and help lead to a better tomorrow for us and our planet

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