CANADA'S WEALTH OF NATURAL CAPITAL

Rouge National Park

David Suzuki Foundation

SOLUTIONS ARE IN OUR NATURE

CANADA'S WEALTH OF NATURAL CAPITAL: ROUGE NATIONAL PARK

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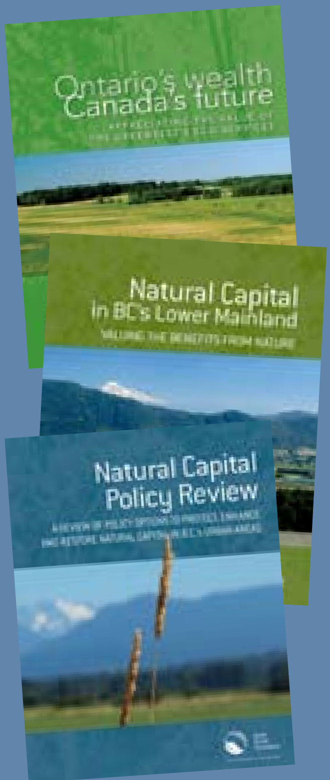

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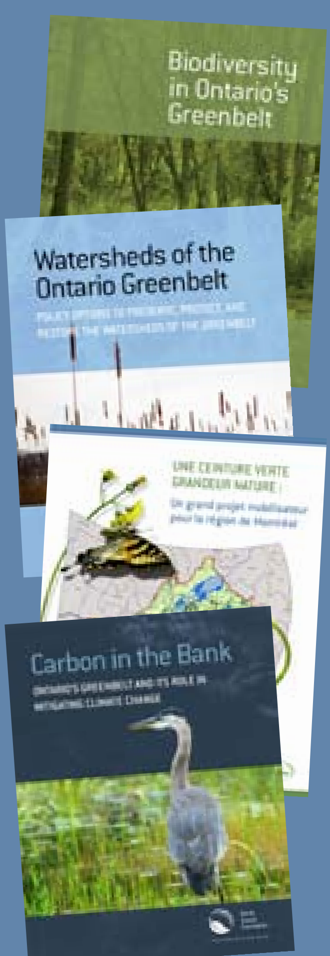


FIGURES

DISCLAIMER

This study should be considered a coarse-scale assessment of the study area's ecosystem services. It is an important step, albeit a first step, towards a full natural capital account for the proposed Rouge National Park and its surrounding watersheds. More comprehensive accounting and monitoring of the services provided by the natural capital assets in the study area is needed to improve the reporting of the flows of ecosystem services. In addition, information on the users of the Park and other natural areas are required for a more accurate and detailed report on the values that the study area provides to nearby communities as well as people from across the Greater Toronto Area.

The content of this study is the responsibility of its author and does not necessarily reflect the views and opinions of those acknowledged above.

Every effort to ensure the accuracy of the information contained in this study has been taken, however, the project was limited by the information and data that was available and peer review was limited by time constraints. In addition, the land cover data is the SOLRIS (2000-2002) database, which is now 10 years old. As such, there will be inconsistencies between the land cover reported and the actual land cover present in 2012. We welcome suggestions for improvements that can be incorporated into later editions.

Executive Summary

Canada's Wealth of Natural Capital: Rouge National Park

The Rouge area has a rich natural, agricultural and cultural history. It is home to a remarkable Carolinian forest, more than 1,000 known wildlife species, two National Historic Sites, and some of the best remaining farmland remaining in the Greater Toronto Area (GTA). It also provides a contiguous natural corridor from the Oak Ridges Moraine to the shores of Lake Ontario.

This past year (2012), the federal government committed to permanently protecting much of the area by establishing Canada's first urban National Park in the Rouge. Rouge National Park has the potential to not only safeguard the Rouge's immense natural capital (green space and farmland); it will create opportunities for millions of nearby residents, including diverse communities of new Canadians, to explore a nearby wilderness gem.

The purpose of this study is to estimate the economic value of the ecosystem services and benefits provided by various types of ecosystems and land uses found within the region.

It examines the value of ecosystem services provided by: (1) the existing 3,890 hectare Rouge Park; (2) the proposed 5,838 hectare new Rouge National Park; and (3) the area's three major surrounding watersheds, covering a total of 64,623 hectares in the Greater Toronto Area (GTA).

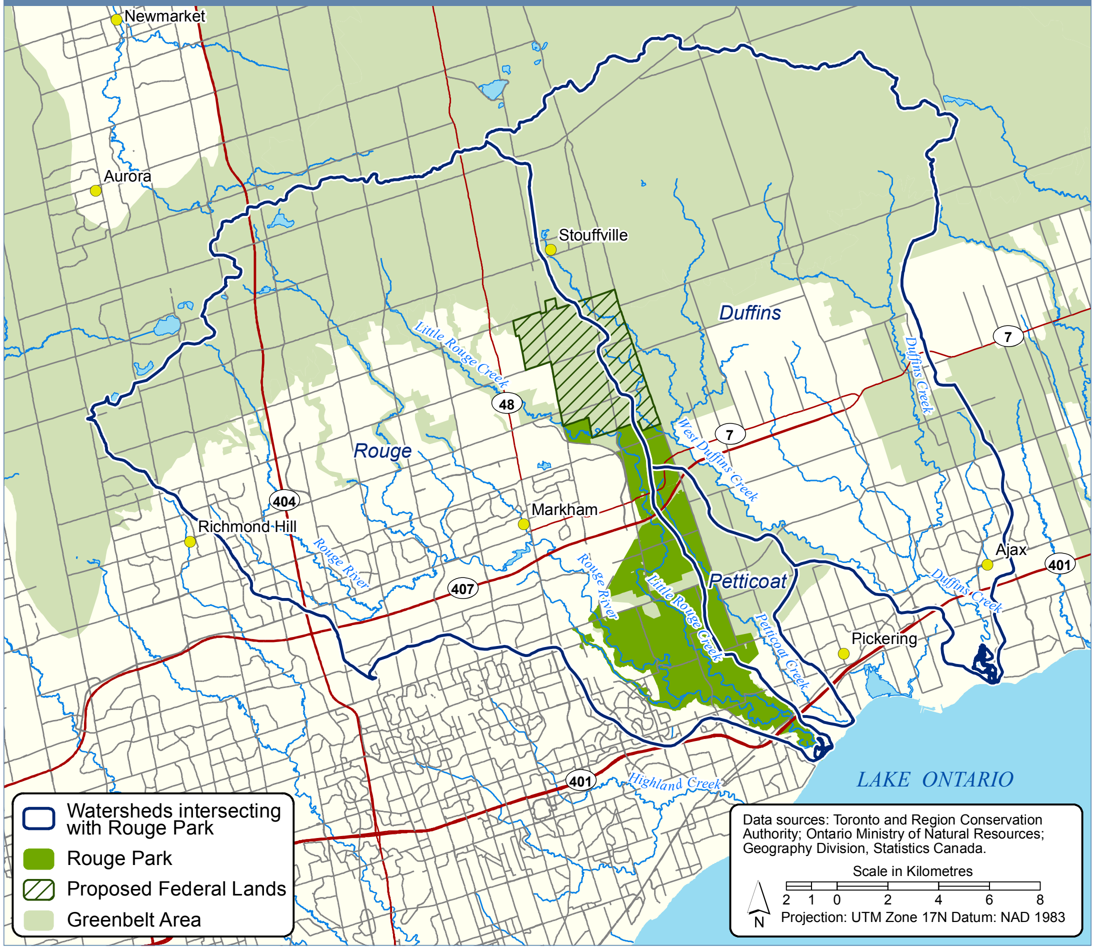
The total study area consists of the Rouge River, Petticoat Creek and Duffins Creek watersheds. This area includes croplands, grazing lands and idle lands (54.4 per cent); built-up urban areas and infrastructure (20.4 per cent); natural cover areas such as forests, wetlands, water, hedgerows and tree plantations (21.2 per cent), and urban green space such as golf courses and playing fields (4.0 per cent). The existing Rouge Park includes natural cover areas (33.0 per cent), croplands, grazing lands and idle lands (57.8 per cent), and other land use such as restored lands, parking lots and the Toronto Zoo lands[1] (9 per cent).

Rouge National Park has the potential to not only safeguard the Rouge's immense natural capital, it will create opportunities for millions of residents to explore a nearby wilderness gem.

PHOTO COURTESY KIRIL STRAX/FLICKR

1 Although the Toronto Zoo is generally not considered part of Rouge Park we have included it for the purposes of this study to be consistent with existing land cover data received from the Toronto Regional and Conservation Authority (TRCA).

TOTAL STUDY AREA MAP, INCLUDING ROUGE PARK AND SURROUNDING WATERSHEDS



The Rouge and its surrounding watersheds provide an estimated $115.6 million in non-market economic benefits for residents in the Greater Toronto Area each year.

The findings of the report reveal that the Rouge and its surrounding watersheds provide an estimated $115.6 million ($2,247 per hectare) in non-market economic benefits for residents in the Greater Toronto Area each year. The future Rouge National Park[2], which includes lands within the existing Rouge Park, is the ecological engine of the region and alone provides at least $12.5 million ($2,239) in annual benefits.

Within the total study area (i.e., all three watersheds that support and surround the proposed new National Park), forests provide the greatest value at $41.2 million per year, wetlands provide an annual value of $34.9 million, and idle agricultural land provides $18.2 million per year.

Wetlands provide the greatest value per hectare, worth, on average, $9,648 per hectare annually, whereas croplands provide the least non-market value at $378 on average per hectare annually.

The ecosystem services that contribute most to the total study area's natural capital assets are pollination services worth $28.2 million per year, stored carbon worth $17.8 million per year, and wetland habitat worth $17.1 million per year.

These findings demonstrate that despite decades of sprawling development throughout the Greater Toronto Area (GTA), the Rouge and its surrounding watersheds have remained a vital ecological – and economic – resource that offers vast benefits to millions of GTA residents each year. This stock of natural capital cleans

2 Based on the proposed boundaries recommended by the Rouge Park Alliance and currently under consideration by Parks Canada as the proposed study area for Rouge National Park: StrategyCorp – Hemson Consulting. 2010. *Governance, Organization and Financial Review of the Rouge Park Alliance*. Rouge Park Alliance Governance Review. Rouge Park Alliance. Toronto, Canada.

To ensure the Rouge's ecological health and economic value is maintained in the long term, this report provides recommendations for legal, policy and conservation efforts.

PHOTO COURTESY LAURENCE LUI/FLICKR

the air, filters the water, cools nearby communities and provides a critical natural corridor from the Oak Ridges Moraine to the shores of Lake Ontario.

By establishing Rouge National Park, the federal government, and the many local stakeholders and Rouge champions, are effectively protecting a bank of natural capital that will benefit communities now and for generations to come. While protecting, restoring and managing such a wild gem on the edge of one of North America's fastest growing urban areas is likely to cost tens of millions, these costs should be weighed against the value of economic and ecological benefits highlighted in this report. Even without consideration of the Park's market (e.g., influence on property values) and health benefits to local residents, Rouge National Park will undoubtedly pay huge dividends.

While this valuation is an important first step in assessing the value of the Rouge area, there is much work still to be done. To ensure the Rouge's ecological health and economic value is maintained in the long term, this report provides recommendations for legal, policy and conservation efforts that should be undertaken, including establishing natural capital accounts for the new Rouge National Park and its surrounding watersheds, carefully managing development activities in and around the Park that could negatively impact its ecosystems (e.g., pipelines, roads) and promoting policies and programs to restore and enhance the supply of ecosystem services in the region, especially on working agricultural lands.

PART 1

Introduction

Rouge Park

Rouge Park was created in 1995 by the Ontario government in response to public concerns about the protection of the Rouge River Valley.

PHOTO COURTESY TSAR KASIM/FLICKR

Rouge Park is a nationally significant ecological area located in the Greater Toronto Area (GTA). It was created in 1995 by the Ontario government in response to public concerns about the protection of the Rouge River Valley. More recently, the Park and the Rouge River watershed were included under Ontario's 2005 Greenbelt Plan (Section 3.2.6), with special recognition for providing a reservoir of biodiversity throughout the Park as well as the only contiguous link connecting the Ontario Greenbelt to Lake Ontario.

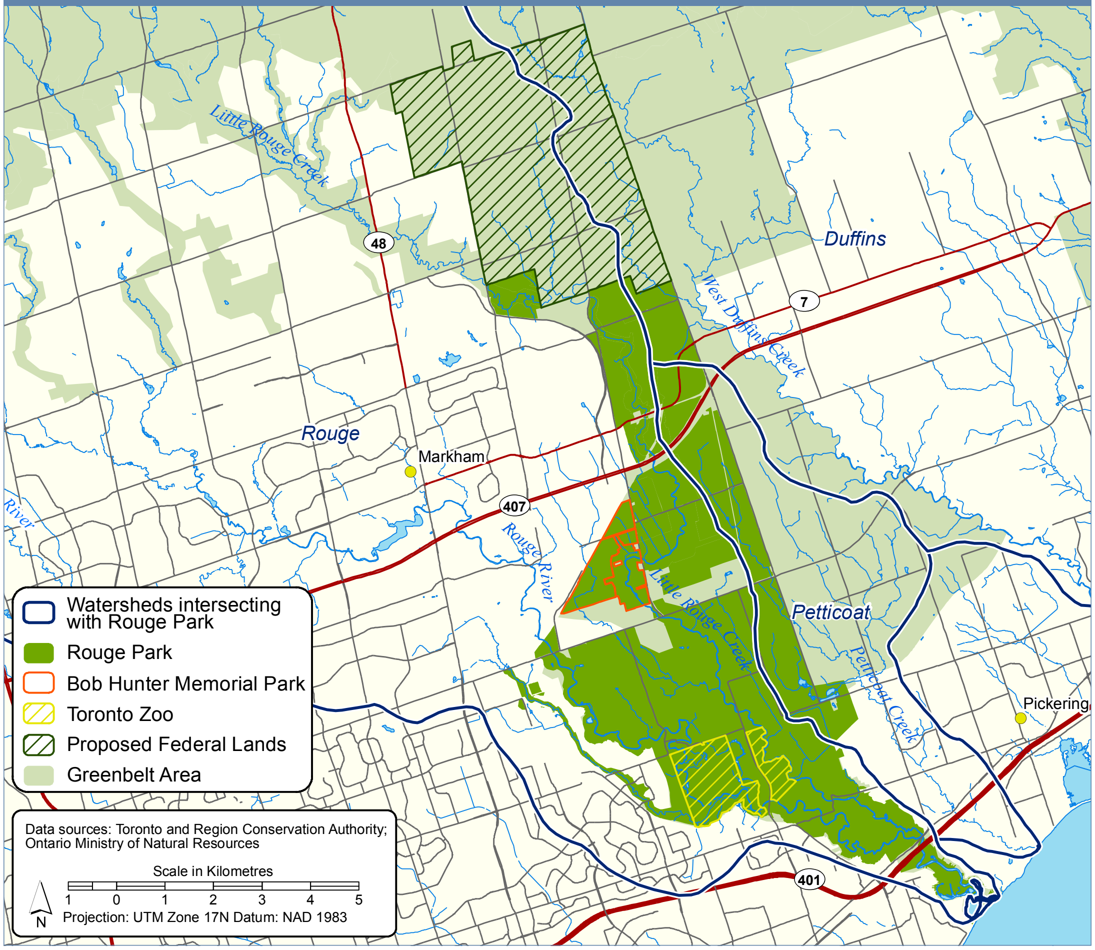
The Park is found within the Rouge, Petticoat and West Duffins watersheds on the eastern edge of the City of Toronto and Town of Markham, running north from the shores of Lake Ontario to just north of 16th Ave in Markham (Figure 1). The existing park is Canada's largest urban wilderness park at 3,890 hectares. It sits at the northeastern edge of the Carolinian Zone. This zone is rare in Canada, covering less than one per cent of the country's land mass, though providing habitat for more species than any other life zone in the country, including: monarch butterflies, peregrine falcons, red-shouldered hawks, barn owls, red foxes, and the iconic Canadian beaver.

Rouge Park has more than:

- 762 plant species (over one quarter of Ontario's flora)
- 225 bird species (123 breeding species)
- 55 fish species
- 27 mammal species
- 19 reptile and amphibian species

The Park also contains working farms and rural landscapes. Indeed, agriculture has been an integral part of the region's rich cultural and economic history for over 200 years.

FIGURE 1: ROUGE PARK BOUNDARIES



Maps can be viewed in high resolution at www.davidsuzuki.org/rouge-landcover

Proposed Rouge National Park

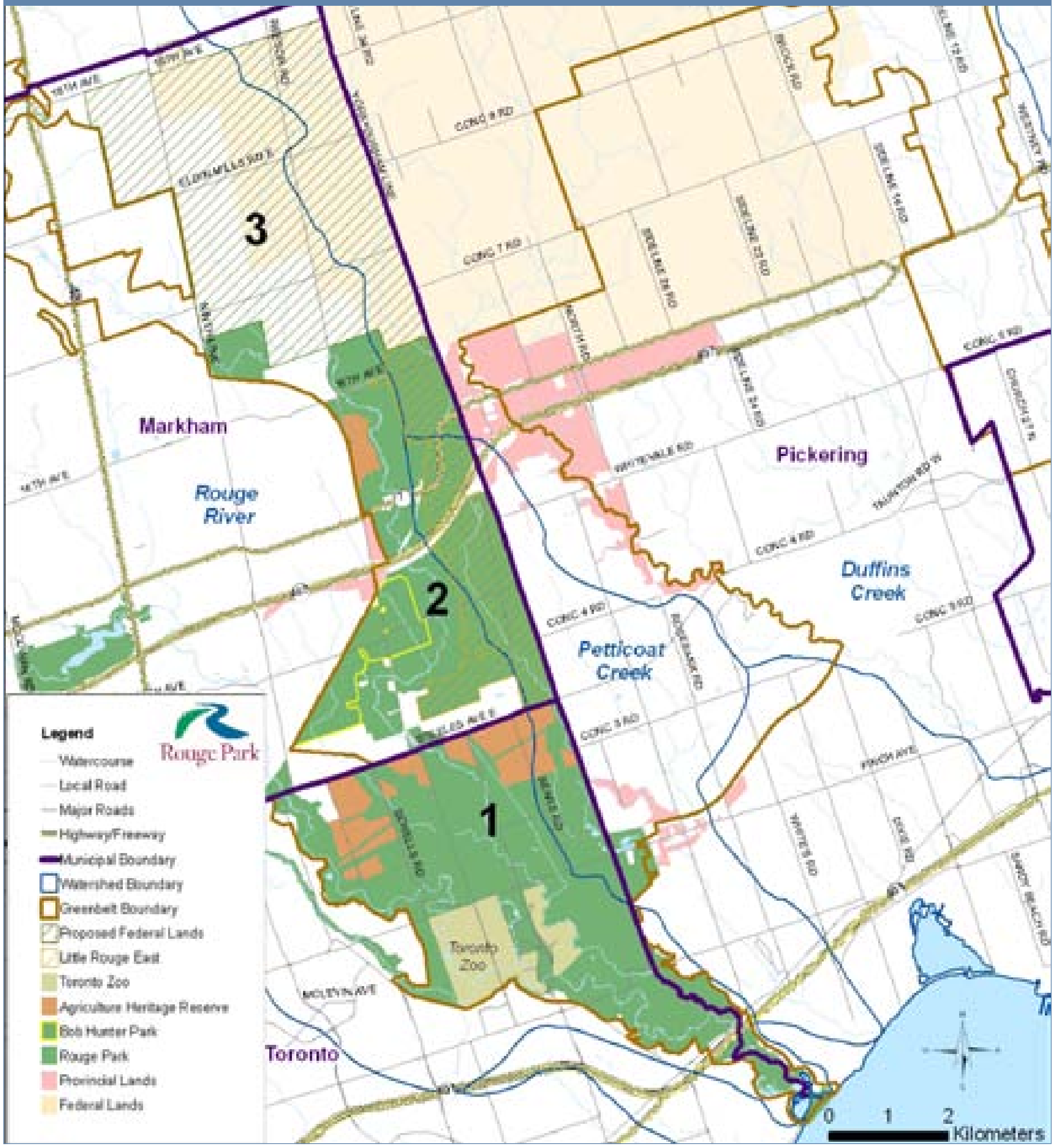
Rouge Park Alliance is a voluntary partnership consisting of 13 organizations, including different levels of government, agencies and not-for-profit groups. The Alliance commissioned a governance and financial review in 2010. This report concluded that a new model of organization, funding and governance was required for Rouge Park, which led to the recommendation to create an urban National Park.[3]

The current 3,890 hectare Rouge Park includes Block 1 and Block 2 shown in Figure 2. The Rouge Park Alliance has proposed that the federal government add an additional 1,948 hectares of federally owned lands (Block 3) west of the York-Durham town-line in Markham to the existing Rouge Park lands, in order to create the new National Park. These additional lands could be managed as an agricultural preserve or conservancy within the new National Park.[4] Parks Canada has recently adopted the Rouge Park Alliance's proposal as its own proposed Study Area for the creation of Rouge National Park. However, it should be noted that some local advocates have proposed that Rouge National Park be much larger in size to include additional contiguous lands in north Markham and Pickering within the Rouge River and Duffins Creek watersheds. These federal

3 StrategyCorp – Hemson Consulting. 2010. *Governance, Organization and Financial Review of the Rouge Park Alliance*. Rouge Park Alliance Governance Review. Rouge Park Alliance. Toronto, Canada.

4 Rouge Park Alliance. 2011. *Rouge National Park – A Good Idea for the Environment, Farmers and GTA Residents*. Backgrounder, April 2011.

FIGURE 2: ROUGE PARK AND PROPOSED ADDITIONAL FEDERAL LANDS



Maps can be viewed in high resolution at www.davidsuzuki.org/rouge-landcover

The proposed national park would add 1,948 hectares of federal land (Block 3) to Rouge Park's current 3,890 hectares (Blocks 1 and 2).

lands are currently designated "Natural Heritage System" under Ontario's Greenbelt Plan and legislation, but remain vulnerable to development.[5]

The creation of Rouge National Park has popular support in the area. A poll by Nanos Research in June 2010 showed that 88 per cent of local residents surveyed support the idea of the federal government establishing Canada's first urban National Park in the Rouge. The Government of Canada committed to the creation of a National Park in the 2011 Speech from the Throne and has since provided multi-year funding for its establishment and management.[6] In 2012, Parks Canada actively developed a process for establishing the new urban National Park based on input from federal, provincial, municipal, Aboriginal, youth and community groups, as well as working with public landholders, such as municipalities, in developing a land transfer processes for the creation the new National Park.

5 Friends of the Rouge Watershed. www.frw.ca/pdf/Support_Rouge_National_Park_Flyer_July_2011.pdf

6 www.pc.gc.ca/apps/cp-nr/release_e.asp?id=1861&andor1=nr

Purpose of Study

The purpose of this study is to estimate the value of the natural capital and the ecosystem services provided by:

1) the existing Rouge Park (3,890 ha);

2) the proposed Rouge National Park[7] (5,838 ha); and

3) its three major surrounding watersheds (64,623 ha) in the Greater Toronto Area.

It includes analysis of built urban, agricultural and natural land cover and land use within Rouge Park and its surrounding watersheds; the monetized values for the ecosystem services provided by each natural land cover type; and a review of agricultural programs for restoring and enhancing the supply of ecosystem services on working agricultural lands (see Appendix 1).

In 2012, Parks Canada actively developed a process for establishing the new urban National Park based on input from federal, provincial, municipal, Aboriginal, youth and community groups, as well as working with public landholders, such as municipalities, in developing a land transfer processes for the creation the new National Park.

PHOTO (COMMON GREEN DARNER, ANAX JUNIUS) COURTESY GARY YANKECH/FLICKR

7 Based on the proposed boundaries recommended by the Rouge Park Alliance and currently under consideration by Parks Canada as the proposed study area for Rouge National Park: StrategyCorp – Hemson Consulting. 2010. *Governance, Organization and Financial Review of the Rouge Park Alliance*. Rouge Park Alliance Governance Review. Rouge Park Alliance. Toronto, Canada.

PART 2

Definition of Study Area

The total study area includes three watersheds that flow through Rouge Park and nested study areas for the current Rouge Park and the proposed Rouge National Park Study Area proposed by Parks Canada.

PHOTO COURTESY VLAD LITVINOV/FLICKR

The total study area includes three watersheds that flow through Rouge Park – the Rouge River, Duffins Creek and Petticoat Creek watersheds (Figure 3). In addition, the study includes nested study areas for the current Rouge Park and the proposed Rouge National Park Study Area proposed by Parks Canada.

Rouge River Watershed

The Rouge River watershed includes 33,288 hectares of land in the regions of York and Durham, cities of Toronto and Pickering, and towns of Markham, Richmond Hill and Whitchurch-Stouffville. It includes all the lands that drain to the Rouge River and its tributaries, including the Little Rouge River. The lower watershed is dominated by the existing Rouge Park, which makes up 12 per cent of the area. The middle and western parts are experiencing rapid urban expansion and have sparse natural cover except in Rouge Park. The upper and eastern portions of the watershed are primarily rural and agricultural with some small towns and villages.

Duffins Creek and Petticoat Watersheds

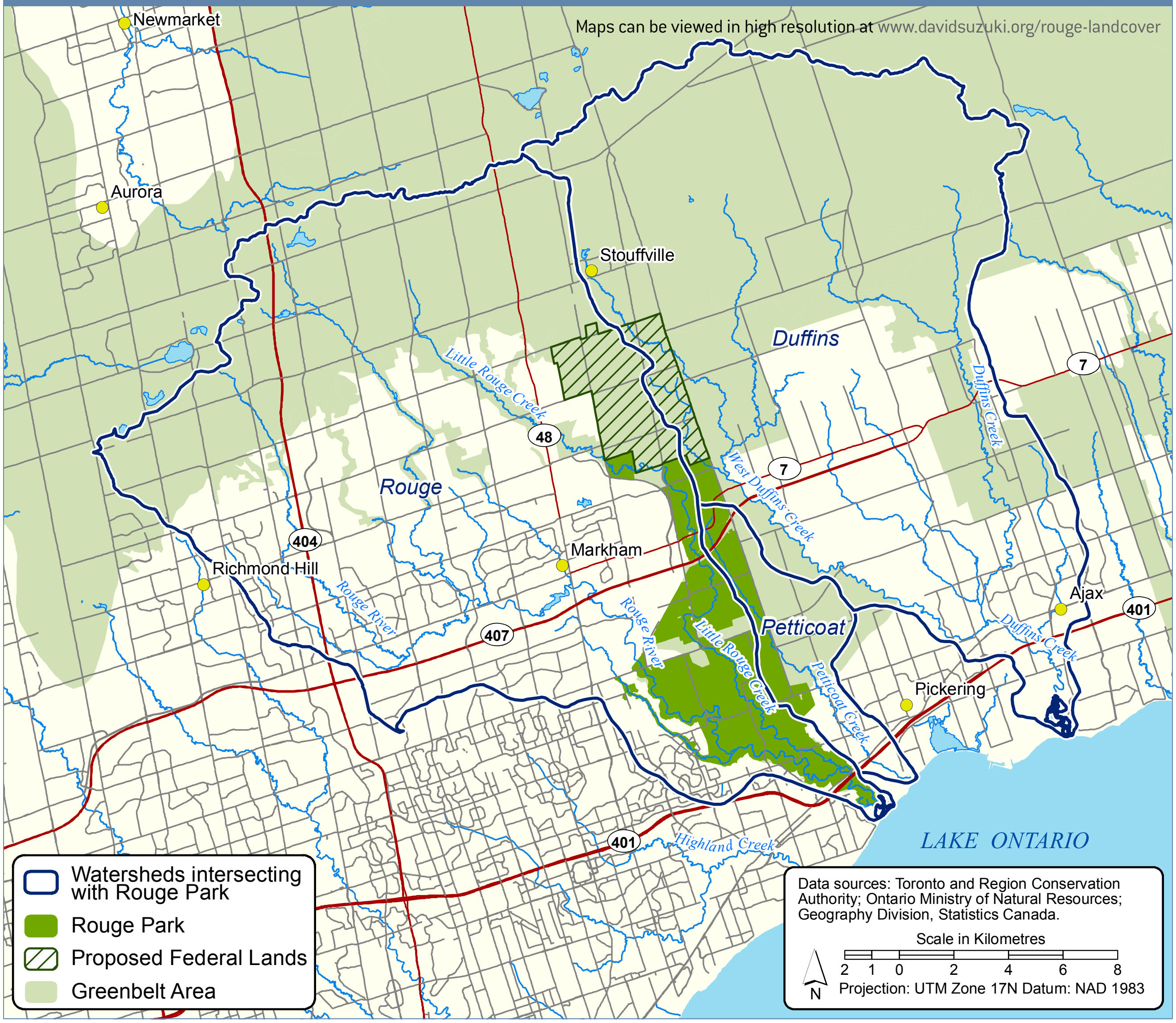
Duffins Creek is located in the Region of Durham and York Region. The Duffins Creek watershed covers 28,653 hectares in the communities of Whitchurch-Stouffville, Markham, Uxbridge, Pickering and Ajax. The Petticoat Creek watershed covers 2,683 hectares located between the Rouge and Duffins Creek watersheds.

Rouge Park and Rouge National Park

The current 3,890 hectare Rouge Park is located in the City of Toronto and Town of Markham (Blocks 1 and 2 shown in Figure 2). The proposed Rouge National Park[8] includes the existing Rouge Park plus 1,948 hectares of additional federal lands west of the York-Durham town-line in Markham (Block 3 in Figure 2).

8 Ibid.

FIGURE 3: TOTAL STUDY AREA MAP, INCLUDING ROUGE PARK AND SURROUNDING WATERSHEDS



PART 3

Importance of Natural Capital and Ecosystem Services

While Canadians recognize the importance and value of the environment to their well-being, there is not a consistent measure of the non-market values that ecosystems provide.

PHOTO COURTESY JOHN WILLIAMS/FLICKR

Definitions

Natural capital refers to the earth's land, water, atmosphere and resources. This capital is organized and bundled within the earth's natural ecosystems, which provide resources and flows of ecosystem services. The benefits that ecosystems provide, such as ecosystem goods and services, are critical to the economic and social well-being of humans. While Canadians recognize the importance and value of the environment to their well-being, there is not a consistent measure of the non-market values that ecosystems provide. As a result, a complete valuation of Canada's natural capital has not been undertaken. Thus, these benefits are generally not accounted for in economic decision-making and land use planning.

Ecosystem services are often defined as the benefits that people obtain either directly or indirectly from ecological systems.[9] Ecosystems provide numerous services, including the storage of flood waters, water capture and filtration by watersheds, air pollution absorption by trees, and climate regulation from carbon storage in trees, plants and soils. These services and benefits are undervalued in market economies, despite being worth trillions of dollars per year, globally.

One of the most common reasons for measuring natural capital and ecosystem services is to report on the financial implications resulting from resource and land use decisions by communities, governments and businesses. Generally, the full costs of human activities and their impacts on the environment have not been accounted for, and as a result these costs have been externalized. However, modern societies are now facing severe environmental problems due to the decline in ecosystem services as a direct result of ignoring these external costs to the environment.

International Reporting

The United Nations Millennium Ecosystem Assessment (MA) reported in 2005 that over the past 50 years humans have changed the earth's ecosystems more rapidly and extensively than in any other period of human history. The assessment concluded that approximately 60 per cent of the world's ecosystem services are

9 Millennium Ecosystem Assessment. 2005. *Ecosystems and Human Well-being: Synthesis*. Island Press. Washington, D.C.

being degraded or used unsustainably.[10] The results are an unprecedented decline in biodiversity and precious natural assets that provide us with life-supporting services.

More recently, the United Nations Environmental Program Finance Initiative found that the total global environmental costs resulting from global human activity was US$6.6 trillion in 2008. This represents 11 per cent of global Gross Domestic Product (GDP).[11] The study also projected that environmental costs will continue to rise over time, amounting to US$28.6 trillion by 2050 (18 per cent of global GDP), if business as usual continues.

The Importance of Valuing Ecosystem Services

The process of quantifying ecosystem services is increasingly recognized as a valuable approach to account for the economic value of ecosystems.[12] Communities, groups and governments are beginning to recognize the essential ecosystem services that nature provides. As a result, the valuation of ecosystem services is an emerging trend at the global, national and local levels.

Global studies have estimated the total value of the world's ecosystem goods and services to be on par with the value of the entire global economy.[13]

In Canada, two studies have assessed the non-market value of natural capital for Canada's boreal region. They estimate that natural capital in the Mackenzie Valley Region is worth $570 billion per year (an average of $3,426 per hectare). This is more than 13 times greater than the market value of the region's natural resources.[14]

In southern Ontario, three studies have assessed the non-market values of natural capital. One study estimated that the value of ecosystem services provided by the Ontario Greenbelt at more than $2.6 billion each year (an average value of $3,487 per hectare).[15] A 2008 study estimated the value of the Lake Simcoe watershed at $975 million per year (an average value of $2,948 per hectare).[16] Another estimated the value of the Credit Valley Watershed at $371 million each year (an average of $490 per local resident).[17]

A benefit transfer study undertaken in 2009 for the Ontario Ministry of Natural Resources reported the annual value of ecosystem services for the entire southern Ontario region to be worth an estimated $63 billion (updated in 2011). This study area of 12.5 million hectares had an estimated average value of $5,060 per hectare each year.[18]

Communities, groups and governments are beginning to recognize the essential ecosystem services that nature provides. As a result, the valuation of ecosystem services is an emerging trend at the global, national and local levels.

PHOTO (BLACK & YELLOW ORBWEAVER, ARGIOPE AURANTIA) COURTESY GARY YANKECH/FLICKR

10 Ibid.

11 Garfunkel, A. (ed.) 2010. Universal Ownership: Why Environmental Externalities Matter to Institutional Investors. Trucost Plc, PRI Association and UNEP Finance Initiative. www.unpri.org/files/6728_ES_report_environmental_externalities.pdf. Accessed Sept. 2010.

12 Troy, A. and Wilson, M.A. 2006. Mapping ecosystem services: Practical challenges and opportunities in linking GIS and value transfer. Ecological Economics. 60: 435-449.

13 Costanza, R. et al. 1997. The value of the world's ecosystem services and natural capital. Nature. 387:253-259.

14 Anielski, M., and Wilson, S. 2007. The Real Wealth of the Mackenzie Region: Assessing the Natural Capital Values of a Northern Boreal Ecosystem. (2009 Update). Canadian Boreal Initiative. Ottawa, Canada.

15 Wilson, S.J. 2008. Ontario's Wealth, Canada's Future: Appreciating the Value of the Greenbelt's Eco-Services. Greenbelt Foundation and David Suzuki Foundation.

16 Wilson, S.J. 2008. *Lake Simcoe Basin's Natural Capital: The Value of the Watershed's Ecosystem Services*. Friends of the Greenbelt Foundation Occasional Paper Series. Lake Simcoe Region Conservation Authority and The Friends of the Greenbelt Foundation. Ontario, Canada.

17 Kennedy, M., and Wilson, J. 2009. Natural Credit: Estimating the Value of Natural Capital in the Credit River Watershed. The Pembina Institute and Credit Valley Conservation. Note: natural capital values per hectare were not provided in the study.

18 Troy, A., and Bagstad, K. 2009. *Estimation of Ecosystem Service Values for Southern Ontario*. Spatial Informatics Group. Prepared for the Ontario Ministry of Natural Resources. Ontario. Total annual value and average value per hectare are lower than those reported in the original report because of an error in the benefit transfer estimates that were first published by the authors. Updated values cited in this study were received directly from the authors. The larger value per hectare in this study, compared to the other southern Ontario studies, was the result of higher values attributed to urban and suburban natural cover because of the greater sized population dependent on these green spaces.

PART 4

Methodological Approach

The distribution of land cover and land use in Rouge Park, the proposed Rouge National Park, and the surrounding watersheds were mapped.

PHOTO (BUFFLEHEADS) COURTESY GARY YANKECH/FLICKR

Framework

This study provides a natural capital account for the existing Rouge Park, the proposed Rouge National Park, and its surrounding watersheds. This account includes the extent and distribution of the land cover and land use across the study area, as well as the non-market ecosystem benefits and the agricultural market values provided by the study area's natural capital.

- **PHYSICAL NATURAL CAPITAL INVENTORY:** The physical account of natural capital and land use was based on the extraction of land cover data using the Southern Ontario Land Resource Information System (SOLRIS 2000-2002) to estimate the area of each land cover type, ecosystem type, and land use type.[19]
- **TYPOLOGY AND IDENTIFICATION OF ECOSYSTEM SERVICES AND BENEFITS:** The typology of ecosystem services was based on the classification developed by the TEEB (The Economics of Ecosystems and Biodiversity) Foundations report.[20] The identification of ecosystem services was determined by ascribing services typically provided by each land cover type. The ecosystem services were attributed based on a review of relevant literature combined with a review of local information sources to assess which ecosystem services were likely provided by the study area's ecosystems and agricultural areas.
- **NON-MARKET ECOSYSTEM SERVICE & MARKET VALUES:** The economic value of the benefits provided by ecosystem services was assessed for each land cover type. The ecosystem valuation was based on the TEEB methodology set out in their Ecological and Economic Foundations report.[21] In addition, the market value for croplands has been estimated based on average net farm revenue per hectare in Ontario.

19 Southern Ontario Land Resource Information System (SOLRIS) 2000-2002. Science and Information Branch. Ontario Ministry of Natural Resources.

20 www.teebweb.org/EcologicalandEconomicFoundation/tabid/1018/Default.aspx Accessed June 2011.

21 Ibid.

- MAPPING OF LAND COVER AND ECOSYSTEM GOODS AND SERVICES: The distribution of land cover and land use in Rouge Park, the proposed Rouge National Park, and the surrounding watersheds were mapped. In addition, the average ecosystem service value per hectare by land cover type has been mapped spatially to provide a visual display of the distribution of natural capital values across the study areas.

Limitations of Benefits Monetization

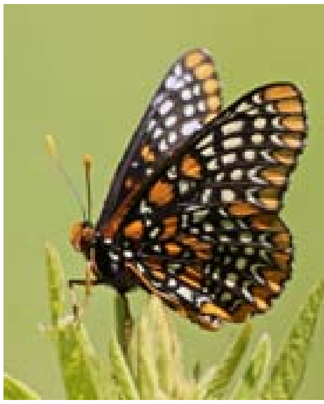
Identifying and developing economic values for ecosystem services is challenging because of limited availability of data and information. One of the key limitations for this study, and for non-market valuation in general, is the difficulty with fully monetizing all ecosystem service benefits that sustain the health and well-being of human communities.

In addition, benefits that are monetized have several limitations. Monetized values generally account for only a portion of the total benefits in each category. Furthermore, estimated values tend to be lower and more conservative because analysts err on the side of caution. This is most often due to the uncertainties of transferring values from other studies. As a result, the values reported in this study are conservative and likely under-estimate the full economic value of natural capital in the study area.

Another limitation is the application of constant values for benefit estimates. For example, values are applied linearly across landscapes and over time. This means that we assume that a benefit is the same value for each hectare of forest, per se, and that the value is the same each year, despite differences in forest quality and quantity. However, given that the benefit values are based on average ecosystem service inputs and often lower or average economic values, the valuation is applicable and meaningful.

The estimated values provided in this report are conservative for several reasons. The valuations are imperfect because our knowledge of *all* the benefits provided by nature is incomplete, and because without the earth's ecosystems and resources, life would be not be possible (i.e., the value of nature is priceless). It is also important to note that the value of natural capital and ecosystem services are likely to increase over time with increasing scarcity due to land use change (e.g., the ongoing loss of nature and farmland with urbanization) as well as the impacts of climate change.

Lastly, we did not consider the benefits to individuals residing outside of the study area when evaluating the recreational value of the Rouge's forests and other green space, nor the cultural value of its farmlands. As a result, our analysis tends to underestimate the total economic value of the Rouge and its surrounding watershed's natural capital.



We did not consider the benefits to individuals residing outside of the study area, nor the cultural value of its farmlands. As a result, our analysis tends to underestimate total economic value.

PHOTO TOP: (BALTIMORE CHECKERSPOT) COURTESY GARY YANKECH/FLICKR
PHOTO BOTTOM: COURTESY KWONG YEE CHENG/FLICKR

PART 5

Natural Capital Valuation Framework for Ecosystem Services Valuation

Typology of Ecosystem Services by Land Cover & Land Use

Some ecological economists called for the valuation of ecosystem *benefits* (e.g., recreation) rather than ecosystem *services* to avoid "double-counting" of values for an ecosystem.

PHOTO (CANADA DARNER) COURTESY GARY YANKECH/FLICKR

The development of conceptual frameworks and methodologies for ecosystem valuation has improved the ability to value natural capital. The United Nations' 2005 Millennium Ecosystem Assessment (MA) reported on the condition of the world's ecosystems and their ability to provide services today and in the future.[22] The MA framework focused on linkages between ecosystem services and human well-being, and categorized ecosystem services into four categories:

- Supporting services: nutrient cycling, soil formation and primary production;
- Provisioning services: food, fresh water, wood and fiber, and fuel;
- Regulating services: climate regulation, flood regulation, disease regulation and water purification;
- Cultural services: aesthetic, spiritual, educational and recreational services.

This typology provided a springboard for several subsequent initiatives and programs. However, some experts criticized the MA framework for including supporting services, such as nutrient cycling and soil formation, arguing that these contribute to the same end uses or "ecosystem benefits." Therefore, some ecological economists called for the valuation of ecosystem *benefits* (e.g., recreation) rather than ecosystem *services* to avoid "double-counting" of values for an ecosystem.

The Economics of Ecosystems and Biodiversity (TEEB) is an international initiative led by the United Nations, the European Commission, and the German and UK governments. The 2010 TEEB framework modifies the MA

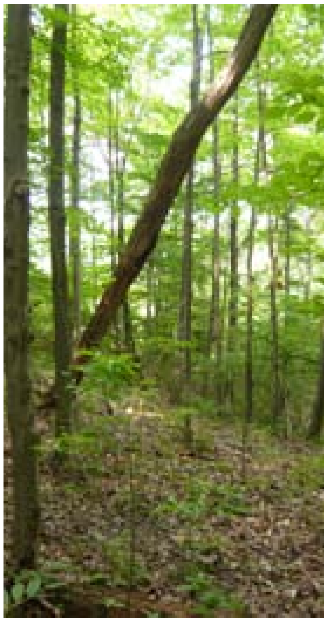
22 Millennium Ecosystem Assessment. 2005. *Ecosystems and Human Well-being: Synthesis*. Island Press. Washington, D.C.

approach in order to avoid "double-counting." TEEB emphasizes the difference between ecological *functions*, the *services* they contribute to human well-being, and the welfare *benefits* they generate.[23] As a result, TEEB is advancing a modified typology of ecosystem services. TEEB's typology for ecosystem services assumes that supporting services such as nutrient cycling are accounted for within the other ecosystem services. As a result, their revised typology excludes supporting services as individual services that were included in the MA typology, and adds habitat services as an additional category to reflect the importance of habitat for migratory species and for maintaining genetic pools (Table 1).

TABLE 1: TYPOLOGY FOR ECOSYSTEM SERVICES

Provisioning services	Regulating services	Habitat services	Cultural services
Food	Air quality regulation; climate regulation; moderation of extreme events	Maintenance of life cycles of migratory species	Aesthetic information
Water	Regulation of water flows	Maintenance of genetic diversity	Opportunities for recreation and tourism
Raw materials	Waste treatment		Inspiration for culture, art and design
Genetic resources	Erosion prevention		Spiritual experience
Medicinal resources	Maintenance of soil fertility		Information for cognitive development
Ornamental resources	Pollination		
	Biological control		

Source: Adapted from The Economics of Ecosystems and Biodiversity: The Ecological and Economic Foundations. September 2009 draft



Services can include products received from ecosystems (e.g., food, fibre, clean air and water), benefits derived from processes (e.g., nutrient cycling, water purification and climate regulation), and non-material benefits (e.g., recreation and aesthetic benefits).

PHOTO COURTESY BAD ALLEY/FLICKR

Identification of Ecosystem Services

Ecosystem services are the benefits derived from ecosystems. These benefits are dependent on ecosystem functions, which are the processes (physical, chemical and biological) or attributes that maintain ecosystems and the people and wildlife that live within them. Services can include products received from ecosystems (e.g., food, fibre, clean air and water), benefits derived from processes (e.g., nutrient cycling, water purification and climate regulation), and non-material benefits (e.g., recreation and aesthetic benefits).[24] Ecosystem services are often also referred to as ecosystem or ecological goods and services, however, this study is focused on non-market ecosystem services, so the term ecosystem services will be used throughout the report.

Ecosystem processes or functions characterize ecosystems. Using the classifications of ecosystem function from a number of published sources, the potential ecosystem services by an ecosystem type can be identified.

The TEEB typology for ecosystem services can be categorized by ecosystem type or landscape type. The potential ecosystem services provided by each ecosystem or land cover type, and the benefits provided are identified in Table 2.

23 Pascual, U., and Muradian, R. 2010. "The Economics of Valuing Ecosystem Services and Biodiversity." (Chpt. 5) in: *The Economics of Ecosystems and Biodiversity: The Ecological and Economic Foundation*. www.teebweb.org/EcologicalandEconomicFoundation/tabid/1018/Default.aspx Accessed Aug. 2010.

24 Millennium Ecosystem Assessment. 2003. *Ecosystems and Human Well-Being: A Framework for Assessment*. World Resources Institute, Island Press. Washington, D.C.

TABLE 2: ECOSYSTEM SERVICES AND POTENTIAL BENEFITS/VALUES BY ECOSYSTEM TYPE

Ecosystem/ Landscape Type	Ecosystem Services (Typology of ES from TEEB)	Potential Benefits for Human Well-being
Wetlands	Fresh water storage Water flow regulation Waste treatment Carbon storage Maintenance of life cycles of migratory species Maintenance of genetic diversity Cultural services Habitat services	Food provision Water supply Climate regulation Flood control Waste processing Amenity/tourism/recreation Cultural/heritage conservation Biological and genetic diversity Habitat provision
Lakes & Rivers	Fresh water storage Waste treatment Maintenance of life cycles of migratory species Maintenance of genetic diversity Cultural services Habitat services	Food provision Water supply Drainage and natural irrigation Transportation Biological and genetic diversity Amenity/tourism/recreation Cultural/heritage conservation
Forests	Water flow regulation Air quality regulation Carbon storage Water filtration Erosion prevention Soil fertility Pollination Biological control Cultural services Habitat services	Food provision Water supply Good air quality Climate regulation Flood control Pest control Erosion control Pollination of wild and cultivated plants Biological and genetic diversity Amenity/tourism/recreation Cultural/heritage conservation Habitat Provision
Grassland & Shrubland	Water flow regulation Air quality regulation Carbon storage Pollination Erosion prevention Soil fertility Habitat services	Climate regulation Flood control Erosion control Air quality Biological and genetic diversity Amenity/tourism/recreation Cultural/heritage conservation
Well-Managed Cultivated Areas	Pollination Carbon storage Erosion prevention Soil fertility	Provision of food Pollination of crops Erosion control Amenity and recreation Cultural/heritage conservation
Urban Green Space	Air quality regulation Water flow regulation Carbon storage Habitat services	Abatement of air/noise pollution Property enhancement Inspiration/spiritual enhancement Amenity/tourism/recreation Cultural/heritage conservation Habitat provision

Determining the non-market values for ecosystem services is much more difficult because they do not have an established price.

PHOTO (CRAB SPIDER) COURTESY GARY YANKECH/FLICKR

Valuation Approach

Measuring the value of goods or services is fairly straightforward when they have a market-determined value. However, determining the non-market values for ecosystem services is much more difficult because they do not have an established price, and there is often a lack of accurate ecological and economic information.

There are several techniques that have been developed to determine economic values for non-market ecosystem services. These include:

1) Direct market valuation approaches, such as 'market-based', 'cost-based' and 'production function-based' valuations;

2) 'Revealed preference' approaches, such as travel cost and hedonic pricing methods; and,

3) 'Stated preference' approaches, such as contingent valuation, choice modeling and group valuation methods.[25]

Direct market valuation methods use data from actual markets and reflect preferences or costs to individuals. Revealed preference techniques are based on the observation of individual choices that are related to the ecosystem service under study. Stated preference use surveys to assess the willingness to pay or accept compensation for a hypothetical change in supply of ecosystem services.

The TEEB framework recommends that values be derived from direct market valuation approaches where possible. In the absence of this information, price information can be derived from market information indirectly associated with the service. If both direct and indirect price information are not available, hypothetical scenarios created by stated preference methods can be used.[26]

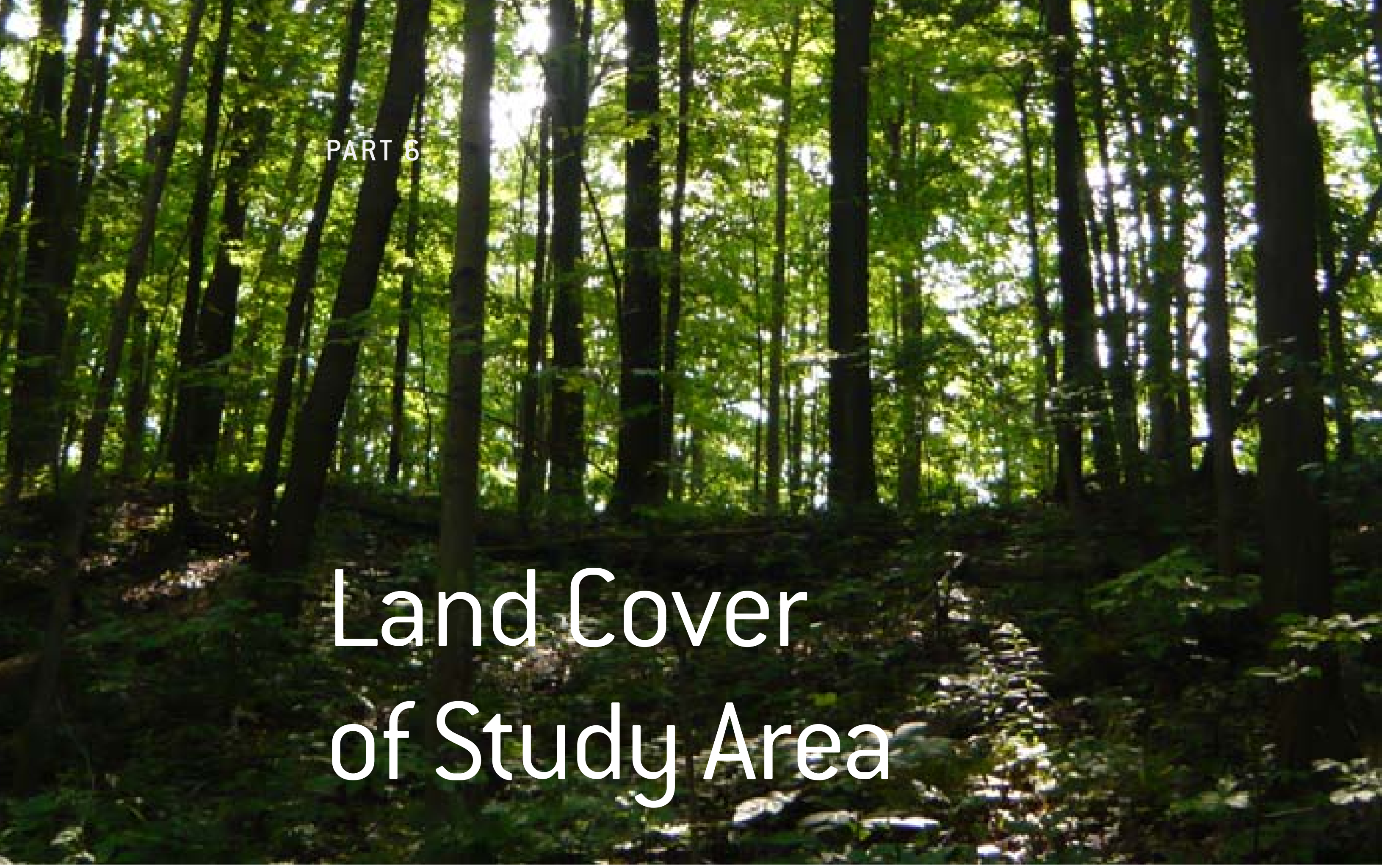
Cost-based valuation approaches, such as avoided cost and replacement cost, were used for this study wherever possible. For example, avoided damage cost estimates assess the value for ecosystem services based on what society would pay if ecosystems and their services were diminished or damaged. In other words, the value is estimated based on the cost of damages that would be incurred in the absence of those services. Replacement cost applies to ecosystem services that could be replaced using another natural source or human-made system. In the case of recreation, values were estimated based on revealed and stated preference methods.

In the case of recreation, values were estimated based on revealed and stated preference methods.

PHOTO TOP: (MYCENA LEAIANA) COURTESY GARY YANKECH/FLICKR
PHOTO BOTTOM: COURTESY MATTHEW ROUTLEY

25 Pascual, U., and Muradian, R., 2010. "The Economics of Valuing Ecosystem Services and Biodiversity." (Chpt. 5) in: *The Economics of Ecosystems and Biodiversity: The Ecological and Economic Foundation*. www.teebweb.org/EcologicalandEconomicFoundation/tabid/1018/Default.aspx Accessed Aug. 2011.

26 Ibid.



PART 6

Land Cover of Study Area

Land Cover & Land Use in Study Area

Land cover, ecosystems and land use within the study area were determined using geospatial data from the 2000-2002 Southern Ontario Land Resource Information System (SOLRIS).

PHOTO COURTESY BAY ALLEY/FLICKR

The total study area includes the Rouge, Duffins Creek and Petticoat Creek watersheds, covering 64,623 hectares (Table 3). Land cover, ecosystems and land use within the study area were determined using geospatial data from the 2000-2002 Southern Ontario Land Resource Information System (SOLRIS).[27] The study area contains three primary types of land cover:

- Agricultural lands (57 per cent);
- Built urban areas and roads (20 per cent) and urban green space (4 per cent);
- Natural ecosystems: forests (12 per cent) and wetlands (6 per cent).

All three watersheds have over half of their land base as agricultural lands; however, only a portion of these lands are currently being cultivated. In the Petticoat watershed, 62 per cent of land is classified as agricultural lands but only 42 per cent is cultivated as annual or mixed crops. In addition, 18 per cent of agricultural land is idle land that has not been cultivated for more than 10 years, 1.5 per cent is hedgerow, and 0.7 per cent is perennial or grazing lands. Annual and mixed croplands account for 35 per cent across all of the watersheds in the total study area.

27 Southern Ontario Land Resource Information System (SOLRIS) 2000-2002. Science and Information Branch. Ontario Ministry of Natural Resources.

TABLE 3: LAND COVER IN THE ROUGE, DUFFINS CREEK AND PETTICOAT CREEK WATERSHEDS (HECTARES)

Land cover	Rouge Watershed	Duffins Creek Watershed	Petticoat Watershed	Total Study Area	% of Total Land Cover
FOREST	**2,688.1**	**5,060.9**	**256.5**	**8,005.5**	12.4%
Coniferous Forest	510.6	1,285.1	57.9	1,853.6	2.9%
Deciduous Forest	1,326.0	2,432.6	165.8	3,924.4	6.1%
Mixed Forest	851.5	1,343.2	32.7	2,227.4	3.4%
WETLAND	**1,684.6**	**1,773.0**	**158.6**	**3,616.2**	5.6%
Shallow Water	8.8	0.0	0.0	8.8	0.0%
Bog	3.9	0.0	0.0	3.9	0.0%
Fen	0.6	0.0	0.0	0.6	0.0%
Marsh	101.6	115.5	14.8	231.9	0.4%
Swamp	1,569.7	1,657.5	143.9	3,371.1	5.2%
WATER/SHORELINE	**81.9**	**53.6**	**0.0**	**135.5**	0.2%
Open Water	73.1	53.6	0.0	126.7	0.2%
Open Shoreline	1.2	0.5	0.0	1.7	0.0%
AGRICULTURAL LANDS	**17,488.3**	**17,940.6**	**1,667.3**	**37,096.2**	57.4%
Annual Crop	5,845.9	5,745.6	827.4	12,418.9	19.2%
Mixed Crop	5,339.2	4,371.3	306.6	10,017.2	15.5%
Grazing Lands	689.6	1,445.6	18.7	2,153.9	3.3%
Hedgerows	584.3	306.5	39.2	930.1	1.4%
Idle Land	4,880.6	5,182.0	474.2	10,536.8	16.3%
Tree Plantations	148.6	889.4	1.2	1,039.3	1.6%
OTHER LAND USE	**11,352.2**	**3,824.2**	**600.2**	**15,776.6**	24.4%
Built-up Impervious	6,613.4	1,542.3	324.6	8,480.3	13.1%
Urban Green Space	1,927.1	615.8	33.0	2,575.9	4.0%
Extraction (includes restored areas within Rouge Park)	138.6	451.0	25.6	615.2	1.0%
Roads	2,673.1	1,215.1	217.1	4,105.3	6.4%
Grand Total	33,287.5	28,652.7	2,682.6	64,622.8	100.0%

The Duffins Creek watershed has the highest percentage of natural cover with 18 per cent forest cover and six per cent wetlands.

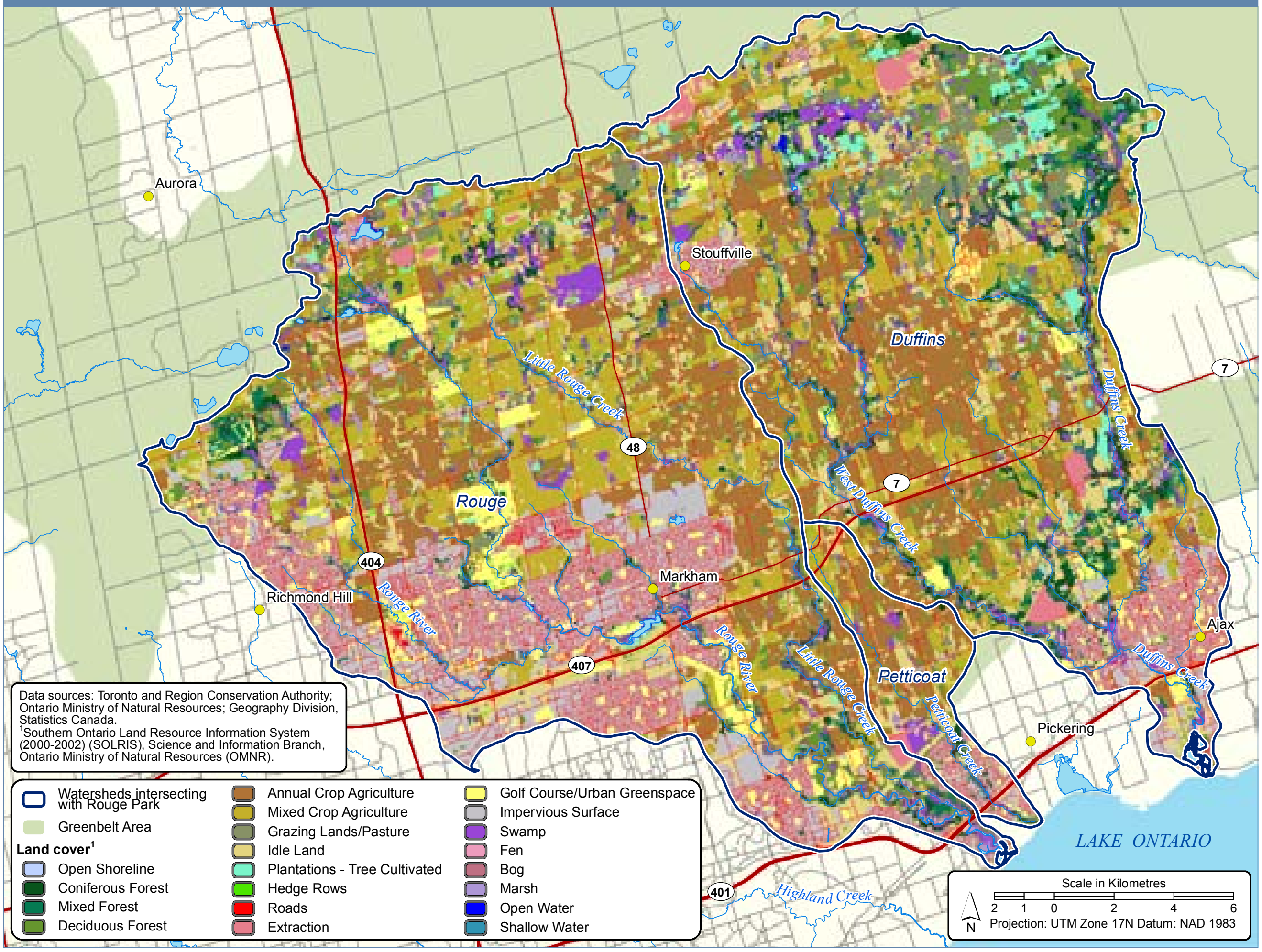
PHOTO (CALICO PENNANT) COURTESY GARY YANKECH/FLICKR

The Rouge watershed has the most built up areas with impervious (non-porous) surfaces, accounting for 20 per cent of the entire watershed, compared to five per cent of Duffins and 12 per cent of the Petticoat watersheds. Urban green space, including golf courses and recreational areas comprise six per cent of the Rouge, two per cent of Duffins, and one per cent of the Petticoat watersheds.

The Duffins Creek watershed has the highest percentage of natural cover with 18 per cent forest cover and six per cent wetlands.

The spatial distribution of the land cover across the study area is illustrated in the map on the following page (Figure 4).

FIGURE 4: LAND COVER & LAND USE IN THE ROUGE, PETTICOAT AND DUFFINS WATERSHEDS (SOLRIS 2000-2002)



Maps can be viewed in high resolution at www.davidsuzuki.org/rouge-landcover

The land cover in Rouge Park includes forests, wetlands, rivers, streams, lake shoreline, agricultural lands, restored lands and other land cover.

Land Cover of the Current Rouge Park

The total area of the existing Rouge Park in our study area is 3,890 hectares. This includes the area north and south of Steeles Avenue, Bob Hunter Memorial Park as well as the Toronto Zoo lands (260 hectares). Although the Toronto Zoo is generally not considered part of Rouge Park we have included it for the purposes of this study to be consistent with existing data from the Toronto Regional and Conservation Authority (TRCA).[28] Our land cover analysis found that the park area was about 24.5 hectares smaller than reported by the TRCA (3,914 hectares). This is a result of ArcMAP rounding the SOLRIS land cover area and averaging along the borders of the boundary.

The land cover in Rouge Park includes forests, wetlands, rivers, streams, lake shoreline, agricultural lands, restored lands and other land cover. Agricultural lands cover 59 per cent, forested land covers 21 per cent, wetlands cover 11 per cent and other land use covers nine per cent of the Park (Table 4).

28 Park boundary data received from Dan Clayton (TRCA) in April, 2011.

The land cover data also provides the following characteristics for Rouge Park:

- Most of the forest lands are deciduous forest (61 per cent), with smaller areas of coniferous (16 per cent) and mixed forest (23 per cent);
- Wetlands are mostly swamps (365 ha) with a small areas of marsh (49 ha);
- Agricultural lands include 37 per cent annual crops, 34 per cent idle lands, 24 per cent mixed crops, and four per cent grazing lands, pastures, meadows and hedgerows;
- There are 103 hectares of transportation corridors within the park boundary and 52 hectares of impervious cover such as Toronto Zoo lands and parking lots.

TABLE 4: LAND COVER TYPES IN ROUGE PARK

Land Cover/Land Use (SOLRIS 2002)[a]	North of Steeles Ave.	South of Steeles Ave.[b]	Toronto Zoo Lands	Total Rouge Park Area	% of Total Land Cover
FOREST	**141.4**	**552.6**	**110.3**	**804.3**	20.7%
Coniferous Forest	36.7	91.9	3.0	131.6	3.4%
Deciduous Forest	83.3	308.1	96.5	487.9	12.5%
Mixed Forest	21.4	152.6	10.8	184.9	4.8%
WETLAND	**65.2**	**312.1**	**36.2**	**413.5**	10.6%
Shallow Water	0.0	0.0	0.0	0.0	0.0%
Bog	0.0	0.0	0.0	0.0	0.0%
Fen	0.0	0.0	0.0	0.0	0.0%
Marsh	4.5	44.3	0.0	48.8	1.3%
Swamp	60.7	267.8	36.2	364.7	9.4%
WATER & SHORELINE	**0.0**	**6.4**	**0.0**	**6.4**	0.2%
Open Water	0.0	5.5	0.0	5.5	0.1%
Open Shoreline	0.0	1.4	0.0	1.4	0.0%
AGRICULTURAL LANDS	**1090.3**	**1167.8**	**52.4**	**2310.5**	59.4%
Annual Crop	473.0	383.6	0.0	856.6	22.0%
Mixed Crop	301.6	4.7	0.0	546.7	14.1%
Grazing Lands/Pasture	47.5	245.1	0.0	52.2	1.3%
Hedgerows	38.9	12.1	0.0	51.1	1.3%
Idle Land	223.5	517.4	52.4	793.3	20.4%
Tree Plantations	5.8	4.9	0.0	10.7	0.3%
OTHER LANDS	**14.4**	**278.9**	**60.9**	**354.2**	9.1%
Urban Impervious (e.g., Toronto Zoo lands, parking lots)	9.2	35.3	7.4	51.9	1.3%
Urban Green Space/ Golf Course	0.0	84.0	46.3	130.3	3.3%
Restored Landfill	0.0	68.8	0.0	68.8	1.8%
Roads	5.2	90.9	7.2	103.4	2.7%
Grand Total	1,311	2,318	260	3,890	100.0%

[a] Southern Ontario Land Resource Information System (SOLRIS) 2000-2002. Science and Information Branch. Ontario Ministry of Natural Resources

[b] Excludes Toronto Zoo lands.

There are 103 hectares of transportation corridors within the park boundary and 52 hectares of impervious cover such as Toronto Zoo lands and parking lots.

PHOTO (SEWELL RD.) COURTESY LONE PRIMATE/FLICKR

FIGURE 5: LAND COVER & LAND USE IN CURRENT ROUGE PARK (SOLRIS 2000-2002)

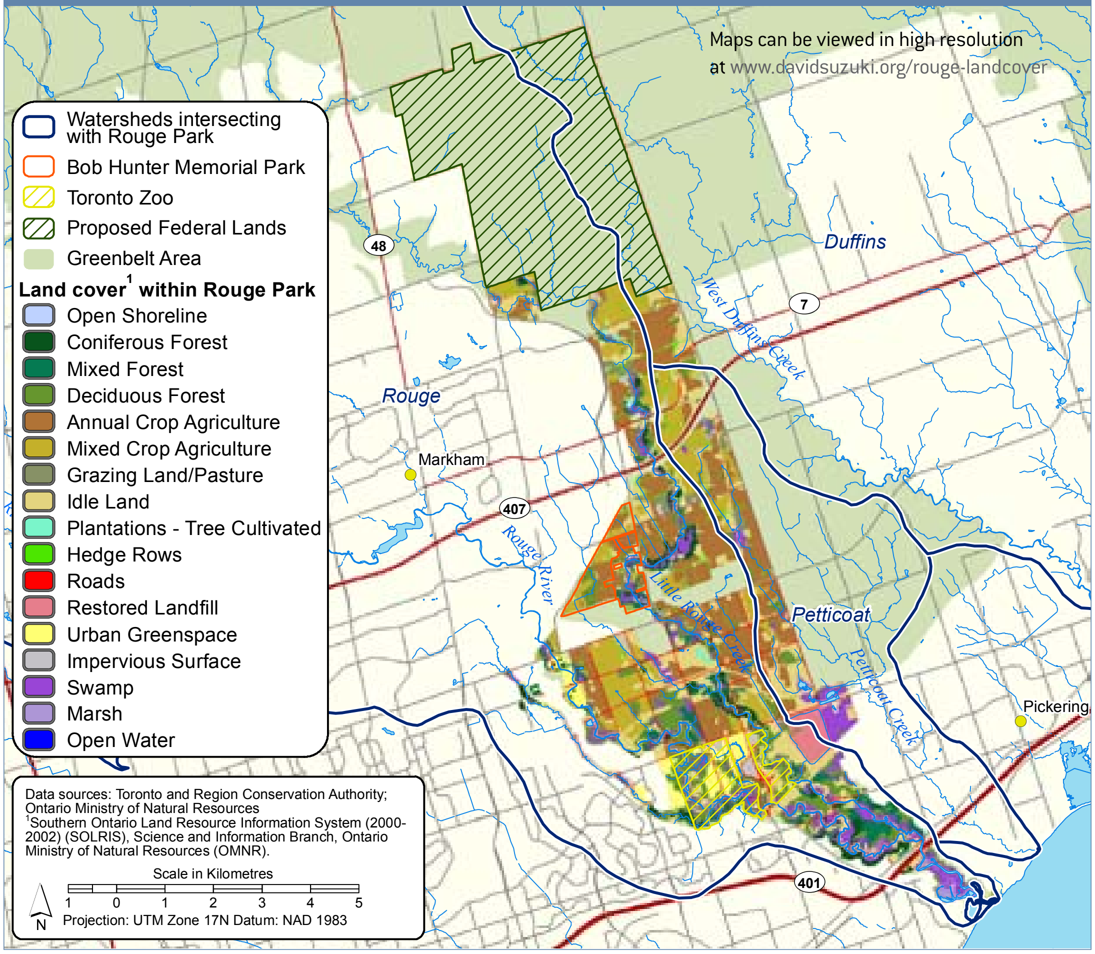


Figure 5 illustrates the spatial distribution of the land cover within Rouge Park and the Toronto Zoo. Forested areas and wetlands, mainly swamps, tend to dominate in the southern part of the park and along the Rouge River.

PHOTO (EASTERN GREY TREE FROG) COURTESY GARY YANKECH/FLICKR

Land Cover of the Proposed Rouge National Park

The proposed new Rouge National Park includes lands within the existing Rouge Park (3,890 hectares) plus 1,948 hectares of additional federal lands west of the York-Durham town-line in Markham. This includes 1,789 hectares of agricultural lands, 71 hectares of forests, 36 hectares of wetlands and 51 hectares of land in other land classes (e.g., parking lots) (Table 5).[29] Approximately half of the additional agricultural lands are cultivated for annual crops, 23 per cent are mixed crops and 17 per cent are classified as idle lands.

TABLE 5: LAND COVER TYPE AND AREA FOR ADDITIONAL LANDS PROPOSED FOR THE ROUGE NATIONAL PARK (SOLRIS 2000-2002)

Land Cover/Land Use Types	Additional Proposed Federal Areas for National Park	Total Proposed Area Rouge National Park (including current Park)
FOREST	71.4	875.7
Coniferous Forest	2.3	133.9
Deciduous Forest	59.9	547.9
Mixed Forest	9.1	194.0
WETLAND	36.4	449.9
Shallow Water	0.0	0.0
Bog	0.0	0.0
Fen	0.0	0.0
Marsh	0.0	48.8
Swamp	36.4	401.0
WATER & SHORELINE	0.0	5.5
Open Water	0.0	5.5
Open Shoreline	0.0	1.4
AGRICULTURAL LANDS	1789.0	4099.5
Annual Crop	963.5	1820.1
Mixed Crop	409.8	956.5
Grazing Lands/Pasture	63.1	115.3
Hedgerows	54.2	105.3
Idle Land	297.8	1091.1
Tree Plantations	0.5	11.2
OTHER LAND COVER	51.5	405.7
Urban Impervious	2.0	53.8
Urban Green Space/Golf Course	10.0	140.3
Restored Landfill	0.0	68.8
Roads	39.5	142.8
Grand Total	1948.2	5837.8

Approximately half of the additional agricultural lands are cultivated for annual crops, 23 per cent are mixed crops and 17 per cent are classified as idle lands.

PHOTO COURTESY MICHAEL GIL/FLICKR

29 Based on the proposed boundaries recommended by the Rouge Park Alliance and currently under consideration by Parks Canada as the proposed study area for Rouge National Park: StrategyCorp – Hemson Consulting. 2010. *Governance, Organization and Financial Review of the Rouge Park Alliance*. Rouge Park Alliance Governance Review. Rouge Park Alliance. Toronto, Canada.

FIGURE 6: LAND COVER & LAND USE FOR PROPOSED ROUGE NATIONAL PARK (SOLRIS 2000-2002)

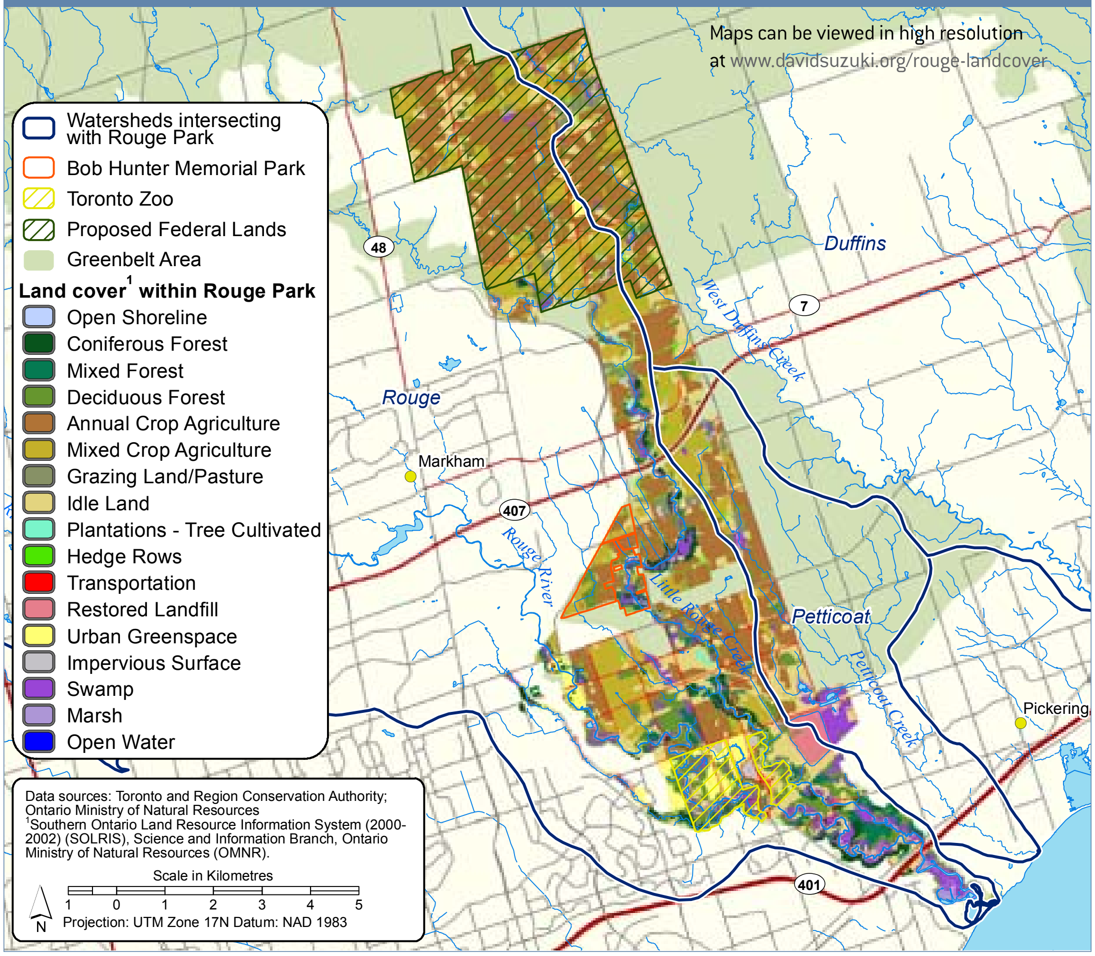


Figure 6 shows the spatial distribution of the land cover and land use across the proposed Rouge National Park, which includes the current Rouge Park and additional federal lands.

PHOTO (HUMMINGBIRD CLEARWING MOTH) COURTESY GARY YANKECH/FLICKR

PART 7

Ecosystem Services of the Rouge Study Area

Our report was designed to provide an assessment of the non-market ecosystem services provided by the existing Rouge Park, the proposed Rouge National Park and the surrounding watersheds in the GTA. This report focuses on non-market values for natural capital because they are generally unaccounted for as socio-economic benefits.

This report focuses on non-market values for natural capital because they are generally unaccounted for as socio-economic benefits.

PHOTO COURTESY BAD ALLEY/FLICKR

Climate Regulation

Climate regulation benefits include both the storage and annual sequestration of carbon. Carbon storage refers to the carbon that is held in biomass and soils of an ecosystem. Carbon sequestration refers to the process that removes carbon from the atmosphere and accumulates it in an ecosystem. As a result, carbon storage is reported as tonnes of carbon per hectare, whereas carbon sequestration is reported as a rate of accumulated tonnes of carbon per hectare per year.

Over half of the global carbon stored in land-based ecosystems is currently stored in forests. Forests store enormous amounts of carbon in standing trees and in the soil because of their cumulative years of growth.[30] Trees remove carbon dioxide from the atmosphere and convert it into organic compounds, such as cellulose and lignin – the main components of wood. About half of the weight of wood is carbon, and every kilogram of carbon in a tree represents almost four kilograms of carbon dioxide removed from the atmosphere. As a result forests have the ability to reduce the build-up of atmospheric greenhouse gases and contribute to efforts to reduce global climate change.

Southern Ontario's forests are found within the Cool Temperate (CT) and Moderate Temperate (MT) eco-climatic zones. The Rouge and surrounding watersheds are within the MT zone, which store an average of 340

30 Pregitzer, K.S., and Euskirchen, E.S. (2004). "Carbon cycling and storage in world forests: biome patterns related to forest age." *Global Change Biology*. 10:2052-2077.

tonnes of carbon per hectare.[31] Based on this average carbon content, the total carbon stored by Rouge Park's forests is approximately 273,311 tonnes of carbon, or one million tonnes CO_2e (carbon dioxide equivalent[32]).[33] This is the equivalent of the greenhouse gas emissions produced by 86,765 households, or 196,498 cars driven for one year.[34] In addition, tree plantations and hedgerows were assumed to store about 50 per cent of the carbon storage compared to natural forest cover (i.e., an average of 170 tonnes of carbon/hectare). As a result, it was estimated that plantations and hedgerows store 10,500 tonnes of carbon.

Using the average carbon value ($74.85/tonne of carbon), explained in Section 7.2 below, the 283,812 tonnes of carbon stored by Rouge Park's forests, plantations and hedgerows was worth an estimated $21.2 million based on the 2000-2002 SOLRIS data (C$2011). Carbon stored by forests was worth $920 per hectare per year, and carbon stored by plantations and hedgerows was worth $460 per hectare per year. The annual value of this carbon stored by forests, plantations and hedgerows was estimated to be $768,144 per year, based on an annuity coefficient.[35]

Extrapolated to the total study area, the total carbon stored by forests was an estimated 2.7 million tonnes of carbon, or 9.9 million tonnes CO_2e. This is the equivalent of the energy used by 857,413 households or 1.9 million cars driven over one year.

PHOTO COURTESY SPIRITFLARE/FLICKR

Extrapolated to the total study area, the total carbon stored by forests was an estimated 2.7 million tonnes of carbon, or 9.9 million tonnes CO_2e (carbon dioxide equivalent).[36] This is the equivalent of the energy used by 857,413 households or 1.9 million cars driven over one year.[37] In addition, there were 1,969 hectares of plantations and hedgerows, estimated to store 334,593 tonnes of carbon.

Using the average carbon value ($74.85/tonne of carbon) defined in Section 7.2, the carbon stored by the total study area's forests, plantations and hedgerows was worth an estimated $228.6 million based on the 2000-2002 SOLRIS data (C$2011). The annual value of the carbon stored by forests, plantations and hedgerows was estimated to be $8.3 million per year, based on an annuity coefficient.[38]

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31 Kurz, and Apps 1999. "A 70-Year Retrospective of Carbon Fluxes in the Canadian Forest Sector." *Ecological Applications*. 9:526-547.

32 A metric measure used to compare the emissions from various greenhouse gases based upon their global warming potential.

33 Author's calculations: multiplied the area for forested lands from SOLRIS (2000-2002) in the Rouge Park derived by spatial land cover analysis by the carbon content estimates for the Moderate Temperate eco-climatic province (340 tonnes of carbon/hectare). Estimated that plantations and hedgerows store about 50 per cent of average stored by natural forest cover (170 tonnes of carbon/hectare). Carbon estimated from: Kurz, and Apps 1999. "A 70-Year Retrospective of Carbon Fluxes in the Canadian Forest Sector." *Ecological Applications*. 9: 526-547.

34 Calculated using The U.S. EPA Greenhouse Gas Equivalencies Calculator; 5.1 metric tons CO_2E /passenger car/year; Source: EPA (2009). Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2007. Chapter 3 (Energy), Tables 3-12, 3-13 and 3-14. U.S. Environmental Protection Agency, Washington, D.C. U.S. EPA #430-R-09-004 (PDF). www.epa.gov/cleanenergy/energy-resources/calculator.html

35 In order to assess the annual value, the carbon stored by forests was considered as an investment over 100 years at 3.5 per cent. An annuity calculation was used, so that the annuity coefficient (0.03616) was multiplied by the total carbon value amount to estimate a yearly value for the carbon stored. Adapted from the annuity approach developed by Mark Anielski in: Anielski, M., and Wilson, S.J. 2009 (update). *Counting Canada's Natural Capital: Assessing the Real Value of Canada's Boreal Ecosystems*. Pembina Institute and The Canadian Boreal Initiative. Canada. www.pembina.org/pub/204 Accessed March 2012.

36 Author's calculations: multiplied the area for forested lands from SOLRIS (2000-2002) in the Rouge Park derived by spatial land cover analysis by the carbon content estimates for the Moderate Temperate eco-climatic province (340 tonnes of carbon/hectare). Carbon estimated from: Kurz, and Apps 1999. "A 70-Year Retrospective of Carbon Fluxes in the Canadian Forest Sector." *Ecological Applications*. 9: 526-547.

37 Calculated using The U.S. EPA Greenhouse Gas Equivalencies Calculator; 4.62 metric tons CO_2E /passenger car/year; Source: EPA (2003). *U.S. Inventory of Greenhouse Gas Emissions and Sinks 1990-2001*. Office of Atmospheric Programs, U.S. Environmental Protection Agency, Washington, D.C. EPA 430-R-03-004. www.epa.gov/cleanenergy/energy-resources/calculator.html

38 In order to assess the annual value, the carbon stored by forests was considered as an investment over 100 years at 3.5 per cent. An annuity calculation was used. So that the annuity coefficient (0.03616) was multiplied by the total carbon value amount to estimate a yearly value for the carbon stored. Adapted from the annuity approach developed by Mark Anielski in: Anielski, M., and Wilson, S.J. 2009 (update). *Counting Canada's Natural Capital: Assessing the Real Value of Canada's Boreal Ecosystems*. Pembina Institute and The Canadian Boreal Initiative. Canada. www.pembina.org/pub/204 Accessed March 2012.

Economic Value of Carbon

The economic value of carbon can be estimated based on several different valuation methods. These include estimating the avoided costs of climate change impacts, the replacement cost to replace natural carbon storage and sequestration services, or the market price of carbon.

In order to estimate the value of carbon for this study, an average value was calculated based on multiple sources of market and social carbon cost estimates. The estimated carbon value, inflated to 2011 dollars, is $74.85 per tonne of carbon. The following carbon values were included in this estimate:

- The Alberta government's Emission Reduction Regulations for large industrial emitters has set a carbon price (as a contribution to Climate Change and Emissions Management Fund) at $15 per tonne of CO_2e (carbon dioxide equivalent), which is equal to $55.05 per tonne of carbon (constant price).[39]
- In British Columbia, the 2011 carbon tax rate was $25 per tonne of CO_2 or $91.75 per tonne of carbon.[40]
- Environment Canada has used a social carbon cost estimate of $25 per tonne of CO_2e, equal to $91.75 per tonne of carbon ($93.86/tonne in 2011 dollars), in its Regulatory Impact Analysis Statement on the Renewable Fuels Regulations.[41]
- The U.S. government social carbon cost estimates range from $5 to $65 per U.S. ton of CO_2e (2007 U.S. dollars), with a central value of $21 per U.S. ton of CO_2e (2007 U.S. dollars), equal to $75.15 per metric tonne of carbon (2011 Canadian dollars).[42]
- The United Nations Intergovernmental Panel on Climate Change reported that the average social cost of carbon (including environmental, economic and social costs), based on the impacts of climate change, was C$52 per tonne of carbon in 2005 ($58.09/tonne in 2011 dollars).[43]

The carbon stored by the total study area's forests, plantations and hedgerows was worth an estimated $228.6 million.

PHOTO COURTESY VLAD LITVINOV/FLICKR

39 Specified Gas Emitters Regulation (SGER), under Alberta's Emission Reduction Regulations, requires 12 per cent reduction in emissions intensity from facilities that emit greater than 100,000 tonnes of CO_2e. Compliance may be achieved through emissions performance credits, generation or purchase of offsets or contribution to the Climate Change Technology Fund at a price of $15 per tonne of carbon dioxide equivalent. http://environment.alberta.ca/02486.html Other country programs in comparison have higher prices: Finland at $89.39/t carbon (US dollars) and Sweden at $150/t carbon.

40 B.C. Ministry of Finance, "How the Carbon Tax Works," www.fin.gov.bc.ca/tbs/tp/climate/A4.htm

41 Environment Canada. 2011. Regulatory Impact Analysis Statement. Regulations Amending the Renewable Fuels Regulation.145: 9. (February 26, 2011) www.gazette.gc.ca/rp-pr/p1/2011/2011-02-26/html/reg3-eng.html#REF22 Sensitivity analysis ranging from $10 to $100 per tonne of CO_2e, equal to $36.70 to $367.00 per tonne of carbon (2010 dollars).

42 In the U.S., carbon and CO_2e is reported per ton, rather than metric tonne. The value per ton of CO_2e was converted to dollars per metric tonne (1 ton = 0.907 metric tonne), then converted to Canadian dollars (www.bankofcanada.ca/rates/exchange/10-year-converter/), then converted to Canadian dollars per tonne of carbon (1 tC = 3.67 tCO_2), and then converted to 2011 Canadian dollars per tonne of carbon (using Bank of Canada online inflation calculator).

43 M.L Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, (Eds.). 2007. *Summary for Policymakers.* In: *Climate Change 2007: Impacts, Adaptation and Vulnerability.* Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. IPCC. Cambridge University Press. Cambridge, UK, 7-22.

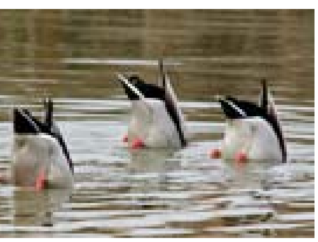
Annual Carbon Uptake (Sequestration) by Forests

Carbon sequestration refers to the annual amount of carbon uptake by an ecosystem. In the 2008 Ontario Greenbelt study, the annual uptake of carbon was assessed using a spatially based Geographic Information Systems software tool called CITYgreen.[44] CITYgreen's carbon module quantifies the removal of carbon dioxide by trees based on the estimated age distribution of forest land cover by assigning three Age Distribution Types.[45] Type 1 represents a distribution of young trees, type 2 represents older trees, and type 3 describes a site with a balanced distribution of ages. Each type is associated with a multiplier (i.e., tonnes of carbon taken up per hectare), which is used to calculate the site's canopy and to estimate how much carbon is sequestered on an annual basis.

The CITYgreen analysis for the Greenbelt study estimated that the carbon annually sequestered is an average of 0.75 tonnes of carbon per hectare. Rouge Park is part of the Greenbelt, so the average results from the CITYgreen analysis were applied to our study area. Therefore, the annual carbon sequestered by the forest cover in Rouge Park is an estimated 603 tonnes of carbon; a value of $45,153 per year or $56.14 per hectare. In addition, plantations and hedgerows sequestered an estimated 46 tonnes of carbon per year, worth $3,470 per year.

The total study area's forest cover sequestered an estimated 6,004 tonnes of carbon per year; a value of $449,406 per year or $56.14 per hectare. In addition, plantations and hedgerows sequestered an estimated 1,477 tonnes of carbon, worth $110,555 per year.

Carbon Stored by Wetlands



Rouge Park wetlands cover is made up of swamps (365 hectares) and marshes (49 hectares).

PHOTO (MALLARDS) COURTESY GARY YANKECH/FLICKR

Wetlands store carbon in their soils and peat. Carbon storage by wetlands was determined for this study based on results from the 2008 Ontario Greenbelt study, which extracted data from the 1996 Canada's Soil Organic Carbon Database.[46] According to this database, the Greenbelt's wetlands stored between 111 tonnes and 334 tonnes of carbon per hectare, depending on the type of wetland (i.e., bog, marsh, swamp and fen).[47]

This study area is part of the Greenbelt, so we have applied the average carbon stored per hectare by wetland type. Rouge Park wetlands cover is made up of swamps (365 hectares) and marshes (49 hectares). As a result we estimated that the total carbon stored by Rouge Park's wetlands is 47,254 tonnes (111 tonnes of carbon per hectare of swamp; 137.8 tonnes of carbon per hectare of marsh). This carbon storage is worth over $3.5 million based on the 2000-2002 SOLRIS wetland cover data ($74.85 per tonne of carbon; see Section 7.2), or $127,894 per year when converted to an annual value.[48]

The total study area's wetlands cover a total of 3,616 hectares, including 3,371 hectares of swamps, 232 hectares of marshes, 8.8 hectares of shallow water wetlands, 3.9 hectares of bog, and 0.6 hectares of fen. These wetlands stored an estimated 409,321 tonnes of carbon based on the 2000-2002 SOLRIS wetland cover data, worth over $30.6 million or 1.1 million per year.[49]

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44 Wilson, S.J. 2008. *Ontario's Wealth, Canada's Future: Appreciating the value of the Greenbelt's eco-services*. David Suzuki Foundation. Vancouver, B.C.

45 American Forests. CITYgreen software ArcGIS 8.x http://rfflibrary.wordpress.com/2009/08/04/citygreen-a-free-windows-based-arcgis-extention-for-ecosystem-services-valuation/

46 Tarnocai, C., and B. Lacelle. 1996. Soil Organic Carbon Database of Canada. Eastern Cereal and Oilseed Research Centre, Research Branch, Agriculture and Agri-Food Canada, Ottawa, Canada.

47 Wilson, S.J. 2008, supra note 44.

48 To assess the annual value, the carbon stored by forests was considered as an investment over 100 years at 3.5 per cent. An annuity calculation was used. The annuity coefficient (0.03616) was multiplied by the total carbon value amount to estimate a yearly value for the carbon stored. Adapted from the annuity approach developed by Mark Anielski in: Anielski, M., and Wilson, S.J. 2009 (update). *Counting Canada's Natural Capital: Assessing the Real Value of Canada's Boreal Ecosystems*. Pembina Institute and The Canadian Boreal Initiative. www.pembina.org/pub/204 Accessed March 2012.

49 Ibid.

Carbon Stored by Croplands

Organic carbon stored in agricultural soils was assessed using spatial analysis of the Canadian Soil Organic Carbon Database from the 2008 Ontario Greenbelt study.[50] The Greenbelt study's average soil carbon content for agricultural soils was 83 tonnes of carbon per hectare.[51] We applied the average soil organic carbon content to Rouge Park's agricultural land cover to estimate the soil carbon stored by croplands, grazing lands and pasture (perennial cover), and idle lands. The total estimated carbon stored in the Park's agricultural soils was 185,785 tonnes, worth over $13.9 million; or an annual value of $502,832 per year over 100 years, or $224 per hectare per year.

The total study area has 35,127 hectares of croplands, grazing lands and pasture (perennial cover), and idle lands, according to the 2000-2002 SOLRIS. The estimated soil carbon stored by croplands, grazing lands and pasture (perennial cover), and idle lands was 2.9 million tonnes, worth an estimated $217 million, or an annual value of $7.8 million per year over 100 years, or $224 per hectare per year.

This value does not reflect the impact of agricultural land use on the carbon released due to conversion of land for farming or the carbon released due to farming practices, such as tillage. When native land is first converted, there is an immediate loss of soil organic carbon. A recent study reported that on average, conversion of native land to cropland results in a loss of 24 tonnes of carbon per hectare (plus or minus six per cent).[52] More is lost by normal tillage practices when they are not offset by rotations with forages, cover crops or manure additions. Decreasing erosion, reducing tillage intensity, reducing summer fallow, using cover crops, spreading manure effectively, and periodically producing forages and crops that leave large amounts of residue are techniques that can be used to reduce soil organic carbon losses or increase gains. These practices need to be preferentially applied to soils that have a combination of low and declining levels of soil organic carbon.

Agricultural practices have improved across Canada since the 1980s through the adoption of conservation tillage and no-till practices. For example, the majority of Canada's croplands had increasing soil organic carbon between 1996 and 2006. However, the increases were mostly seen in the Prairies and western Canada, whereas in Ontario and eastern Canada there was an overall loss in soil organic carbon from 1981 to 2006.[53] These losses were mostly the result of the conversion of pastures and hay lands to annual croplands. The average change in soil organic carbon on Ontario croplands was a loss of 89 kilograms of carbon per hectare per year in 2006.

Due to the average changes on Ontario croplands being a loss of carbon, we have not attributed a carbon sequestration value to croplands in the study area. However, we have estimated that perennial grazing lands and idle lands are sequestering soil carbon because of their continuous plant cover, plant residues and the absence of tillage. As such, we estimated the annual increases in carbon sequestration on these land classes to be 0.5 tonnes of carbon per hectare (1.79 tonnes of CO_2 per hectare per year), based on the reported increase in carbon sequestration resulting from a change from conventional crop tillage to permanent vegetative cover for the Grand River Watershed in southern Ontario.[54] The annual carbon sequestered is worth $36.51 per hectare based on the carbon value of $74.85 per tonne of carbon (see Section 7.2). A total annual value of $30,864 for the Rouge Park and $463,305 per year for the total study area.

When native land is first converted, there is an immediate loss of soil organic carbon. A recent study reported that on average, conversion of native land to cropland results in a loss of 24 tonnes of carbon per hectare (plus or minus six per cent).

PHOTO COURTESY APPLETREECAFE/FLICKR

50 Tarnocai, C. and Lacelle, B. 1996, supra note 46.

51 Wilson, S.J. 2008, supra note 44. Note: Only includes estimated soil carbon per hectare for mixed crop, annual crop, perennial crop and idle land classes. Hedgerows are included in the forest cover in this study, and there are no vineyards or orchards in this study area.

52 Vanden-Bygaart, A.J., Gregorich, E. G., and Angers, D. A. 2003. "Influence of Agricultural Management on Soil Organic Carbon: A Compendium and Assessment of Canadian Studies." *Canadian Journal of Soil Science*. Agriculture and Agri-Food Canada. Ottawa, Canada.

53 Environment Canada 2009. Land Use, Land-Use Change, and Forestry pp. 163-195 In National Inventory Report: Greenhouse Gas Sources and Sinks in Canada 1990-2007, Greenhouse Gas Division, Environment Canada, Gatineau, QC.

54 Olewiler, N. 2004. *The Value of Natural Capital in Settled Areas of Canada*. Ducks Unlimited Canada and the Nature Conservancy of Canada. Ottawa, Canada.

A review of innovative government programs that can be employed to support better soil carbon-management and other practices by agricultural producers is presented in Appendix 1.

Clean Air

By absorbing and filtering nitrogen dioxide, sulfur dioxide, ozone, carbon monoxide, and particulate matter in their leaves, urban trees perform a vital service that directly affects the well-being of humans.

PHOTO (CEDAR WAXWING) COURTESY PEARL VAS/FLICKR

Trees produce oxygen and improve air quality by absorbing pollution and airborne particles in their leaves. By absorbing and filtering nitrogen dioxide, sulfur dioxide, ozone, carbon monoxide, and particulate matter less than 10 microns (PM10) in their leaves, urban trees perform a vital service that directly affects the well-being of humans. Studies show that trees can remove eight to 12 grams of air pollutants per square metre of tree canopy cover.[55]

In the Ontario Greenbelt study, CITYgreen software was used to assess the amount of air pollutants removed by the tree canopy cover across the Greenbelt study area, based on the air quality within the Greater Toronto Area.[56] It calculated that trees in the Greenbelt removed about 60 kilograms of pollutants per hectare per year, including 1.2 kg of carbon monoxide, 4.2 kg of sulfur dioxide, 7.5 kg of nitrogen dioxide, 16.8 kg of particulate matter and 30.3 kg of ozone.[57] To calculate the value of filtering these pollutants, CITYgreen used the United States Public Services Commission's estimates of national average indirect costs of reduced air quality, including rising health care expenditures and reduced tourism revenue.

We applied the removal rates and values to our study area's forests, tree plantations and hedgerows, assigning only 50 per cent of the removal rate to the latter two cover types. Using these rates, we estimated that 48,260 kilograms of pollutants were removed by the Rouge Park's forests and 1,854 kilograms by plantations and hedgerows.

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55 Nowak, D.J., Wang, J., and Endreny, T. 2007. "Environmental and Economic Benefits of Preserving Forests within Urban Areas: Air and Water Quality." In: *The Economic Benefits of Land Conservation*. The Trust for Public Land. San Francisco, California. www.tpl.org/publications/books-reports/park-benefits/the-economic-benefits-of-land.html Accessed April 2012.

56 Nowak, D.J. and Crane, D.E. 2000. The Urban Forest Effects (UFORE) Model: quantifying urban forest structure and functions. In M. Hansen and T. Burk, eds. Proceedings: Integrated tools for natural resources inventories in the 21st century. IUFRO Conference, 16-20 August 1998, Boise, ID; General Technical Report NC-212, U.S. Department of Agriculture, Forest Service, North Central Research Station, St. Paul, MN. pp. 714-720.

57 Wilson, S.J. 2008. *Ontario's Wealth, Canada's Future: Appreciating the value of the Greenbelt's eco-services*. David Suzuki Foundation. Vancouver, B.C.

The total estimated annual value provided by this service is equal to $382,057 per year, or $475 per hectare per year of natural forest cover plus $14,679, or $237.50 per hectare of plantation and hedgerow cover (2011$).

The forest cover across the total study area removed an estimated 480,343 kilograms of pollutants, and plantation and hedgerow cover removed an additional 59,082 kilograms. The annual value of this service for the total study area was an estimated $3.8 million per year for forests, plus $467,730 for plantations and hedgerows.

Flood Prevention & Water Regulation

Forests and wetlands regulate the flow of water in a watershed. This provides protection against flooding, soil loss and erosion. The loss of forest and wetland cover also leads to reduced infiltration and increased peak flows. In other words, forest and wetland loss can result in: lower water levels in dry seasons; higher than normal water levels in wet seasons or storms; increased soil erosion and sedimentation; and increases in water temperatures, which all can negatively affect aquatic ecosystems.[58]

Research demonstrates that forests and tree cover significantly improve the quality of water in a watershed. Studies by the United States Environmental Protection Agency show that forests in rural areas improve water quality because trees divert rainwater through the soil where bacteria and micro-organisms filter out pollutants.[59] This filtering significantly reduces the sediment, pollutants and organic matter that reach streams and rivers. Riparian forests (i.e., forested buffers along waterways) are especially effective at reducing non-point source pollution, such as nitrogen in agricultural runoff.

Research demonstrates that forests and tree cover significantly improve the quality of water in a watershed.
PHOTO COURTESY BAY ALLEY/FLICKR

Forest cover and wetlands, therefore, provide green infrastructure services for the Rouge study area. For this study, we have adopted the average additional water storage provided by forest cover, and the replacement cost converted to 2011$ ($64.02/cubic metre) from the Greenbelt study based on the conversion of forest/tree cover for urban development.[60] As a result, Rouge Park forest cover provides storage for 246,510 cubic metres of storm water runoff, worth $15.8 million, or $570,651 per year ($709.47/hectare/year) over 100 years at 3.5 per cent. We used the annuity calculation applied to the carbon value, to estimate the annual value for the storm water runoff benefit. Applied to the total study area's forested land cover area, the benefit is equal to $5.7 million per year.

This value was also attributed to plantations and hedgerows at 50 per cent ($354.74/hectare/year). As a result, the plantation and hedgerow cover provides a benefit of $21,925 per year in Rouge Park, and a total of $698,588 in the total study area ($354.74/hectare/year).

If we wanted to assess the costs for a loss in a portion of forest cover, the benefit value for storm water regulation could be used to assess the costs of proposed land use change. For example, if 10 per cent of the study area's forest land cover was converted to urban land use, the replacement cost in terms of water regulation (i.e., stormwater management) would be an estimated $567,966 (calculated as 10 per cent of total study area forest cover multiplied by annual benefit of $709.47 per hectare).

The CITYgreen program also evaluated the cost of conversion of forest cover to cropland. The additional stormwater storage when forest land cover is compared to cropland is 118.5 cubic metres per hectare. Therefore, the annual value is an estimated $274.40 per hectare of forest cover, when comparing additional benefits between these two land cover types. As a result, if 10 per cent of forest cover were converted to croplands, the cost would be $219,669. All values are in 2011 dollars.

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58 Committee on Hydrologic Impacts of Forest Management. 2008. Hydrological Effects of a Changing Forest Landscape. Water Science and Technology Board. National Research Council of the National Academies. Washington, D.C. http://dels.nas.edu/Report/Hydrologic-Effects-Changing-Forest/12223 Accessed: April 2012

59 U.S. EPA 2007. *Reducing Stormwater Costs Through Low Impact Development Strategies and Practices. Nonpoint Source Control Branch. US Environmental Protection Agency.* www.epa.gov/owow/NPS/lid/costs07/ Accessed April, 2012.

60 Wilson, S.J. 2008, supra note 57.

Value of Flood Control by Wetlands

Wetlands also regulate the flow of water providing protection against flooding and erosion. Wetlands act as natural retention reservoirs for water, slowing the release of water and replenishing base flows for groundwater. The annual value of flood control by wetlands is based on a conservative global average ($867.95 per hectare; 2011$) derived from a global meta-analysis of values provided by wetlands.[61] Based on this average, the annual value of flood control services provided by wetlands is an estimated $358,902 per year within Rouge Park and over $3.1 million annually for the total study area.

Waste Treatment

Wetlands across the total study area have an estimated capacity to remove 290,381 kilograms of phosphorus and 1.3 million kilograms of nitrogen each year, based on the low-end removal rates.

PHOTO COURTESY FRIENDS OF THE ROUGE WATERSHED

Wetlands can absorb nutrients such as nitrogen and phosphorus that run-off farmlands because of fertilizer and manure use, and from livestock. The amount that a wetland can absorb varies depending on the wetland type, size, plants and soils.

Estimates range from 80 to 770 kilograms per hectare per year for phosphorus removal, and 350 to 32,000 kilograms per hectare per year for nitrogen removal.[62] We applied the lower removal rates to the wetland cover in Rouge Park and the surrounding watersheds, to estimate the wetlands capacity for waste removal.[63] As a result, wetland cover in Rouge Park has an estimated capacity to remove 33,204 kg of phosphorus and 144,727 kg of nitrogen. Wetlands across the total study area have an estimated capacity to remove 290,381 kilograms of phosphorus and 1.3 million kilograms of nitrogen each year, based on the low-end removal rates.

For the study area, we estimated nitrogen loss from croplands based on an annual loss of 10 to 20 kilograms nitrogen per hectare (i.e., the risk class reported for the majority of Ontario's farmlands).[64] As a result, the estimated nitrogen loss from croplands in Rouge Park ranges from 14,033 to 28,066. Estimated nitrogen losses from croplands across the study area range from 224,361 kilograms to 448,722 kilograms of nitrogen.

The costs of removing nitrogen and phosphorus by waste treatment plants have been estimated to range from $3.49 to $9.90 per kilogram of nitrogen, and $25.62 to $71.05 (2011$) per kilogram of phosphorus (2011$).[65] Using the low-end cost ($3.49 per kilogram) as a proxy for the value of wetland waste treatment services for excess nitrogen, the annual value is $118.44 per hectare of wetland in Rouge Park. Based on the wetland and cropland area across the total study area, the value of nitrogen removal is $216.53 per hectare (range of $216.53 to $433.06/hectare/year).

Information on the risk of water contamination by phosphorus is not available at the provincial level for Ontario. However, the Canadian national average for excess phosphorus runoff from croplands is 14.3 kilograms per hectare per year. Using the national average, an estimated 320,836 kilograms of excess phosphorus may run off croplands in the Rouge study area, including 20,067 kilograms from croplands in Rouge Park. Based on a low-end estimate, the wetland area in the total study area has the capacity to absorb at least 290,381 kilograms of phosphorus per year. Based on the above calculations and the low-end cost of phosphorus removal ($25.62/

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61 Schuyt, K., and Brander, L. 2004. *The Economic Values of the Worlds' Wetlands*. World Wildlife Fund and the Institute for Environmental Studies, Vrije Universiteit, Amsterdam, The Netherlands. http://awsassets.panda.org/downloads/wetlandsbrochurefinal.pdf The average value from a World Wildlife Fund global wetland study ($773) per hectare per year in U.S. dollars (2000$).

62 Olewiler, N. 2004. The Value of Natural Capital in Settled Areas of Canada. Ducks Unlimited Canada and the Nature Conservancy of Canada

63 Calculated 413.5 hectares of wetlands in Rouge Park multiplied by the low-end estimates of removal rates of 80.3 kg/ha/year of phosphorus and 350 kg/ha/yr of nitrogen.

64 Wilson, S.J. 2008, supra note 57.

65 Olewiler, N. 2004, supra note 62.

kg), the value of phosphorus removal provided by wetlands is $2,273.06 per hectare per year across the total study area and $1,243.31 in Rouge Park, based on the costs of water treatment to remove excess phosphorus.

Therefore, the estimated annual total value for the waste treatment of nitrogen and phosphorus provided by wetlands in Rouge Park is $563,089 per year, or $1,361.75 per hectare. In the total study area these ecosystem services are worth an estimated $9 million per year or $2,489.59 per hectare, annually. All values are reported in 2011 dollars.

Clean Water: Filtration Services provided by Forests & Wetlands

Water pollution comes from point sources, such as industrial discharges and wastewater treatment plants, and non-point sources, including run-off from agricultural lands and facilities, urban areas, construction sites, and septic tanks. In the United States, it has been estimated that the economic damages to surface water from sediment and nutrient run-off from croplands costs between $2.2 billion and $7 billion each year.[66]

Poor water quality degrades recreational areas and fish habitats, which affects human health by increasing insect and waterborne diseases. It also leads to odour problems and diminished aesthetic values. Forests and wetlands can reduce non-point source water pollution because they filter, store and transform pollutants into non-harmful forms.

Ontario's drinking water comes from lakes, rivers, streams or underground sources like aquifers. All of these drinking water sources are linked in watersheds or drainage basins by the ecosystems that capture, filter and deliver water. The Walkerton Inquiry recommended source protection as one of the most effective and efficient means of protecting the safety of Ontario's drinking water.[67]

Forested watersheds are vital for a clean and regular supply of drinking water. Protected forests provide higher quality water with less sediment and fewer pollutants than water from watersheds with unprotected forests.[68] A U.S. study concluded that the cost of treatment for surface water supplies varies depending on the per cent forest cover in the water source area.[69] They found that based on a survey of numerous cities across the United States, there is a 20 per cent increase in water treatment costs for each 10 per cent loss in forest cover. In other words, where forest cover is low in municipal watersheds, municipal water treatment costs more.

The Ontario Greenbelt study used this correlation to estimate the value of forest and wetland cover for water quality benefits in terms of the potential increases in drinking water treatment costs if the combined forest and wetland cover declined. The Lake Ontario watershed was used for the Greenbelt study, which includes this study area's watersheds. The combined forest and wetland cover in the Lake Ontario watershed was 30 per cent according to SOLRIS 2000-2002 land cover data. Based on the 2007 cost for drinking water treatment in the City of Toronto ($0.60 per cubic metre), water treatment costs were estimated to increase to $0.94 per cubic metre if the overall forest and wetland cover declined from 30 per cent of land cover to 10 per cent within the Lake Ontario watershed. Based on this proxy, the Greenbelt study reported that forest

Ontario's drinking water comes from lakes, rivers, streams or underground sources like aquifers. All of these drinking water sources are linked in watersheds or drainage basins by the ecosystems that capture, filter and deliver water.

PHOTO COURTESY VLAD AGING ACCOZZGLIA/FLICKR

66 Lovejoy, S. B., J. G. Lee, T. O. Randhir, and B. A. Engel. 1997. Research Needs for Water Quality Management in the 21st Century. Journal of Soil and Water Conservation. January-February 1997: 18-21.

67 Ontario Ministry of the Environment. 2004. *White Paper on Water on Watershed-based Source Protection Planning*. Integrated Environmental Planning Division, Strategic Policy Branch. Ministry of the Environment. Queen's Printer for Ontario. www.waterprotection.ca/download/swp_background_whitepaper.pdf Accessed April 2012.

68 Dudley, N. and Stolton, S. 2003. *Running Pure: The importance of forest protected areas to drinking water*. World Bank/ WWF Alliance for Forest Conservation and Sustainable Use. Washington D.C.

69 Ernst, C., Gullick, R. and Nixon, K. 2007. "Protecting the Source: Conserving forest to protect water." In *The Economic Benefits of Land Conservation*. The Trust for Public Land. www.tpl.org.

land cover provides water filtration services worth an estimated $532.39/hectare/year (2011$) in terms of the avoided additional costs.

We have applied this same avoided cost estimate to Rouge Park, which also had 30 per cent forest and wetland cover according to the SOLRIS 2000-2002 data. The annual value of water filtration services provided by forests is in Rouge Park is an estimated $428,217 per year. Extrapolated to the total study area, the forests provide a value of $4.3 million each year.

The combined forest and wetland cover in 2002 across our total study area was only 18 per cent. As a result, the value of the remaining forest cover is arguably even greater in value because there is less of it left across the smaller watersheds. As natural capital and the ecosystem services decline, the services that are provided by the remaining areas become increasingly critical because there are fewer areas that can offer the services.

Nature-Based Recreation

Wetlands across the total study area have an estimated capacity to remove 290,381 kilograms of phosphorus and 1.3 million kilograms of nitrogen each year, based on the low-end removal rates.
PHOTO COURTESY JODE ROBERTS

The study area is unique among Toronto-area watersheds because it contains a large area of protected rural and natural habitats in close proximity to a major city and many growing suburbs. Within and beyond the Park, there are many opportunities for public recreational use in the watershed, through natural areas, trails, agricultural tourism and recreational fishing. These natural areas are highly valued for their aesthetic, social, recreational and spiritual values.[70] As a result, Rouge Park and other natural areas across the surrounding watersheds are important for recreation and healthy living.

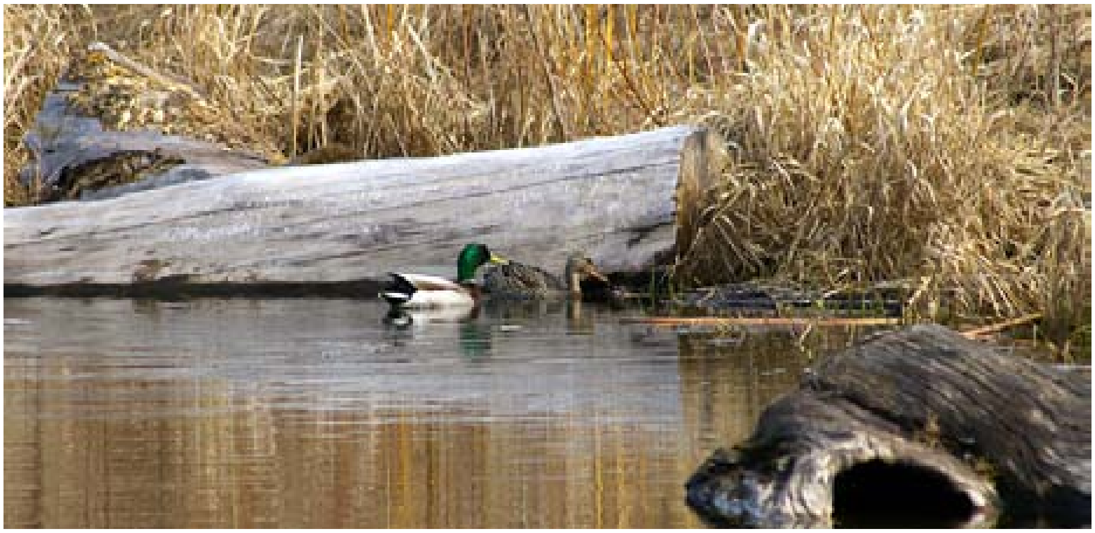
In order to report on these recreational values, we adapted some of the values of nature-based recreation from the 1996 Canadian national survey that estimated the economic value of nature-based activities.[71] The survey reported that Ontario residents spent $4.3 billion in 1996 on nature-based recreation. In addition, the survey asked respondents how much economic value they placed on these nature-based experiences. In other words, survey respondents were asked "how much they would be willing to increase their spending for each recreational activity."

The survey does not report specifically on sub-regions within Ontario. Therefore, we opted to use the "economic value", or the value based on how much participants would be willing to increase their spending (rather than the expenditure-based values), and the average number of same-day trips only. This information best suited the Rouge study area because most of the recreational trips to Rouge Park and surrounding areas would be same-day trips, and trip expenditures would be low because there are no entry fees to the Park, and most recreationalists traveling to the Park would be coming from relatively short distances.

According to the survey, 43.4 per cent of Ontario's population participated in same-day trips, and the average number of annual same-day trips, taken by Ontario residents, was 10.6 days. For our study, we only included the average economic value for two of the activity categories (i.e., outdoor activities and recreational fishing) from the survey to provide a conservative proxy value. The average daily economic value, in terms of the willingness to increase spending, as defined above, was $9.70 ($13.70 in 2011$) per day for outdoor activities, and $10.80 ($14.57 in 2011$) per day for recreational fishing. Using these statistics, we estimated that 279,050 same-day trips were taken within the Rouge watershed (based on 43.4 per cent of the Rouge watershed population of 242,631, taking 25 per cent of their same-day trips within the watershed) for nature-based outdoor activities and recreational fishing. The estimated annual value of recreation in the Rouge watershed is $3.85 million, inflated to 2011 dollars, or $541.06 per hectare per year when distributed

70 TRCA. 2007. *Rouge River Watershed: State of the Watershed Report*. Toronto and Region Conservation Authority. Downsview, Ontario. http://trca.on.ca/dotAsset/37818.pdf.

71 Duwors, E. et al. 1999. *The Importance of Nature to Canadians: The Economic Significance of Nature-Related Activities*. Environmental Economics Branch. Environment Canada. Ottawa, Canada.



amongst all natural cover (7,116 hectares; included forest, wetland, water, shoreline, hedgerows, plantations and urban pervious areas).[72]

The annual recreational per hectare value for the Rouge watershed was extrapolated to the total study area's natural cover. As a result, the total recreational value provided by natural areas in the study is an estimated $8.8 million annually (2011$) or $541 per hectare of natural area. The total recreational value within Rouge Park is an estimated $1.2 million for the total natural cover area (2,210 hectares).

Wildlife Habitat: Wetlands

Wetlands are well known for the important habitat they provide for many species, especially birds, amphibians and reptiles. Most of Ontario's species at risk are located in the southern part of the province, which includes our study area. For example, the southern Ontario Greenbelt is home to 72 species at risk, and provides habitat for more than one-third of all of Ontario's species at risk.[73]

Forests, wetlands, grasslands, pastures, lakes, rivers and streams all provide important habitat types for wildlife. Although, all these cover types provide habitat values, we were only able to provide a monetary value for wetland habitat. The value for wetland habitat is an estimated $4,724.83 per hectare based on the average annualized wetland habitat restoration costs for Rouge Watershed Wetland Creation Projects.[74] The annualized value of habitat restoration represents the value of wetland habitat in terms of the avoided costs associated with degradation to, or loss of, habitat. This is particularly important for wetland habitat in southern Ontario where over 70 per cent of wetlands have been drained for other land use such as agriculture and urban development.[75]

Based on the estimated dollar value, the total value for wetland habitat is worth $1.9 million per year in Rouge Park, and $17.1 million across the total study area.

Wetlands are well known for the important habitat they provide for many species, especially birds, amphibians and reptiles.

PHOTO (SONG SPARROW) COURTESY GARY YANKECH/FLICKR

72 Proxy value is based on the assumption that 50 per cent of trips were for outdoor activities and 50 per cent for recreational fishing, These values were adopted to represent the overall recreational value for the area, given the lack of information on the number of visitors to the Rouge Park and surrounding areas as well as the type of activities that recreationalists are participating in.

73 Biodiversity in Ontario's Greenbelt. 2011. Ontario Nature and the David Suzuki Foundation. Available at: www.davidsuzuki.org/publications/downloads/2011/REPORT-GB_Habitat-Dec2011.pdf.

74 IJC Study Board. 2006. Valuating Wetland Benefits compared with Economic Benefits and Losses. International Lake Ontario – St. Lawrence River Study. www.losl.org/PDF/Wetland-Value-Paper-April-27-2006-e.pdf. Accessed June 2012.

75 Ducks Unlimited Canada. 2010. Southern Ontario Wetland Conversion Analysis. Ontario, Canada. www.ducks.ca/aboutduc/news/archives/prov2010/101012.html. Accessed July 2012.

Pollination

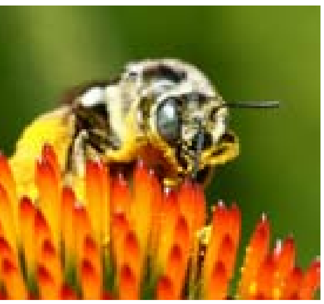
In Canada, there are more than 1,000 species of pollinating insects.[76] Insect pollination is necessary for most fruits and vegetables crops, such as tomatoes, peppers and strawberries, as well as tree fruits such as apples and peaches. Overall, about 30 per cent of the world's food production comes from crops that depend on pollinators like bees, insects, bats and birds.[77]

The value of bee pollination for crops in Canada has been conservatively estimated at $1.2 billion per year.[78] Globally, the value of pollinators for food production ranges from $112 to $200 billion each year. In the United States, the economic value of all pollinator services for agriculture is an estimated $5.7 to $13.4 billion per year.[79]

Honeybees provide about 90 per cent of managed pollination services, but a range of new research shows how wild pollinators can add significant value to a crop. In the United States alone, the annual contribution of wild bee pollination services is estimated at more than $3 billion annually.[80] In Costa Rica, wild bees increased coffee yields by 20 per cent, increasing crop values by up to $393 per hectare.[81] In Canada, enhanced pollination services produce larger and more symmetrical apples in orchards, providing marginal returns of five to six per cent or $250 per hectare.[82]

Several studies have documented the significance of natural habitat in close proximity to growing crops for optimum yields and increased farm production. A Canadian study concluded that canola yield is correlated to the proximity of uncultivated areas. The researchers found that optimum yield and profit would be attained if 30 per cent of the field areas were set aside for wild pollinator habitat.[83] Similarly, studies that examined pollination and surrounding land use for tomato and sunflower production found that natural habitat near farms increases pollination services.[84]

We have extrapolated the analysis and values for pollination services from the Ontario Greenbelt study. The total annual value of pollination services provided by natural cover within the Greenbelt was estimated to be $360 million. This value was calculated by multiplying the total value of farm crop production for the Greenbelt ($1.2 billion in 2005) by 30 per cent, the global average of crop production that is dependent on pollination. Given the significance of natural cover for pollinator biodiversity, nesting habitat, food and nectar, the total value of pollination services was attributed to idle agricultural lands, grazing lands/pasture (perennial), hedgerows, plantations and forest lands, with a resulting average annual value per hectare of $1,242.50 (2011$).



Insect pollination is necessary for most fruits and vegetables crops, such as tomatoes, peppers and strawberries, as well as tree fruits such as apples and peaches.

PHOTO COURTESY PATTY O'HEARN KICKHAM/FLICKR

76 Pollination Canada. Environmental Canada's Ecological Monitoring and Assessment Network and Seeds of Diversity Canada. www.seeds.ca/proj/poll/ Accessed August 2008.

77 Klein, A.-M., et al. 2007. "Importance of pollinators in changing landscapes for world crops." *Proceedings of the Royal Society B*. 274:303-313.

78 Environment Canada. 2003. Protecting Plant Pollinators. Envirozine. Issue 33 (June 26, 2003). www.ec.gc.ca/EnviroZine/english/issues/33/feature3_e.cfm. Accessed February 2008.

79 Tang, J, Wice, J., Thomas, V.G., and Kevan, P. 2005. *Assessment of the Capacity of Canadian Federal and Provincial Legislation to Conserve Native and Managed Pollinators*. The International Network of Expertise for Sustainable Pollination. University of Guelph. Canada. www.pollinator.org/Resources/Laws%20Affecting%20Pollinators-Canada.pdf. Accessed March 2008.

80 Losey, J.E., and Vaughan, M. 2006. *The Economic Value of Ecological Services Provided by Insects*. *Bioscience*. 56:311-323.

81 Ricketts, T.H., Daily, G.C., Ehrlich, P.R., and Michener, C.D. 2004. *Economic value of tropical forest to coffee production*. *Proceedings of the National Academy of Sciences*. 101:12579-12582.

82 Kevan, P. G. 1997. "Honeybees for better apples and much higher yields: study shows pollination services pay dividends." *Canadian Fruitgrower*. (May 1997): 14, 16. (cited by FAO)

83 Morandin, L.A. and Winston, M.L. 2006. "Pollinators provide economic incentive to preserve natural land in agro-ecosystems." *Agriculture, Ecosystems and Environment*. 116:289-292.

84 Greenleaf, S.S., and Kremen, C. 2006. "Wild bee species increase tomato production and respond differently to surrounding land use in Northern California." *Biological Conservation*. 133:81-87; Greenleaf, S.S., and Kremen, C. 2006. "Wild bees enhance honey bees' pollination of hybrid sunflower." *Proceedings of the National Academy of Sciences*. 103:13890-13895.

In Rouge Park, the natural cover for pollinators (as defined above) totals 1,712 hectares, which provides a value of $2.1 million per year in pollination services. In the total study area, the natural cover attributed for pollinators is 22,666 hectares, providing pollination services worth $28.2 million.

Biological Control: Birds as Pest Control

Studies show that birds provide valuable biological control services for farmlands and forests. It is estimated that birds can eat up to 98 per cent of pest species, such as spruce budworms, cicadas and crickets.[85] These services have been valued at as much as $5,000 per year per square mile of forest. Farmers benefit from the role birds play in helping to control agricultural pests.

A 1998 United States Forest Service study estimated the annual cost to replace the pest control services provided by birds with chemical pesticides or genetic engineering at US$7.34 per acre.[86] We have transferred this annual value at $36.48 per hectare in 2011 Canadian dollars, for forest cover, as well as other important habitat for birds including plantations, perennial lands, idle land and hedgerows. Based on the annual value, the total value provided by these cover types across the study area, in terms of biological control, is estimated to be worth $826,839 annually; $62,437 per year within Rouge Park.[87]

Studies show that birds provide valuable biological control services for farmlands and forests. It is estimated that birds can eat up to 98 per cent of pest species, such as spruce budworms, cicadas and crickets.

PHOTO (SAVANNAH SPARROW) COURTESY GARY YANKECH/FLICKR

85 Wenny, D.G., DeVault, T.L. Johnson, M.D., Kelly, D., Sekercioglu, C.H., Tomback, D.F., Whelan, C.J. 2011. *The Need to Quantify Ecosystem Services Provided by Birds*. *The Auk*. 128: 1, pp. 1-14. www.jstor.org/stable/10.1525/auk.2011.10248.

86 Moskowitz, K. and Talberth, J. 1998. *The Economic Case Against Logging our National Forests*. Forest Guardians. Santa Fe, New Mexico. Cited in: Krieger, D.J. 2001. Economic Value of Forest Ecosystem Services: A Review. The Wilderness Society. Washington, D.C. http://wilderness.org/files/Economic-Value-of-Forest-Ecosystem-Services.pdf.

87 Includes forest, plantation, idle land, perennial cover and hedgerow area.

Soil Formation and Erosion Control

Soil formation and erosion control are very important for maintaining the productivity of agricultural areas, especially croplands. Erosion control is also a key ecosystem service provided by trees, plants and other vegetation cover, because when vegetative cover is present soils have a protective layer that prevents soil erosion. Soil erosion is a problem because losses in soil reduce productivity and contribute to increases in sedimentation in streams, rivers and lakes. However, it is difficult to quantify the value of soil formation and erosion control.

Unfortunately, no valuation was possible for soil formation. In terms of erosion control, we have included the value of erosion control for agricultural lands that have permanent cover in terms of the savings in water treatment due to reduced sedimentation. This value was reported for the Grand River Watershed in southern Ontario (average value of $5.60 in 2003 dollars).[88] We transferred the average annual value at $6.55 per hectare (2011$) for grazing land/pasture (perennial land) and idle agricultural lands. The total value for Rouge Park was $5,537 each year, and the total value for the total study area was worth $83,125 per year.

Cultural Value of Farmlands

The aesthetic and cultural value of agricultural lands has traditionally included the draw of their visual attractiveness. This value is reflected today in terms of property values, tourism values and weekend visits to the countryside and its communities.

PHOTO COURTESY REZA VAZIRI/FLICKR

The aesthetic and cultural value of agricultural lands has traditionally included the draw of their visual attractiveness. This value is reflected today in terms of property values, tourism values and weekend visits to the countryside and its communities. The willingness to pay for farmland preservation has been examined through studies that utilize surveys to determine what nearby residents will pay to protect farmland.

In the Greenbelt study, assuming that a minimum of 10 per cent of the region's households placed a monetary value on farmland preservation, the cultural value of the Greenbelt's farmlands was estimated at $138 per hectare per year (2005$). This value was based on a 1994 study that surveyed the willingness of residents in Eastern Canada to pay for farmland preservation.[89] This value was applied in 2011 dollars ($154.79 per hectare per year) to the croplands, perennial lands (grazing and pasture lands), idle agricultural lands and hedgerows in this study area. The cultural value attributed to farmlands in the Rouge Park is estimated at $355,981, and in the total study area, a value of $5.6 million

Local Food Production

Agricultural lands in close proximity to cities and towns can provide local grown food that is fresh and full of nutrients because it has not been shipped hundreds or thousands of kilometres. Preference for local food is growing in Canada's urban areas.

For this report, the value of local food production was estimated using a survey for residents within the City of Abbotsford and Metro Vancouver in British Columbia. First, the survey reported the value of food production in terms of the number of local farm visits by residents of Abbotsford. The survey determined that local residents buy from local farms an average of 12 times per year and each round trip was on average 9.4 kilometres. The average travel cost per trip was estimated as $4.50, or $54.14 per year.[90] In addition, a survey of local farm stand owners reported that the average sale per customer visit was $20.83, an amount

88 Olewiler, N. 2004. *The Value of Natural Capital in Settled Areas of Canada*. Ducks Unlimited Canada and the Nature Conservancy of Canada.

89 Bowker, J. Michael; Didychuk, D.D. 1994, *Estimation of nonmarket benefits of agricultural land retention in Eastern Canada*. Agricultural and Resource Economics Review: 218-225.

90 Ibid. Based on assumption that travel cost is $0.48/km.

Agricultural lands in close proximity to cities and towns can provide local grown food that is fresh and full of nutrients because it has not been shipped hundreds or thousands of kilometres. Preference for local food is growing in Canada's urban areas.
PHOTO COURTESY VLAD DGRIEBELING/FLICKR

similar to an estimated per visit sales for farmers markets throughout the province of B.C.[91] The survey also asked Abbotsford residents how much more they were willing to pay for Abbotsford-grown corn rather than California-grown corn. The average response was $0.91 per dozen cobs of corn (a 46 per cent premium over corn from California).

Based on these findings, the value of local food production for the entire B.C. Lower Mainland's agricultural lands were conservatively estimated to be worth $24 million each year. The total estimated travel costs were estimated at $24 million per year, which equalled $382.48 per hectare when the total value was divided by the total agricultural lands in the study area.

The majority of crops grown within the existing Rouge Park are cash crops such as corn, soy, and wheat, with some hay fields.[92] These fields currently do not provide a significant contribution to local food production in terms of fresh produce to local residents. Croplands in the surrounding watersheds, including those in Markham, would contribute to local food production. However, information on the value of local production was not available for the study area.

Market Value of Croplands

The market value of crops grown in Rouge Park was not available, so we have estimated the value based on the average farm receipts reported for croplands in the Town of Markham, the Greater Toronto Area, and Ontario. The average gross farm receipts in 2006 were $1,272 per acre in Markham ($3,436.17 per hectare; 2011$), $999 per acre in the GTA ($2,698.69 per hectare; 2011$), and $777 per acre across Ontario ($2,098.98 per hectare; 2011$); and, the average net revenue was $118 per acre in Markham ($318.77 per hectare; 2011$), $136 per acre in the GTA ($367.39 per hectare; 2011$), and $113 per acre across Ontario ($306.76 per hectare (2011$).[93] Because most of the crops currently grown in Rouge Park are cash crops, this report uses the lower gross farm receipts and net revenue value, which is an average across Ontario. These values converted to 2011 dollars are $2,098.98 and $306.76 per hectare, respectively.

91 2007. *Public Amenity Benefits and Ecological Services Provided by Farmland to Local Communities in the Fraser Valley: A Case Study in Abbotsford, B.C.* Strengthening Farming Report. File Number 800-100-1. British Columbia Ministry of Agriculture and Lands. Victoria, B.C.

92 Personal communication. Vicki MacDonald. Biologist, Rouge Park. April 23, 2012.

93 Planscape. 2009. *The Town of Markham: A Recommended Strategy for Markham – Phase 3*. Markham, Ontario.

PART 8

Summary of Ecosystem Service Valuations

Summary Tables of Ecosystem Service Value by Land Cover Type

The total value for the proposed Rouge National Park is an estimated $12.5 million annually, an average value of $2,239 per hectare

PHOTO COURTESY BAD ALLEY/FLICKR

In the existing Rouge Park, the total value provided by ecosystem services is an estimated $10.4 million annually, an average of $2,846 per hectare. The land cover types that provide the greatest total value are forests at $4.1 million per year, followed by wetlands which provide $4 million per year and idle land which provides $1.4 million per year. Wetlands provide the greatest value per hectare, worth an average of $9,651 per year (Table 6).

The cumulative ecosystem service value for the total study area (i.e., all three major watersheds) is $115.6 million annually, an average each year of $2,247 per hectare. Forests provide the greatest value at $41.2 million per year, wetlands provide an annual value of $34.9 million and idle agricultural lands provide $18.2 million per year. Wetlands provide the greatest annual value worth, on average, $9,648 per hectare (Table 7). The dollar value per hectare of each wetland varies depending on the type of wetland because of varying amounts of soil carbon stored. Therefore, the average value per hectare is based on the total value for all wetlands divided by the overall total area. The annual dollar value per hectare for each type of wetland varies, ranging from $9,642 for swamps to $10,245 for fens per hectare.

The non-market ecosystem values provided by the designated additional federal lands for the proposed National Rouge Park are worth an estimated $2.0 million, each year an average of $1,070 per hectare per year, making the total value for the proposed Rouge National Park an estimated $12.5 million annually, an average value of $2,239 per hectare (Table 8 on page 46).

TABLE 6: ANNUAL ECOSYSTEM SERVICE VALUE BY LAND COVER TYPE FOR ROUGE PARK (2011$)

Land Cover Type	Area (hectares)	Value per hectare ($/ha/year)	Total Value ($/year)
Forest	804.3	$5,149	$4,141,841
Plantations	11	$3,802	$40,804
Wetlands	414	$9,651*	$3,990,727
Croplands	1,403	$378	$531,002
Grazing Land/Pasture	52	$1,728	$90,106
Hedgerows	51	$3,110	$158,861
Idle Land	793	$1,728	$1,370,482
Urban Green Space	130	$785	$102,521
Water (Rivers)	6	$1,241	$6,839
Shoreline (Beach)	1.4	$541	$779
Total	3,666		$10,433,962
Average $/hectare			$2,846

Notes: Total Area only includes land cover types reported in this table (excludes built-up impervious, extraction and transportation land use). This is the total area used to calculate the overall average dollar value per hectare for each study area.

*Wetland value per hectare is an average value calculated as the total value for all wetland types divided by the total wetland area. As a result, the average value for wetlands varies between the Rouge Park and the total study area.

Wetlands provide the greatest value per hectare, worth an average of $9,651 per year.

PHOTO (MALE AMERICAN GOLDFINCH) COURTESY PATTY O'HEARN KICKHAM/FLICKR

TABLE 7: ANNUAL ECOSYSTEM SERVICE VALUE BY LAND COVER TYPE FOR THE TOTAL STUDY AREA (ROUGE, PETTICOAT AND DUFFINS WATERSHEDS, INCLUDING ROUGE PARK; 2011$)

Land Cover Type	Area (hectares)	Value per hectare ($/ha/year)	Total Value ($/year)
Forest	8,006	$5,149	$41,223,528
Plantations	1,039	$3,802	$3,951,193
Wetlands	3,616	$9,648*	$34,889,234
Croplands	22,436	$378	$8,489,832
Grazing Land/Pasture	2,154	$1,728	$3,721,284
Hedgerows	930	$3,110	$2,892,807
Idle Land	10,537	$1,728	$18,204,015
Urban Green Space	2,576	$787	$2,027,441
Water (Rivers Streams)	127	$1,241	$157,238
Shoreline (Beach)	1.7	$541	$901
Total	51,422		$115,557,474
Average $/hectare			$2,247

Notes: Total Area only includes land cover types reported in this table (excludes built-up impervious, extraction and transportation land use). This is the total area used to calculate the overall average dollar value per hectare for the study area.

*Wetland value per hectare is an average value calculated as the total value for all wetland types divided by the total wetland area. As a result, the average value for wetlands varies between the Rouge Park and the total study area.

TABLE 8: TOTAL ANNUAL ECOSYSTEM SERVICE VALUE BY LAND COVER TYPE FOR THE PROPOSED ROUGE NATIONAL PARK (IN 2011$)

Land Cover Type	Additional Lands for National Park (hectares)	Value per Hectare ($/ha/year)	Total Value for Additional Lands ($/year)	Total Value for Proposed Rouge National Park ($/year)
Forest	71.4	$5,149	$367,1631	$4,509,471
Plantations	0.5	$3,802	$1,796	$42,601
Wetlands	36.4	$9,642*	$350,599	$4,341,326
Croplands	1,373	$378	$519,678	$1,050,680
Grazing Land/Pasture	63	$1,728	$109,037	$199,143
Hedgerows	54	$3,110	$168,728	$327,589
Idle Land	298	$1,728	$514,553	$1,885,034
Urban Green Space	10	$787	$7,898	$110,419
Water (Rivers)	0	$1,241	$0	$6,839
Shoreline (Beach)	0	$541	$0	$779
Total	1,907		$2,039,921	$12,473,882
Average $/hectare			$1,070	$2,239

Note: Total Area only includes land cover types reported in this table (excludes built-up impervious, extraction and transportation land use). This is the total area used to calculate the overall average dollar value per hectare for the study area.

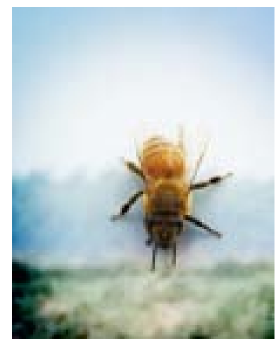
*Wetland value per hectare reported in this table is the value for swamps only because that is the only wetland type in the additional proposed lands for the National Park. However, the total wetland value for the total proposed National Park area reports the total value of all wetland types across this area, based on the respective dollar per hectare for each wetland type.

Summary Table of Ecosystem Services Total Values

Table 9 shows the total value for each ecosystem service for Rouge Park, the proposed National Park area, and for the total study area (Rouge, Duffins Creek and Petticoat Creek watersheds). The ecosystem services with the greatest values are pollination worth $28.2 million per year, stored carbon worth $17.8 million per year and wetland habitat worth $17.1 million.

TABLE 9: TOTAL ANNUAL VALUE OF ECOSYSTEM SERVICES IN ROUGE PARK, THE PROPOSED ROUGE NATIONAL PARK, AND THE TOTAL STUDY AREA (ROUGE, PETTICOAT AND DUFFINS WATERSHEDS (IN 2011$)

Ecosystem Service	Value per Hectare ($/ha/year)	Total Value ($/year)		
		Rouge Park	Proposed National Park	Total Study Area
Removal of Air Pollutants	$475 ($237.50 for plantations/ hedgerows)	$396,736	$443,643	$4,270,303
Stored Carbon (annual value)	$223.61 – $919.68	$1,427,996	$1,919,301	$17,806,553
Annual Carbon Uptake	$18.71 – $56.21	$87,287	$108,233	$1,091,655
Wetland Flood Control	$867.95	$358,902	$390,460	$3,138,681
Forest/Green Space Water Flow Regulation	$22.41 – $709.47	$595,495	$665,783	$6,435,973
Drinking Water (filtration)	$236.99 – $699.54	$723,880	$787,436	$7,126,656
Erosion Control and Sediment Retention	$6.55	$5,537	$7,902	$83,125
Waste Treatment	$27.22 – $2,489.59	$1,081,384	$1,185,634	$9,679,043
Pollination	$1,242.50	$2,126,604	$2,731,773	$28,161,924
Seed Dispersal (birds)	$603	$491,369	$534,693	$5,452,692
Biological Control	$36.48	$62,437	$80,205	$826,839
Wetland Habitat	$4,724.83	$1,953,739	$2,125,534	$17,085,912
Recreation	$541.07	$766,614	$859,952	$8,816,867
Cultural	$154.79	$355,981	$632,831	$5,581,251
Total		$10,433,962	$12,473,882	$115,557,474



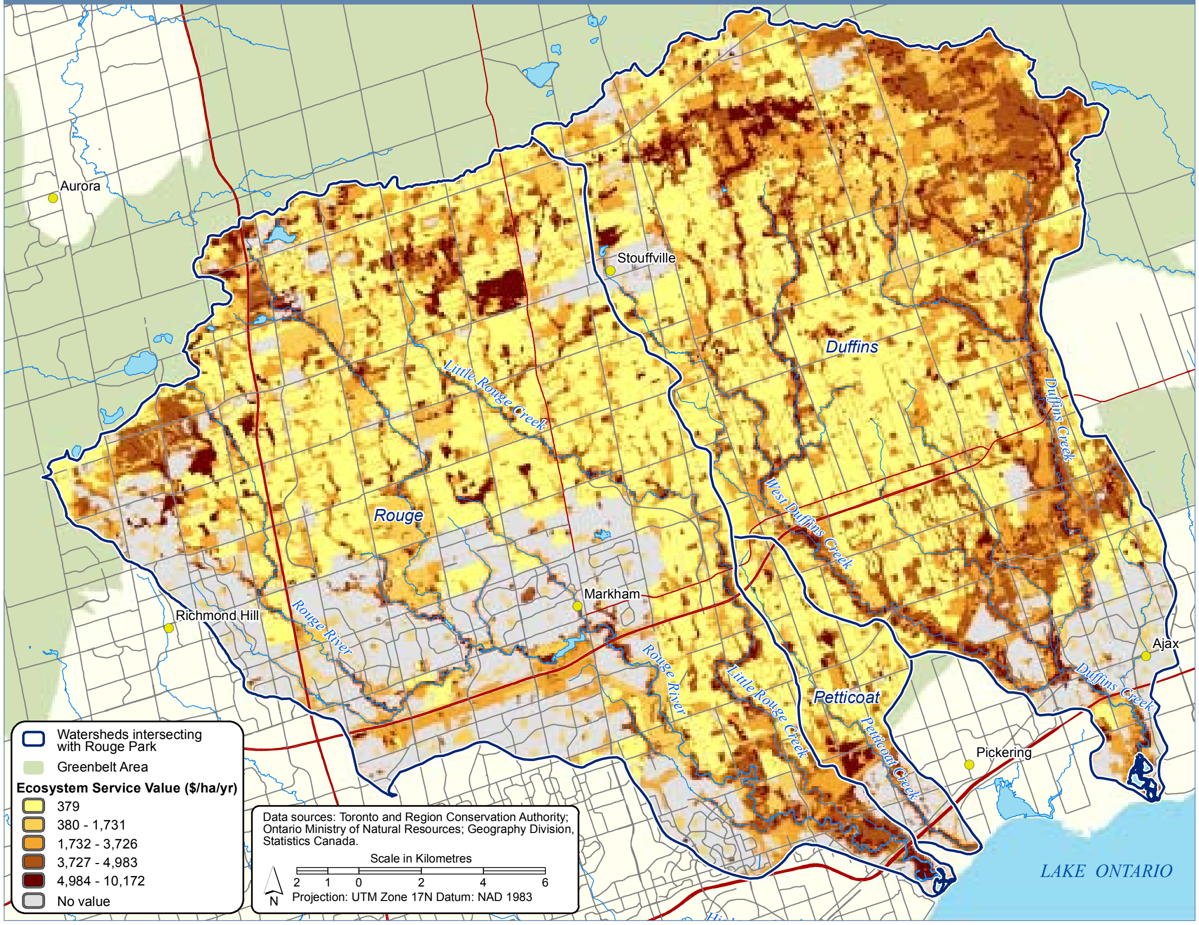
The ecosystem services with the greatest values are pollination worth $28.2 million per year, stored carbon worth $17.8 million per year and wetland habitat worth $17.1 million.

PHOTO COURTESY ESKIMO_JO/FLICKR

Summary Maps of Ecosystem Service Values

The value by land cover type ranges from an average of $378 per hectare (croplands) to $10,245 per hectare (fen wetland type) annually. The range of ecosystem services values and the distribution of the values across the landscape of the study area is illustrated in Figure 7. Higher values are evident in the southern part of Rouge Park and along rivers and streams within the surrounding watersheds.

FIGURE 7: SUMMARY MAP OF ECOSYSTEM SERVICE VALUES BY LAND COVER TYPE, TOTAL STUDY AREA

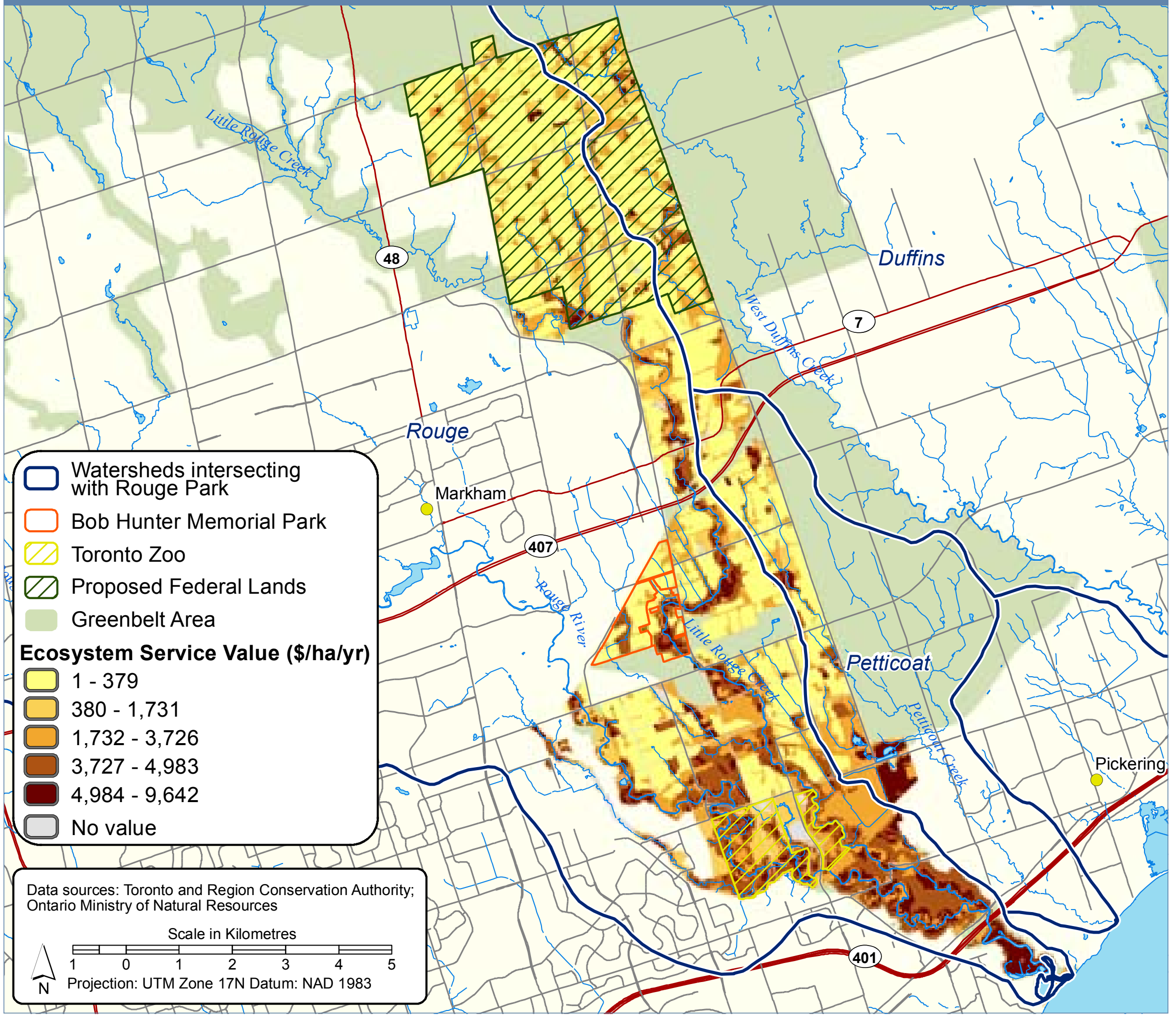


Maps can be viewed in high resolution at www.davidsuzuki.org/rouge-landcover

PHOTO COURTESY TSAR KASIM/FLICKR

Figure 8 illustrates the same range and distribution of ecosystem service values but only for the current Rouge Park plus the designated federal lands for the proposed National Park. The greatest values are shown along the Rouge River and within the southern part of the park where forest and wetland cover is greatest.

FIGURE 8: SUMMARY MAP OF ECOSYSTEM SERVICE VALUE BY LAND COVER TYPE, ROUGE PARK AND ADDITIONAL LANDS FOR PROPOSED NATIONAL PARK



Maps can be viewed in high resolution at www.davidsuzuki.org/rouge-landcover

PART 9

Discussion

Importance of Conserving Natural Capital in Southern Ontario

The recognition and valuation of ecosystem services are emerging trends at the global, national and local level.

PHOTO (CEDAR WAXWING) COURTESY PEARL VAS/FLICKR

Natural capital and ecosystem services are in decline worldwide.[94] The current and projected impacts of population growth and climate change will place additional pressure on our ecosystems in terms of their ability to supply regular services such as water for drinking supplies and irrigation for crops, flood control and pollination. Communities with diminished natural capital and "green living infrastructure" will have more difficulty adapting to a changing climate, making them more vulnerable to adverse and costly outcomes.

As a result, communities and governments are beginning to recognize the essential services that natural areas provide. The recognition and valuation of ecosystem services are emerging trends at the global, national and local level. For example, the United Nations Millennium Ecosystem Assessment reported on the condition of the world's ecosystems and their ability to provide services today and in the future.[95] It found that over the past 50 years humans have changed the earth's ecosystems more rapidly and extensively than in any other period in human history. The assessment concluded that approximately 60 per cent of the world's ecosystem services are being degraded or used unsustainably, including fresh water, air and water purification, and the regulation of regional and local climate. The full costs of these losses are difficult to measure, but the report concludes that they are substantial.[96]

One of the main reasons for ecosystem degradation is the exclusion of natural capital in our current measures of progress and decision-making. In general, we measure progress and well-being using an economic indicator – called GDP (gross domestic product) – as the primary marker of national or provincial performance. The GDP measures what we buy and sell, or the market value of goods and services. Values not reflected in market prices are considered externalities.[97] For example, the value of a forest in controlling stream bank

94 Millennium Ecosystem Assessment. 2005. *Ecosystems and Human Well-being: Synthesis*. Island Press. Washington, D.C.

95 www.millenniumassessment.org/en/Condition.aspx

96 Millennium Ecosystem Assessment, 2005, supra note 94..

97 An externality is a value that is not reflected in that commodity's market price.

erosion and sediment load in a river is not reflected in the market price of forested land. Nor is the value of a swamp or marsh in recharging an aquifer reflected in the price of water. Therefore, cutting forests and converting land for development result in a problematic scenario where timber is counted as monetary income without accounting for losses in natural capital resulting from deforestation.

In most cases, we do not recognize the non-market value of natural capital until services become so degraded or scarce that we have to pay to replace what had been previously provided for free. Similarly, the costs of our impact on the environment, such as losses in ecosystem services from pollution, go unaccounted. As a result, the way in which we measure and count our environmental, social and economic well-being is currently misleading.

Natural capital and ecosystem service accounts provide resources that can inform decision making at all jurisdictional levels, in regards to how policy and land use planning will affect economic and social well-being. For example, such an account can provide an inventory of the ecosystem services provided by a forest as well as its estimated value, such as the value of stormwater management, erosion control and carbon storage. This information can be used to assess the impact of human communities such as land use change and the effects of pollution.

Importance of Conserving Carbon Stored in Ecosystems

Maintaining the integrity of natural ecosystems is important for conservation and for mitigating and adapting to the impacts of climate change. As the earth's climate continues to change, the conservation of natural ecosystems will become even more vital. Their immense stores of carbon and for their provision habitat and migration corridors for wildlife, marine and plant species. When a forest is converted to a housing development or other built infrastructure, the disturbance of natural vegetation and soil results in the release of carbon dioxide to the atmosphere. Consequently, protecting the carbon stores that exist in our natural ecosystems will minimize the loss of ecosystem carbon.

Ontario's forests cover a vast area (712,200 km^2) representing two per cent of the world's forests and therefore are important to the global carbon cycle.[98]

Maintaining the integrity of natural ecosystems is important for conservation and for mitigating and adapting to the impacts of climate change.

PHOTO (HAIRY CATERPILLAR) COURTESY GARY YANKECH/FLICKR

Wetlands

Wetlands are one of the most productive, and yet threatened, ecosystems on the earth. Recent analysis by Ducks Unlimited determined that there were over two million hectares of wetlands throughout southern Ontario in the early 1800s. By 2002, only 506,844 hectares remained – a loss of 72 per cent of the pre-settlement wetlands. The decline in wetlands has been most dramatic in southwestern Ontario, parts of eastern Ontario, Niagara and the Toronto area, where 85 per cent of the original wetlands have been converted for urban development and agricultural lands.[99] Despite the important role that wetlands play in watersheds, the loss in wetland cover in southern Ontario has continued.[100]

Ontario's wetlands are vital natural assets that provide numerous ecological services while directly supporting a range of economic benefits. Beyond providing habitat for plants and wildlife, wetlands enhance

98 Colombo, S.J., Chen, J. and Ter-Mikaelian, T. 2007. *Carbon Storage in Ontario's Forests, 2000-2100*. Climate Change Research Information Note. Note Number 6. Ontario Ministy of Natural Resources. Ontario, Canada.

99 Ducks Unlimited Canada. 2010. *Southern Ontario Wetland Conversion Analysis*. Ducks Unlimited Canada. Barrie, Ontario. www.ducks.ca/aboutduc/news/archives/prov2010/pdf/duc_ontariowca.pdf.

100 Pattison, J.K., Yang, W., Liu, Y., and Gabor, S. 2011. A Business Case for Wetland Conservation: The Black River Subwatershed. Ducks Unlimited Canada and Environment Canada. www.ducks.ca/blackriver2011

There is support among southern Ontario residents for wetland protection and restoration. A recent survey for the Credit Valley found that 83 per cent of households in the watershed would be willing to pay for wetland protection and restoration.

PHOTO COURTESY TSAR KASIM/FLICKR

water quality, ground water recharge, flood and drought prevention and mitigate the impacts of climate change. Wetlands also offer ecotourism opportunities and provide important social and cultural benefits.

There is support among southern Ontario residents for wetland protection and restoration. A recent survey for the Credit Valley found that 83 per cent of households in the watershed would be willing to pay for wetland protection and restoration – between $229 and $259 per household each year over five years to support wetland restoration and conservation efforts.[101]

Agriculture in Rouge Park Study Area

Agriculture has been a part of the Rouge River area for over 200 years. Currently, agricultural land covers 59 per cent of the Park's lands, rented to farmers on one-year leases from the Toronto Regional Conservation Authority (TRCA). These short-term leases have prevented long-term investment in the maintenance of soil quality and croplands because they do not provide the security farmers need to rationalize investing in farm infrastructure, enhanced environmental practices and perennial crops that have longer growth cycles (e.g., orchards and vineyards).[102] Therefore, innovative governance and economic mechanisms will be needed to ensure sustainable farming practices that will enhance the natural capital of the Rouge. Rouge Park and TRCA staff have initiated discussions with farm tenants regarding longer-term leases.

Two recent studies have undertaken surveys to assess the importance of farmland to nearby communities. In 2007, residents in Abbotsford, British Columbia were surveyed about the value of benefits provided by farmland in their community. This study estimated that benefits and ecological services were an estimated $72,815 per hectare of farmland (not an annual value).[103] It also benefits from industrial land use at $14,000, and a value of $13,960 for residential lands, because residential land users received more services that the benefits that they paid.

101 Lantz, V., Boxall, P., Kennedy, M., and Wilson, J. 2010. Valuing Wetlands in Southern Ontario's Credit River Watershed: a Contingent Valuation Analysis. The Pembina Institute. Drayton Valley, Alberta. www.creditvalleyca.ca/wp-content/uploads/2011/01/ValuingWetlandsPhase2-final.pdf. Accessed April 2012.

102 StrategyCorp and Hemson Consulting. 2010. Governance, Organization and Finance Review of the Rouge Park Alliance. Rouge Park Alliance. Toronto, Canada.

103 Public Amenity Benefits and Ecological Services Provided by Farmland to Local Communities in the Fraser Valley: A Case Study in Abbotsford, B.C. 1997. Strengthening Farming Report. File Number 800.100-1. B.C. Ministry of Agriculture and Lands. Victoria, B.C.

A similar study was undertaken in 2009 in Metro Vancouver. The study found the value of farmland in Metro Vancouver was $143,210 per hectare; about 10 times greater than the market value of farm products produced ($14,198 per hectare).[104]

Incentive Programs to Promote the Provision of Ecosystem Services on Private Land

Economic instruments can be used to incentivise the maintenance or restoration of ecosystems by offering financial compensation to individuals, corporations and communities that adopt ecologically based best practices and green technology.

Incentive programs that compensate for conservation efforts and improve management practices by farmers and landowners are being developed in many countries. The storage of carbon in soils is an example of a key ecosystem service that can be maintained through the use of financial incentives. Soil contains huge amounts of carbon in the form of organic matter. Globally, the top metre of soil alone stores about 2,200 billion tonnes of carbon; equal to three times the amount of carbon currently held in the atmosphere.[105] Soil carbon stocks decrease significantly in response to changes in land cover and land use such as urban development, deforestation, and increased tillage or unsustainable agricultural practices. For example, the conversion of natural land cover to cultivated agriculture on average results in losses of soil organic carbon on the order of 20-50 per cent reduction from the original soil carbon stock.[106]

Financial incentives can be designed to encourage agricultural methods that protect soils from erosion such as reduced tillage and the careful use of animal manure and crop rotation. Initiatives in Canada are small pilot programs.

A review of innovative programs underway in other regions that could be applied to promote ecosystem services in working lands in the Rouge is provided in Appendix 1.

Incentive programs that compensate for conservation efforts and improve management practices by farmers and landowners are being developed in many countries.

PHOTO (AMBER-WINGED SPREADWING) COURTESY GARY YANKECH/FLICKR

Benefits of Integrating Natural Capital Values in Urban Planning and Communities

A case study was undertaken in the Rouge River Watershed to assess the net benefits of future urban development scenarios. The economic analysis evaluated the costs and benefits for two alternative future land development scenarios in the watershed; a 'Full Build-out' scenario where development occurred on all available lands according to approved municipal plans, and a 'Sustainable Communities' scenario that included many sustainable design interventions, such as stormwater retrofit plans, an ecological corridor and improved surface water quality practices in new and existing developments."[107] The study concluded that a net benefit for the sustainable communities scenario to be $416 million to $960 million (average value of $687 million).[108]

104 Robbins, M., Olewiler, N, and Robinson, M. 2009. An Estimate of the Public Amenity Benefits and Ecological Goods Provided by Farmland in Metro Vancouver. Fraser Basin Council and Simon Fraser University. B.C. Ministry of Agriculture and Lands.

105 Goverse, T. (ed). UNEP Year Book 2012: Emerging issues in our global environment. United Nations Environment Program. Nairobi, Kenya. www.unep.org/yearbook/2012/. Accessed March 2012.

106 Watson, R.T., Noble, I.R., Bolin, B., Ravindranath, N.H., Verardo, D.J., and D. J. Dokken (Eds.). 2000. Intergovernmental Panel on Climate Change (IPCC). Cambridge University Press, UK. www.ipcc.ch/ipccreports/sres/land_use/index.php?idp=172

107 Marbek Consulting. 2010. *Assessing the Economic Value of Protecting the Great Lakes: Rouge River Case Study for Nutrient Reduction and Nearshore Health Protection*. Prepared for the Ontario Ministry of Environment. Marbek. Ottawa, Ontario.

108 Ibid.

PART 10

Conclusions

This report conservatively estimates that the Rouge and its surrounding watersheds provide services of an economic value of at least $115.6 million each year.

The Rouge and its surrounding watersheds provide essential ecosystem services and economic benefits for residents throughout the Greater Toronto Area. This report conservatively estimates that these services provide an economic value of at least $115.6 million each year. The future Rouge National Park, including lands within the existing Rouge Park, is the ecological engine of the region and provides at least $12.5 million annually in non-market economic benefits for residents.

These findings demonstrate that despite decades of sprawling development in the Greater Toronto Area, the Rouge and its surrounding watersheds have remarkably remained a vital ecological – and economic – resource that offers vast benefits each year that contribute to the health and well-being of the region's communities. This stock of natural capital cleans the air, filters the water, cools nearby communities and provides a critical natural corridor from the Oak Ridges Moraine to the shores of Lake Ontario.

By establishing Rouge National Park, the federal government, and the many local stakeholders and Rouge champions, are effectively protecting a bank of natural capital that will benefit communities now and for generations to come. While protecting, restoring and managing such a wild gem on the edge of one of North America's fastest growing urban areas is likely to cost tens of millions, these costs should be weighed against the value of economic and ecological benefits highlighted in this report. Even without consideration of the Park's market and health benefits, the future Rouge National Park will undoubtedly pay huge dividends.

PART 11

Recommendations

While this valuation is an important first step in assessing the value of the Rouge area, there is much work still to be done. To ensure the Rouge's ecological health and economic value is maintained in the long term as a National Park, there are several legal, policy and management efforts that should be undertaken.

While this valuation is an important first step in assessing the value of the Rouge area, there is much work still to be done.

PHOTO COURTESY HANADI TRAIFEH/FLICKR

Governance and Management

1. Given the significant economic and ecological values of the Rouge and its surrounding watersheds, the Federal government should work quickly to establish Rouge National Park under legislation.
2. The legislation and management plans governing Rouge National Park must:
   - a) give priority to the protection and restoration of ecological health and water quality;
   - b) ensure that existing and new development activities that impact natural capital, such as infrastructure (e.g., pipelines, roads), are minimized and managed to the highest standards of sustainability;
   - c) mandate the achievement of a "net gain" in natural capital (e.g., biodiversity) as a result of any activity that degrades the ecological health of the Park;[109]
   - d) ensure that resource extraction in the Park is prohibited; and
   - e) ensure that First Nations are fully involved with the establishment and management of the new National Park.

109 A potential template could be the 'overall benefit' clause in Ontario's Endangered Species Act. ESA, s. 17.2.c.i., a permit may be granted if, among other criteria, "the Minister is of the opinion that an overall benefit to the species will be achieved within a reasonable time through requirements imposed by conditions of the permit".

3. The close interrelationships between First Nations peoples and the lands and waters of Rouge National Park and surrounding areas must be recognized. First Nations must be engaged and recognized throughout the process as keepers of traditional botanical and ecological knowledge, included in public education and interpretive programming.

4. Parks Canada should work collaboratively with the Province, municipalities and regional conservation authorities to protect natural capital outside of the new National Park through the establishment of special management zones (i.e., protected buffers and connected corridors contiguous to the park), expanding the surrounding Greenbelt to protect vulnerable farmland, and identifying and protecting sensitive hydrological and natural heritage features within the surrounding Rouge River, Petticoat Creek and Duffins Creek watersheds.

It is important that all levels of government, as well as regional conservation authorities and non-governmental organizations, continue to fund and deliver public education programs that build awareness of natural capital and its role in providing clean air, clean water, healthy food and wildlife protection.

PHOTO (TREE SWALLOW) COURTESY GARY YANKECH/FLICKR

Stewardship

5. Programs and incentives that support farm and land stewardship should be made available to farmers to support local food production and promote sustainable agricultural practices that restore and enhance ecosystem services (e.g. carbon storage, habitat for pollinators) in the new Rouge National Park and surrounding lands. Examples of innovative programs that could be applied in the Rouge (e.g., the ALUS program in Ontario) are presented in Appendix 1.

6. Municipalities, regional conservation authorities and other agencies should continue to support conservation and ecological restoration programs (e.g., tree planting, invasive species removal) to expedite recovery of wetlands, forests, rivers and other elements of natural capital within the new National Park and its surrounding watersheds.

Monitoring

7. Programs should be established to identify, measure and monitor natural capital (e.g., wildlife habitat) in the new Rouge National Park and its primary watersheds on a regular basis.

8. Detailed land cover data for the new Rouge National Park and its primary watersheds should be updated on an annual basis.

9. The results of monitoring programs should be reported to the public and monitoring data should be made publicly available.

Education and Public Awareness

10. It is important that all levels of government, as well as regional conservation authorities and non-governmental organizations, continue to fund and deliver public education programs that build awareness of natural capital and its role in providing clean air, clean water, healthy food and wildlife protection.

Economic Incentive Programs to restore and enhance the supply of ecosystem services on agricultural lands and woodlots in Canada

Ecological Gifts Program (Federal)

The Ecological Gifts federal program encourages individual and corporate landowners to protect nature in perpetuity by donating ecologically sensitive lands or a partial interest in their lands (i.e., through land transfer, conservation easements, covenants or servitudes) to environmental charities or government bodies.[110] Donors can receive income tax benefits in return. The financing mechanism is a tax credit or deduction to donors and a reduction in the taxable capital gain realized on the disposition of the property. Corporate donors may deduct the amount of their gift directly from their taxable income, while the value of an individual's gift is converted to a non-refundable tax credit.

Intergenerational Capital Gains Exemption and Rollovers for Transfers of Commercial Farms/Woodlots (Federal)

This federal program allows for the exemption and/or deferment of the capital gains tax on the transfer of woodlots from one generation to another.[111] Before the establishment of this incentive, the burden of the inheritance tax would result in the new owners paying the capital gains by harvesting the timber on the woodlot. This tax therefore had been a perverse incentive, encouraging landowners to harvest.

Managed Forest Tax Incentive Program (Ontario)

This provincial program encourages landowners, who own four hectares or more of forest, to carry out specific management activities and to prepare and follow a Managed Forest Plan for their property.[112] Management activities approved under this program include: tree planting or harvesting; recreational activities; wildlife management involving habitat work or participating in monitoring programs; protecting environmentally sensitive areas; and education. Under this program the property is reassessed and classified as a Managed Forest, and is eligible for a tax reduction at 25 per cent of the municipal tax rate set for residential properties. A Five-Year Progress Report must be submitted in the fifth year of the agreement, and Ministry audits including field visits can take place at any time.

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110 Ecological Gifts Program. Environment Canada. Government of Canada. www.ec.gc.ca/pde-egp/

111 www.omafra.gov.on.ca/english/busdev/facts/09-015.htm

112 www.mnr.gov.on.ca/en/Business/Forests/Publication/MNR_E000245P.html

Alternative Land Use Services (ALUS)

The ALUS concept recognizes that farmers and ranchers can play an important role in producing benefits to Canadians through land stewardship practises. The program builds on the stewardship ethic by recognizing that farmers are in a unique position to restore and enhance nature's benefits to society.

ALUS supports the conservation, restoration, and management of native habitat on working farms and ranches by providing project start up assistance, technical expertise and support, and incentive payments. The ALUS concept is a "fee for service" proposal that recognizes and rewards farmers and ranchers for the role they play in creating healthy, sustainable landscapes vital to healthy human populations. ALUS sees the production of agricultural crops and livestock as compatible with the production of nature's benefits; and seeks to assist farmers and ranchers in continuing to employ land management practises that create productive agricultural systems and healthy rural landscapes.

Alternative Land Use (Prince Edward Island)

The P.E.I. ALUS (Alternative Land Use Services) program was designed to protect or restore the provision of ecosystem goods and services such as the purification of water by wetlands; the filtering of soil and other contaminates from run-off entering watercourses by riparian ecosystems; and the provision of fish and wildlife habitat by forests and rivers. In this program, financial compensation can be obtained for actions taken to reduce levels of soil erosion, stream siltation, or improve water quality and enhance wildlife habitat. These activities include: retiring sensitive land, taking land out of production, and maintaining livestock fences adjacent to water courses and wetlands. Payment is through annual compensation/payments that are subject to audits to verify compliance.[113]

Alternative Land Use (Alberta)

The ALUS (Alternative Land Use Services) program in Alberta pays producers/farmers to provide ecosystem services such as clean air, water and wildlife from their land. The program's goal is to protect and restore wetlands, create buffers along creeks and waterways to improve water quality and enhance fish habitat, plant native grasses around wetlands and uplands for bird-nesting habitat, re-introduce flowering plants for native pollinators, and improve habitat for grouse and other species along shelterbelts, and in restored, natural areas.[114] Providers include farmers, ranchers and hunters. Buyers and brokers include governments, farming and ranching organizations, conservation groups and others. Among the current partners of the program are: the Alberta Conservation Association, Alberta Sustainable Resource Development, County of Vermilion River, Cows and Fish, Delta Waterfowl, and Wildlife Habitat Canada.

Norfolk Alternative Land Use (Ontario)

The Norfolk ALUS (Alternative Land Use Services) Pilot Project in Ontario is a voluntary, incentive-based project testing the concept of providing payments to farmers for returning marginal, environmentally sensitive or inefficient farmland to native vegetative cover and wetlands.[115] Norfolk ALUS supports the conservation, restoration and management of native habitat on working farms and ranches by providing project start-up assistance, technical expertise and support, and incentive payments. The program provides a "fee for service" that recognizes and rewards farmers and ranchers for the changes they make in land use and practices.

113 www.gov.pe.ca/growingforward/ALUS

114 www.deltawaterfowl.org/media/pr/2010/100120-ALUSCanada.php

115 www.norfolkalus.com/index.php?option=com_content&view=article&id=9&Itemid=2

Conservation Land Tax Incentive Program (Ontario)

This program encourages the protection of Ontario's provincially significant conservation lands as determined by the Ontario Ministry of Natural Resources by providing property tax relief to landowners who agree to carry out specific activities to conserve the natural heritage values of their properties.[116] Landowners participating in this program retain full ownership and property rights. The financing mechanism is a 100 per cent tax-exemption on the eligible portion of the property.

Habitat Conservation through Conservation Easements (Ducks Unlimited Canada)

This program focuses on wetland rehabilitation and wetland protection through land conservation easements, donations or purchase.[117] The government or a conservation organization can purchase conservation easements. Landowners can receive tax benefits if the conservation easement is donated to a qualified conservation organization.

Riparian Tax Credit (Manitoba)

This program recognizes farm operators who take actions to upgrade their management of lakeshores and river and stream banks (mostly to prevent soil erosion and to improve water quality). Agricultural and livestock producers across Manitoba who have a lake or waterway running through their property and who voluntarily commit to protect a strip of agricultural land along a waterway (i.e., riparian land) can receive a credit for a five-year commitment period.[118]

Landowners must commit, on former grazing land, to:

i) set up a livestock exclusion zone 100 feet wide along each side of the lake or waterway;

ii) maintain permanent fencing to separate grazing livestock from land in the exclusion zone; and,

iii) use the livestock exclusion zone only for haying.

Payments and tax reductions include the following:

- Former cropland that is no longer cultivated, but that is maintained with native and tame forage, bushes and trees: $20 annually for five years, for a total of $100 per riparian acre.
- Former grazing land used only for haying: $20 annually for five years, for a total of $100 per riparian acre.
- Former grazing land with no agricultural activity: $28 annually for five years, for a total of $140 per riparian acre.
- The basic tax reduction is paid on acreage within the 100-foot strip along the waterway. The basic tax reduction yearly amount cannot exceed 120% of the 2010 property taxes on your farm property.

116 www.mnr.gov.on.ca/en/Business/CLTIP/index.html

117 www.ducks.ca/aboutduc/how/conserve.html

118 www.gov.mb.ca/finance/tao/pdf/riparian/info_for_taxpayers.pdf

PHOTO COURTESY TSAR KASIM

This report is the eighth in a series that studies natural capital and ecosystem services in Canada's major urban centres and provides the first-ever estimate of the economic value of ecosystem services provided by Canada's future Rouge National Park and its surrounding watersheds.

Using valuation techniques from the field of natural capital economics, the report estimates that the Rouge region's rich tapestry of natural, agricultural and cultural assets provide more than $115 million in economic benefits each year, including $12.5 million/yr in benefits from the approximately 6,000-hectare proposed Rouge National Park. The report also provides recommendations for legal, policy and conservation efforts that should be undertaken to ensure the Rouge's ecological health and economic value is maintained in the long term.

For more information on Rouge National Park and natural capital economics, please visit www.davidsuzuki.org.

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