Ecological Services: Valuing Natural Areas within CLOCA

Action Plan #14

Central Lake Ontario Conservation

October 2017

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1. INTRODUCTION

Through the watershed management and planning process, Central Lake Ontario Conservation (CLOCA) has revealed the wealth of natural resources that exist within its jurisdiction and demonstrated the need to preserve these features long-term to maintain healthy watersheds. Protecting and enhancing natural features not only provides habitat for wildlife, it sustains human health and prosperity - an aspect that is often undervalued when land-use decisions are being made in our watersheds.

1.1 PURPOSE

The development of an Ecological Services Action Plan was a recommendation from the Watershed Management Plans. The purpose of this action plan is to look more closely at some of the goods and services that the natural features in CLOCA's watersheds provide to its residents and attempt to frame these services in an economic context.

CLOCA's Strategic Plan also supports the development of this action plan as it will facilitate a better understanding of the importance of our watershed's natural resources and enable CLOCA to build awareness within our watershed community about the social and economic value of our watershed features through an effective and targeted marketing and communication campaign.

1.2 CONTEXT

Through its Watershed Management Plans CLOCA has established minimum forest and wetland cover targets for each of its watersheds based on recommendations from Environment and Climate Change Canada's (ECCC) 2004 publication *How Much Habitat Is Enough?*[1]. Currently, 29% of CLOCA's land cover can be classified as natural, with 11% being forest and 10% being wetland. While the CLOCA jurisdiction is fortunate to have enough wetland cover to meet ECCC's minimum 10% wetland cover target, the watersheds fall short of meeting the recommended 30% minimum forest cover. Although the Watershed Management Plans provide a lengthy rationale for why it is important to meet these land cover targets from an ecosystem health point of view, an economic rationale has not yet been presented. It is hoped that this action plan and its associated communication products will provide additional motivation for policy makers, municipalities and watershed residents to protect and improve natural cover within the CLOCA jurisdiction.

[1] Environment Canada. (2004). *How Much Habitat Is Enough? Second edition.* Toronto, Canada: Environment and Climate Change Canada.

2. DISCUSSION

2.1 WHAT ARE ECOLOGICAL GOODS AND SERVICES?

"Ecological goods and services" are the physical benefits that people derive from nature; generally food, building materials, and fuel. An example of a "good" is the timber that people extract from a forest that is then turned into market goods like lumber. An example of a "service" is the oxygen that forests produce and that people breathe in. Together these goods and services are called "natural capital", and this capital provides benefits over time.

Natural Capital = Ecological Goods + Ecological Services

Unless a market exists for an ecological good or service it is generally difficult to account for its monetary value when land use changes are being considered. As a result, many of the ecological goods and services that sustain human populations, and which would be costly to replace with built infrastructure, are left out of the economic equation when a natural feature is removed. This process is often referred to as revealing the "hidden" economic value of ecosystem goods and services.

Although ecosystems are complex and the relationships between ecosystem components are often not well-understood, efforts have been made to quantify the economic value of the goods and services that natural features provide to people in order to develop more realistic cost-benefit equations and generate additional economic rationale that can be used by land use planners to justify the preservation of local natural resources when faced with competing interests.

2.2 METHODOLOGY

CLOCA has reviewed several natural capital valuations prepared for other jurisdictions and has determined that *Ontario's Wealth, Canada's Future: Appreciating the Value of the Greenbelt's Eco-Services*, prepared by the David Suzuki Foundation in 2008 (referred to henceforth as the Greenbelt report), is the most relevant and replicable example to the CLOCA jurisdiction.

Adopting the structure laid out in the Greenbelt report, monetary values were calculated for the ecological services provided by forests, wetlands, successional habitats, and rivers in each of CLOCA's watersheds. These ecosystem types are defined in Section 8 and the cover for each ecosystem type was determined using the 2017 ELC layer. River calculations utilized the 2016 CLOCA drainage layer.

This report focuses on estimating the monetary value of the services provided by ecosystems rather than the goods, and an overview of the findings for the CLOCA jurisdiction can be found in Section 8. The economic value of each ecosystem type, along with a discussion of the services included in the calculation for that ecosystem type, is presented in Sections 3-6.

2.3 LIMITATIONS

The intent of this valuation exercise is to offer some insight into the economic advantage that protecting these features may provide to Durham Region and CLOCA's municipal partners. In some cases the values developed by the David Suzuki Foundation for the Greenbelt may vary somewhat for CLOCA's jurisdiction and many services may have increased in value as a result of inflation, which has not been accounted for in this exercise. Nevertheless, utilizing their values within our watershed provides a clear illustration of the significance of the value that ecological services provide to our community.

The ecological services valued in this report follow those outlined in the Greenbelt report and include air quality, climate regulation, water runoff and flood control, water filtration and waste treatment, soil formation, biological activities such as pollination, and recreation. However, there are numerous other benefits that humans derive from our natural areas that have not been accounted for or which may not have been incorporated into the valuation of an included service. For example, the value of recreation for various ecosystem types was calculated based on a 1996 national survey that estimated the economic impact of outdoor recreation and asked participants to assess their willingness to pay for such activities. While there is certainly an economic benefit to communities from increased tourism in a natural area, the calculated value does not include any of the human health benefits that people derive from undertaking outdoor activities. Studies suggest that these benefits include decreased stress, improved mental well-being, increased attention span and focus, improved physical fitness, shortened recovery times, and greater social capital, and that these benefits increase the closer natural areas are to people.[2] The decreased load on the Health Care system as a result of fewer people needing medical attention due to increased physical activity likely represents significant sums of saved money, but quantifying those savings is extremely difficult and is not represented in the values presented in this report. As a result, it is safe to say that the economic value of the ecological services outlined in this report are conservative in nature.

[2] Coutts, C., & Hahn, M. (2015). Green Infrastructure, Ecosystem Services, and Human Health. *International Journal of Environmental Research and Public Health*, 9768-9798.

Although it is recognized that the suite of ecosystem services and human benefits included in this report may not be exhaustive, this valuation exercise is still worthwhile as it begins to reveal the otherwise hidden economic value of CLOCA's ecosystems to its residents and planning partners.

2.4 FINDINGS

The annual economic value of forests, wetlands, successional habitats, and rivers to the local and regional economy is almost $130 M. Some of the economic considerations included in this calculation are the estimated cost of replacing an ecosystem service with built infrastructure or with human labour, and/or the health care costs (air pollution only) that are avoided by maintaining natural areas. These considerations are explained in more detail in Sections 3-6.

Per ecosystem type, wetlands are the most economically valuable followed by forests, successional habitats and rivers.

Table 1 – Summary of annual non-market ecosystem service values by ecosystem type for the CLOCA jurisdiction

ECOSYSTEM TYPE	AREA (HA)	$/HA/YR	TOTAL ($M/YR)
Forest	6,683	5,414	36.2
Wetland	6,024	14,153	85.3
Successional	4,502	1,667	7.5
River	966	335	0.3
TOTAL	**18,176**		**128.9**

Per watershed, the Bowmanville/Soper Creek watershed contributes the most towards CLOCA's overall natural capital. This is attributable to its overall size and natural cover, and this trend is consistent across the watersheds with the exception of the Black/Harmony/Farewell Creek watershed, which has slightly less natural cover than the Oshawa Creek watershed but economically contributes more. This is a result of the high proportion of wetlands in this watershed, particularly along the Lake Iroquois Beach.

Table 2 – Summary of annual non-market ecosystem service values by ecosystem type for each of CLOCA's watersheds.

Ecosystem Type	Lynde	Oshawa	Black/ Harmony/ Farewell	Bowmanville/ Soper	Small watersheds (West)	Small watersheds (East)
Forest						
Area (ha)	1406	1093	669	3008	213	291
$M/Year	7.6	5.9	3.6	16.2	1.2	1.5
Wetland						
Area (ha)	1295	833	1333	1798	400	362
$M/Year	18.3	11.8	18.9	25.4	5.7	5.1
Successional						
Area (ha)	974	768	465	1374	408	511
$M/Year	1.6	1.3	0.8	2.3	0.7	0.9
River						
Area (ha)	193	221	138	311	61	41
$/Year	64,745	74,271	46,161	104,252	20,588	13,755
TOTAL ($M/ YR)	**27.6**	**19.1**	**23.3**	**44.1**	**7.5**	**7.6**

3. FORESTS

CLOCA has 6,683 ha of forest cover in its jurisdiction. Table 3 represents a conservative list of the services that forests provide which benefit human health and contribute to the economy.

Table 3 – Summary table of annual forest ecosystem values (including air pollution removal) in CLOCA

ECOSYSTEM SERVICE FUNCTION		KG PER HECTARE	TOTAL KG REMOVED PER YEAR	VALUE PER KG	$/HA/YR	TOTAL ($M/YR)
Air Quality (total)		60	400980	6.29	377.14	2.52
Air Quality components	CO	1.2	8020	1.04	1.25	0.008
	O^3	30.3	202495	7.51	227.59	1.52
	NO^2	7.5	50123	7.51	56.34	0.38
	PM	16.8	112274	5.01	84.25	0.56
	SO^2	4.2	28069	1.83	7.71	0.05
Climate regulation (carbon stored)					919.00	6.14
Climate regulation (carbon uptake)					39.11	0.26
Water runoff control					1,523.00	10.18
Water filtration					473.98	3.17
Soil formation					17.00	0.11
Waste treatment					58.00	0.39
Pollination (agriculture)					1,109.00	7.41
Seed dispersal					537.00	3.59
Biological control					25.97	0.17
Recreation & Aesthetics					334.73	2.24
TOTAL					**5,414.00**	**36.18**

Generally, the most significant services that forests provide for human health are water supply, carbon storage, and air quality maintenance.

3.1 CLIMATE CHANGE

Predicting the impacts of climate change and mitigating for these effects has become an increasingly important task at all levels of government in Ontario. Of primary interest is minimizing atmospheric carbon, the main contributor to climate change, and forests can play a central role in this respect.

There are two distinct ways in which forests can aid in minimizing atmospheric carbon levels:

1. Intact forests are carbon stores. They contain more than half of all terrestrial carbon and when they are removed to make room for agriculture or development this carbon is released, contributing to climate change over time. In the CLOCA jurisdiction forests currently store an estimated 1.5 million tonnes of carbon (220 tonnes/ha), which can be prevented from entering into the atmosphere by simply preserving CLOCA's forest ecosystems.
2. Forests reduce atmospheric carbon levels by removing CO^2 from the atmosphere through respiration (uptake). Based on numbers provided in the Greenbelt report, CLOCA's forests remove an additional 5000 tonnes of carbon each year (0.75 tonnes/ha).

As Table 3 shows, CLOCA's forests provide $6.3M in carbon storage and sequestration services each year, with the primary service being carbon storage.

The economic value of forests as carbon storage banks was calculated using an avoided damages cost. This calculation was developed by the David Suzuki Foundation based on a 2005 estimate of the average cost of global damages due to CO^2 levels in the atmosphere from the Intergovernmental Panel on Climate Change.

The economic value of carbon uptake by forests was calculated using CITYgreen software, a model that quantifies the removal of CO^2 by trees based on their age class. Each age class is associated with a set number of tonnes of CO^2 uptake per year. On average, a hectare of forest removes 0.75 tonnes of carbon annually, and the monetary value of the carbon removed is calculated using the global average cost of carbon emissions. In 2008 it was C$52 per tonne of Carbon.

3.2 AIR QUALITY

Air pollution, in particular carbon monoxide (CO), ozone (O^3), nitrogen oxide (NO^2), particulate matter (PM), and sulphur dioxide (SO^2), is detrimental to human health and has damaging environmental effects, including agricultural crop damage, poor visibility and soil damage. The economic impacts of air pollution are significant, with 70% of associated costs being related to humans and health care needs.

Forests play a significant role in reducing the impacts of air pollution by removing many of them via leaf absorption. Studies have shown that 1 m^2 of tree canopy can remove 8 – 12 grams of pollutants. In terms of mitigating human health impacts, urban forests are most valuable as they remove pollutants from areas where people are concentrated. In addition, trees provide us with oxygen – an essential service.

Table 3 shows that in the CLOCA jurisdiction forests remove an estimated 400 tonnes of pollutants from the air each year, which amounts to an annual economic savings of $2.5M.

3.3 WATER

Forests play a significant role in maintaining water quality and regulating flows, and these services are valuable to human health and well-being.

Water Filtration

As water travels overland through forests they filter, store, and transform pollutants into non-harmful forms. Riparian forests are particularly valuable in this respect. This filtration service helps to ensure that the water entering into our aquifers and into the Great Lakes system is clean, and for municipalities it represents a cost savings: studies show that for every 10% loss in forest cover there is an associated 20% increase in water treatment costs.

In practical terms, the Greenbelt report estimated that water treatment costs would increase from $0.60 per cubic metre to $0.94 per cubic metre in the City of Toronto if a 10% loss of forest cover occurred. By comparison, if residential water had to be replaced by bottled water, the 2008 Greenbelt report estimated that it would cost residents $825 billion per year ($1.50/L).

In the CLOCA jurisdiction it is estimated that forests provide a water filtration value of $3.1M each year.

Run-off Control

Forests protect against flooding and erosion by regulating overland flows. Loss of forest cover leads to changes in the drainage system resulting in lowered water levels in dry seasons, higher water levels in wet years or during rain events, increased sediment in the creek system, and increased water temperatures.

In the CLOCA jurisdiction it is estimated that forests provide run-off control services of over $10M annually.

3.4 OTHER SERVICES

As Table 3 demonstrates, forests provide people with recreational opportunities, contribute to waste treatment and soil formation, and serve a role in agricultural processes. Together these services amount to almost $14M annually.

Recreation

In the Greenbelt report, the value of recreation services provided by forests was based on the economic benefit of tourism and the price that people would pay to participate in nature-based recreation. As was previously discussed under 'limitations' there are likely numerous other human benefits from recreation that have not been accounted for in this valuation.

Pollination and Seed Dispersal

Pollinators are essential for the production of many fruits and vegetables in Ontario and their activities represent an enormous economic value. Natural cover is key to maintaining wild pollinator populations and forests provide important nesting habitat, food and nectar which supports pollinator biodiversity.

Forests provide habitat for birds and mammals, who in turn contribute to the regeneration of natural areas by dispersing seeds. In some instances planting is a paid service and birds and mammals do it free of charge, so there is an economic value to the activity.

Soil Formation, Waste Treatment, Biological Control

Studies suggest that forests also provide humans with services in the form of soil formation, waste treatment, i.e., trapping phosphorus and nitrogen, and natural pest control (providing habitat for birds). They contribute almost $700,000 worth of services each year, based on the estimated cost of replacing them with built infrastructure or human labour.

4. WETLANDS

CLOCA has approximately 6,024 ha of wetland in its jurisdiction. As Table 4 indicates, there are different types of wetlands, each providing a slightly different set of services: as such, the economic value of each wetland type varies slightly.

The most abundant wetland type in the CLOCA jurisdiction is swamp and these wetlands are estimated to contribute almost $7M worth of economic services.

Table 4 – Summary table of annual wetland ecosystem values in CLOCA

Ecosystem Services	Open Water $/HA/YR	Bog $/HA/YR	Marsh $/HA/YR	Swamp $/HA/YR	Fen $/HA/YR	Total $M/year
Climate regulation (carbon stored)	676.59	486.09	539.61	429.41	1,360.35	**2.7**
Climate regulation (carbon uptake)	13.02	13.02	13.02	13.02	13.02	**0.8**
Flood Control	4,038.51	4,038.51	4,038.51	4,038.51	4,038.51	**24.3**
Water filtration	473.98	473.98	473.98	473.98	473.98	**28.5**
Waste treatment (removal of excess P and N runoff)	3,017.00	3,017.00	3,017.00	3,017.00	3,017.00	**18.1**
Habitat/Refugia	5,830.88	5,830.88	5,830.88	5,830.88	5,830.88	**35.1**
Recreation & Aesthetics	335.00	335.00	335.00	335.00	335.00	**2.0**
Total ($ / ha / year)	*14,385.00*	*14,194.00*	*14,248.00*	*14,138.00*	*15,069.00*	
Area (ha)	*166*	*1*	*904*	*4949*	*3*	*6024*
TOTAL ($M/Year)	**2.4**	**0.14**	**12.9**	**69.9**	**0.48**	**85.3**

4.1 CLIMATE CHANGE

Wetlands, like forests, store and sequester carbon. The estimated value of stored carbon and carbon uptake is based on the soils and peat found within wetlands; however, the calculations presented in the Greenbelt report do not consider the carbon uptake that occurs by plants within the

wetlands. It is likely, therefore, that the overall economic value of wetlands, in terms of climate change prevention and mitigation, is underestimated.

4.2 WATER

Water Treatment

The real economic value of wetlands on the landscape is their role in water management. Like forests, they filter contaminants and sediment from point sources and improve the quality of drinking water, and in this respect the Greenbelt report values both forests and wetlands at the same annual rate.

Where wetlands differ from forests is in their ability to treat waste water. They effectively absorb nutrient waste, such as nitrogen and phosphorus, which runs off from farmlands. Studies show that one hectare of wetland can remove 80 – 770 kg of phosphorus and 350 – 32,000 kg of nitrogen each year. If CLOCA's wetlands were subjected to these minimum and maximum nutrient loadings on an annual basis (Table 5) they would have the potential to remove millions of kg of nitrogen and phosphorus from the waste treatment system. At an estimated treatment cost of $22 - $61/kg of phosphorus and $3 - $8.50/kg of nitrogen (2008 values), the potential nutrient removal cost savings from wetlands is significant.

Table 5 – Low-end and high-end estimates of nutrient removal capacity in CLOCA wetlands.

NUTRIENT	ESTIMATED REMOVAL RATE (KG/HA)		REMOVAL CAPACITY OF CLOCA WETLANDS (KG / YR)	
	LOW	HIGH	LOW	HIGH
Phosphorus	80	770	481,920	4,638,480
Nitrogen	350	32,000	2,108,400	192,768,000
TOTAL			**2,590,320**	**197,406,480**

Water Storage

Another important service that wetlands provide is water storage. While both forest and wetland ecosystems help to regulate water flows, thereby providing protection against flooding and erosion, wetlands retain large quantities of water and release it slowly over time. The benefit of this is that there are more stable stream water levels in both dry and wet seasons, reduced sedimentation in streams and cooler water

temperatures. In particular, stream level moderation reduces flooding incidents and provides an important economic benefit for private landowners (protection of property) and government (protection of infrastructure). The estimated value of this service is over $24M/year.

4.3 OTHER SERVICES

The Greenbelt report also assigned economic value to wetlands for their contribution to wildlife habitat and human recreation. In terms of habitat, the service value relates to the cost savings that a community/agency incurs as a result of preserving an existing wetland; in other words, there is value in the fact that money will not have to be spent in the future to restore the lost/degraded wetland. The recreational values, are similar to those for forests and were derived from a 1996 survey. Together, the estimated value of these services is $37 M per year.

5. SUCCESSIONAL HABITATS

The Greenbelt report includes grassland ecosystems in its overall service valuation; however, the CLOCA jurisdiction does not have many, if any, true grassland ecosystems. CLOCA does have numerous idle and regenerating ecosystems that certainly provide benefits and should be accounted for. As such, CLOCA has adopted the term "successional" habitat to describe the 4500 ha of idle fields and regenerating areas within the jurisdiction and has used the ecosystem services and values assigned to the "idle land" category in the Greenbelt report to estimate their economic value.

Table 6 – Summary table of annual successional habitat ecosystem values in CLOCA

ECOSYSTEM SERVICES	$/HA/YR	ANNUAL TOTAL
Climate regulation (carbon stored)	317.00	$ 1,427,134
Climate regulation (carbon uptake)	29.00	$ 130,558
Erosion control and sediment retention	6.00	$ 27,012
Soil Formation	6.00	$ 27,012
Nutrient cycling	24.00	$ 108,048
Habitat for Pollination for Crop Production	1,109.00	$4,992,718
Biological control	40.00	$ 180,080
Cultural Value	138.00	$ 621,276
TOTAL	**1,667.00**	**$7,504,834**

Although successional habitats do not provide the same level of service as forests and wetlands, their contribution can't be overlooked.

- Successional habitats help prevent climate change by containing the carbon stored in the soil and preventing it from entering into the atmosphere.
- Because the land is in permanent vegetative cover, carbon is sequestered from the atmosphere as the vegetation grows thereby helping to slow climate change.
- They contribute to maintaining water quality in the creek system by slowing the flow of overland water, which reduces erosion and retains sediment.
- Successional habitats provide food, nectar and habitat for pollinators, which is an important service for food production and agriculture.
- Habitats in permanent vegetative cover help promote soil formation, cycle nutrients through the food web and contribute to biological control of pests by providing habitat for birds and other wildlife.
- Cultural values have been included for accuracy but the Greenbelt report associates this service more with cultivated agricultural lands and as such it may not be relevant to the successional habitat ecosystem that CLOCA has included in this report.

6. RIVERS

The Greenbelt report doesn't include a discussion about rivers but does assign an economic service value to the ecosystem type of $335 per ha and associates that value with recreation and aesthetics, with the cost derived, presumably, from the same recreation survey that was used to assess value for all of the other ecosystem types. It is unclear from the Greenbelt report if the 'river' category is meant to describe only certain systems or if it applies to all creek systems. CLOCA generally does not have large rivers; rather, we tend to have creeks and streams. As the definition is unknown, CLOCA has included all of its creeks in the calculation and estimates that the recreational value is $323,610 per year.

7. CONCLUSIONS

CLOCA's natural areas play an important role in maintaining ecological integrity and watershed health, but they also contribute to the local and larger economies by preventing flooding, attracting tourism, cycling nutrients, filtering our breathing air and drinking water, and providing habitat for wildlife whose activities directly benefit us. In this report those services have been quantified to paint a clearer picture of how much we benefit from our local ecosystems.

Conservatively, it is estimated that CLOCA's natural areas contribute almost $130 million annually to the economy. In some cases this sum represents actual income generated, but in most cases this sum represents savings to land-owners and government agencies through the avoidance of damage to crops, property or infrastructure, or the avoided cost of replacing a natural service with built infrastructure.

For some benefits, such as human health, it is difficult to account for the role that local ecosystems play in contributing to overall well-being and happiness. Certainly the evidence is mounting that exposure to nature has a positive impact on people's mental and physical health, and it is likely that there is economic value for citizens who require less medical attention or are more productive members of the community.

The purpose of this report was to demonstrate the potential economic value of CLOCA's forests, wetlands, successional habitats and rivers, and it is hoped that the figures provided will further motivate residents, land-owners, and planning agencies to protect existing natural features and continue to invest in enhancing and restoring degraded or lost features across the jurisdiction.

7.1 COMMUNICATING ECOSYSTEM SERVICE VALUES

It is particularly important for watershed residents to understand how valuable local natural areas are for maintaining personal and community health and well-being. As such, CLOCA will follow up this action plan with a series of communication products aimed at raising awareness about how natural areas benefit people. Products may include brochures or fact sheets, interactive online tools such as storyboards, partnering with local agencies to streamline messaging, and working with municipal partners to incorporate the economic value of natural areas into their own budgets.

8. DEFINITIONS

Forest

This ecosystem was defined using the following ELC categories from CLOCA's 2017 ELC layer: CUP, CUW, FOD, FOM, and FOC.

River

This ecosystem type is not defined in the 2008 Greenbelt Report. For this report all creeks were included in the calculation and area (ha) was determined by sorting the streams into smaller and larger segments and applying a 3m average width to smaller creeks and a 10 m average width to larger ones.

Successional

This ecosystem is comprised of regenerating habitats and includes the CUM, CUT, and CUS ELC categories. These habitats are more closely related to the 2008 report's definition of 'idle land', but in practice in the CLOCA jurisdiction it is more fitting to call these lands 'successional'. The values used the by the 2008 report for calculating the services from idle land have been used in this valuation to calculate the service costs for successional ecosystems.

Wetland

This ecosystem was defined using the following ELC categories from CLOCA's 2017 ELC layer: BOS, BOT, FEO, FES, FET, MAM, MAS, SAM, SAS, SAF, SWD, SWM, SWC, SWT, OAO.