Ecosystem services and natural capital

Pierrefonds-West development project

May 2015

Coalition Verte
Green Coalition

ECOSYSTEM SERVICES AND NATURAL CAPITAL

PIERREFONDS-WEST DEVELOPMENT PROJECT

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Report prepared by Gestion Environnement MM

for the Green Coalition and the Association of Proprietors & Residents of Pierrefonds-Roxboro

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CAUTION

The main goal of this study is to assess the value of ecosystem services and natural capital of the area affected by the proposed Pierrefonds-West developpement project. This study was sdone objectively by an outside contributor. The content of this report is based on peer reviewed scientific data and findings. Efforts were made to ensure the precision and exactitude of informations presented. The author of this report is not responsible of the way this data is used or interpretated by the public.

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1 CONTEXT

1.1 Ecosystem services and natural capital

Ecosystem goods and services are the benefits provided to society through the functions of various elements of the natural environment. In fact, ecosystems, by their composition, structure and productivity, play important roles in supporting and regulating the environment we live in. These are the services that ensure a balance between the natural environment and the community.

The benefits of these services are quantifiable and represent the natural capital of the ecosystems. Using various economic methods, it is therefore possible to assess the value of ecosystem services. This evaluation results in a value of $/hectare that can be associated with different ecosystems according to their type and to the services they provide.

Table 1.1 presents the various services provided by natural ecosystems.

1.2 Evaluating economic ecosystem value

The assessment of the economic value of natural capital is becoming increasingly relevant today. In addition to offering practical arguments for policy makers, this assessment also creates practical tools to help with planning, management and decision-making.

In our case, the objective of this assessment is to estimate the monetary value assigned to different ecosystems. The total economic value is divided into several types of value: the direct use value, indirect use value, the optional use value and the non-use value of. Figure 1.2 shows the chart of these values and concrete examples to be considered in the total economic evaluation of natural capital.

Since no market exists for most ecosystem goods and services, the economic evaluation of these attributes is not always easy or straightforward. Nonetheless, more and more research is performed in this field. This research is based on various concrete and proven methods to estimate the economic value of various services.

Table 1.1: Type of ecosystem services

Ecosystem services	Ecosystem function	Example of services
Atmospheric regulation	Stabilisation of chemical composition of the atmosphere	Carbone-oxygen regulation
Climate regulation	Regulation of temperature, microclimates, regulation of precipitation	Gas concentration, forming of clouds, shading, cool zones
Water regulation	Stabilizing water levels and debit, water retention	Water retention, irrigation, protection against floods, protection against droughts, supply of aquifers
Waste disposal	Recovery and removal of nutrients and compounds	Water filtration, soil detoxification, air pollution control
Erosion control and retention of sediments	Soil retention	Prevention of soil loss due to wind or water, sediment storage
Soil forming	Physical and chemical soil formation process	Rock alteration and accumulation of organic matter
Nutrient cycling	Storage, cycling, processing and supply of nutrients	Nitrogen fixing, nutrient cycling
Pollination	Movement and role of pollinators	Pollination of edible plants (fruits, seeds, nuts, etc.)
Biological control	Population control (vegetation, herbivores, carnivores, scavengers, etc.)	Biological control of pests, competition against weeds
Wildlife habitat	Habitat for resident and transient species	Nurseries, habitat for migratory species, habitat for harvested species, wintering habitat
Raw materials	Primary natural resources	Wood, fuel, crops, hunting and fishing
Genetic resources	Biological material and genetics	Medicine, science, genes, pathogen resistance, ornamental species
Leisure	Potential recreational activities	Ecotourism, hunting and fishing, swimming, boating, wildlife viewing, hiking, etc.
Culture	Non-commercial uses of the environment	Aesthetics, arts, education, spirituality, science, local culture and heritage

Adapted from (Wilson, 2008; Olewiler, 2004)

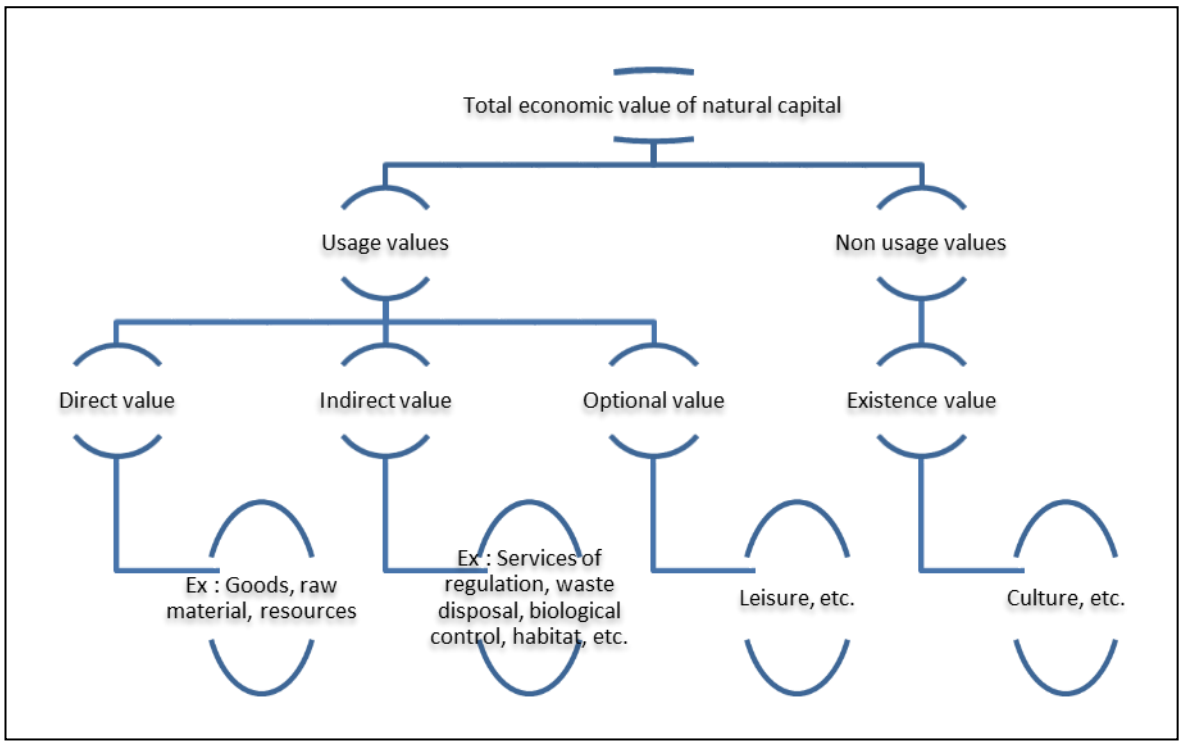

Figure 1.2: Total economic value of natural capital and its components

1.3 Pierrefonds-West

The land use planning and development plan of the City of Montreal, as well as its urbanism plan, identifies a large track of land of about 185 hectares (457 acres) in Pierrefonds-West to be destined for a major housing development.

Nonetheless, the development project proposes more than 5 000 housing units that would be established in an area targeted for conservation. In fact, this area could be included within the Anse-à-l'Orme conservation corridor. This area is known for its ecological interest due to its grasslands, woodlands, streams and marshes which provide essential and exceptional habitat for wildlife.

2 PORTRAIT OF CURRENT LAND USE

The first step to evaluating the value of the natural capital of the Pierrefonds-West development area is classifying and mapping its current land use. The land use cover analysis is done by using geographic information system (GIS) software as well data from several sources.

The target area includes the assigned as residential by the City of Montreal, a total area of 180 hectares (445 acres). Some areas within the proposed development project aren't included within the assigned area and were not considered during this analysis as they are not part of the Projet particulier en urbanisme (PPU) proposed by the City of Montreal. Figure 2.1 shows the targeted area for this current analysis.

Figure 2.1: Target area for land use analysis as part of evaluating the value of natural capital

2.1 Woodland cover

Woodland covers 41.95 hectares (103.7 acres) within the target area, which represents 23.3 % of this area. Forest cover within the targeted area is quite fractionated into

patches. In fact there is no extended connectivity of forests within this area. There are three main patches of forest. The biggest one is located on the east side of the study area. The forests have connectivity mostly towards the west and south-west, where it connects with other forests from conservation areas nearby. Figure 2.2 shows forest cover within the target area.

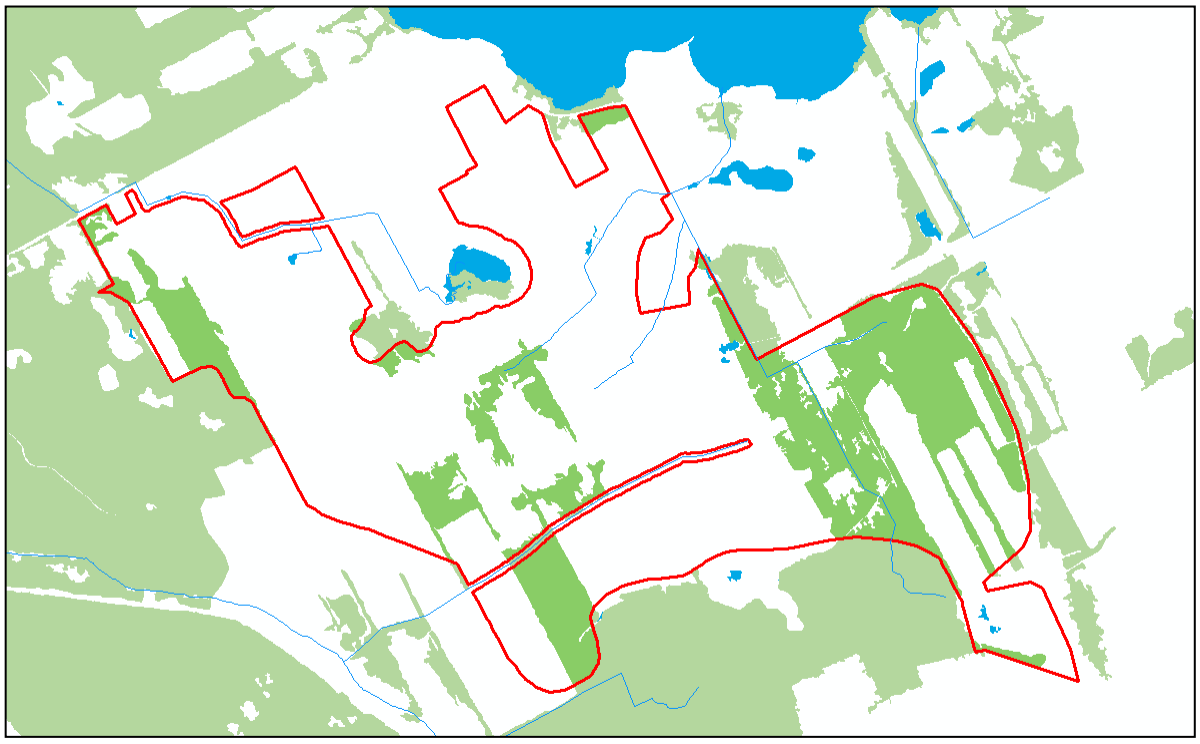

Figure 2.2: Forest cover within the target area

2.2 Cropland and pastures

Other than the forested areas, the remaining cover, representing over 138 hectares (341 acres), is mostly old pastures and fields. Some of these pastures are transitioning to early stage tree cover of pioneer species such as aspen and birch. This large track of unused agriculture land within the target area connects to other fields to the north, the east and the west. Figure 2.3 shows cropland and pastures within the target area.

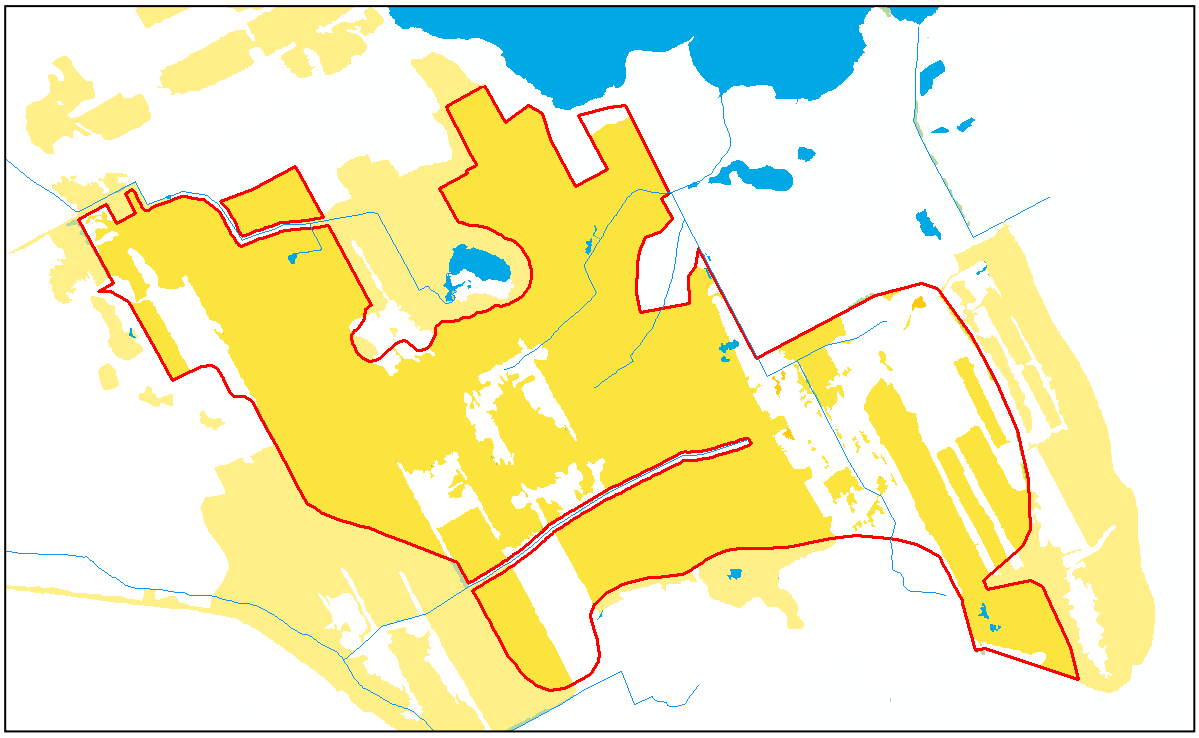

Figure 2.3: Cropland and pasture cover within the target area

2.3 Wetlands

A few wetlands are located within the target area. Some of these wetlands are located near streams, while others are located in the lower, southern part of the target area. The wetlands are swamps and wet meadows. In total, they represent 4.11 hectares (10.15 acres) within the study area. By their nature, some wetlands also count towards total forest cover, as others are meadows and pastures. Figure 2.4 shows these wetlands located in and around the target area.

2.4 Summary of land use

Table 2.1 shows the total land uses according to the area they cover within the target area. This data is used to evaluate the total value of natural capital for this area.

Figure 2.4: Wetland cover within the target area

Table 2.1: Summary of land use and total area

Land use	Total area	Percentage of total area
Rural woodland	41.95 hectares	23.3 %
Pasture and range land	138.13 hectares	76.6 %
Rural wetland	4.11 hectares	2.28 %

3 EVALUATION THE NATURAL CAPITAL

The natural capital derives from the economic value of goods and services provided by each ecosystem within the target area. Table 3.1 shows those to be considered in this study.

Table 3.1: Goods and services provided by each ecosystem type located within the targeted area

Land use	Ecosystem services to be considered
Rural woodland	• Air quality • Climate regulation • Water provisioning • Waste treatment • Pollination • Biodiversity habitat • Disturbance prevention • Recreation
Pasture and range land	• Waste treatment • Erosion control • Pollination • Biodiversity habitat • Nutrient cycling • Aesthetics • Recreation
Rural wetland	• Water provisioning • Waste treatment • Biodiversity habitat • Disturbance prevention • Recreation

(Adapted from Dupras, 2014)

3.1 Methodology

A great deal of these ecologically significant services do not refer to any existing economic market and therefore, these arguments are rarely taken into consideration in decision making and often leads to unsustainable use. Understanding the economic value of these services can be quite useful in cost-benefit analysis when comparing land use alternatives. The benefit transfer method is widely used to transfer a monetary value to non-market environmental benefits.

This topic has become quite an important research interest among applied scientists and the benefit transfer has been applied to many situations across North America and the world. Comparing results of these studies allows appreciation of the complexity of the task at hand when evaluating the economic benefits of ecosystem services.

This type of study has recently been done by Jérôme Dupras, Ph.D. student of University of Montreal. During his thesis, he selected 103 economic value estimates from 62 peer-reviewed studies that estimate values of ecosystem services also provided by southern Quebec natural environments and referring to temperate regions. Because his work is substantial and applies quite well to the Pierrefonds-West area, the results of his thesis were used for the current study.

3.2 Results

Because economic value estimates are taken from many studies, they allow us to obtain an average value for each of the services provided by the ecosystems studied, as well as considering the lowest value, the highest value and the standard deviation of the obtained values. The following tables present the results of Dupras' thesis on this matter. Table 3.2 shows non-market values provided by rural woodlands, pastures and range land as well as rural wetlands. The values are expressed in 2013 Canadian dollars per hectare per year.

Table 3.2: Non-market values of ecosystem services based on Dupras, 2014

Land use	Ecosystem services	Nb. of studies	Non-market values ($/ha/yr)			
			Min. value	Max. value	Mean value	Standard deviation
Rural woodland	Air quality	1	-	-	414	-
	Climate regulation	4	2	116	48	53
	Water provisioning	1	-	-	594	-
	Waste treatment	1	-	-	137	-
	Pollination	1	-	-	4	-
	Biodiversity habitat	8	2	6 987	2 344	3 025
	Recreation	4	4	5 261	700	1 170
Pasture and range land	Waste treatment	2	100	135	117	25
	Erosion control	3	59	189	106	71
	Pollination	2	18	39	29	15
	Biodiversity habitat	1	-	-	5	-
	Nutrient cycling	1	-	-	143	-
	Aesthetics	6	21	187	75	68
	Recreation	1	-	-	143	-
Rural wetland	Water provisioning	2	8	53	30	32
	Waste treatment	8	35	6 224	2 252	2 488
	Biodiversity habitat	8	2	4 148	1 172	1 792
	Disturbance prevention	5	30	5 823	1 430	2 492
	Recreation	19	18	2 443	579	658

(Adapted from Dupras, 2014)

Using the non-market value and the total area of these different ecosystems, the total non-market value of the natural capital of the Pierrefonds-West study area can be calculated. Table 3.3 shows these results.

Table 3.3: Summary of the non-market values provided by ecosystems located within the Pierrefonds-West study area

Land use	Total area (ha)	Non-market values ($/ha/yr)			Total values ($/yr)		
		Min. value	Max. value	Mean value	Min. value	Max. value	Mean value
Rural woodland	41.95	1 157	13 513	4 241	48 536	566 870	177 910
Pasture and range land	138.13	489	841	618	67 546	116 167	85 364
Rural wetland	4.11	93	18 691	5 463	382	76 820	22 453
				Total	116 464	759 857	285 727

Using the non-market of every type of services associated with each ecosystem, it is also possible to calculate the total non-market values per ecosystem service. See Table 3.4.

Table 3.4: Summary of the non-market values per ecosystem service within the Pierrefonds-West study area

Ecosystem services	Occurrence in ecosystems	Total values ($/yr)
		Mean value
Air quality	1	17 367
Climate regulation	1	2 014
Water provisioning	2	25 042
Waste treatment	3	31 164
Erosion control	1	14 642
Pollination	2	4 174
Biodiversity habitat	3	103 838
Nutrient cycling	1	19 753
Disturbance prevention	1	5 877
Aesthetics	1	10 360
Recreation	3	51 497
	Total	285 727

(Adapted from Dupras, 2014)

4 USING THE NATURAL CAPITAL IN PLANNING AND DECISION MAKING

The results of the economic study done on the targeted area of Pierrefonds-West shows a net value of more than 285 000 $ (2013 dollars) per year in terms of services provided by the ecosystems. This information becomes quite useful and should be used as a planning and decision making tool.

4.1 Guiding conservation efforts

As part of his doctorate thesis, Mister Jérôme Dupras also analyzed the natural capital in a half century perspective in relation to urban sprawling in the Montreal metropolitan area. In this study, he evaluated the impact of urban sprawling and the loss of ecosystem services economic value over a period of 45 years, between 1966 and 2011. During this period that showed an increase of 48.7% of the population of the Montreal Metropolitan Region, large portions of natural ecosystems were transformed and lost due to urban sprawling. This loss includes a decrease of 20% in croplands and 28% in forests correlated with an increase of 59,700 hectares of urban areas, an increase of 93% in this same time period. It also includes a loss of 100 hectares of wetlands (6%) and 7,800 hectares of grasslands (30%). This also results in loss of ecosystem services such as food production, climate regulation, air quality, water provisioning, waste treatment, erosion control, pollination, disturbance protection, biodiversity habitat, pest management, nutrient cycling, aesthetics and recreation. This study concludes that, between 1966 and 2011, the loss of ecosystem services can be evaluated at 235.6 millions dollars per year, which represents a loss of 22.9% compared to the 1966 economic evaluation of natural capital.

Using the know data on loss of ecosystem services over the last decades as well as the current data obtained for the target area of Pierrefonds-West, one could argument the priority for protecting the remaining services within the Montreal Metropolitan Region. When it comes to planning conservation efforts, it would seem much more beneficial to protect ecosystems provide the services that are being lost. According to Dupras' thesis, the greatest losses in terms of ecosystem services are related to climate regulation

(29.4%), air quality (28.3%), pollination (28.6%) and biodiversity habitat (29.1%). Protecting forests and pastures would help preserve these same services. Within the target area of Pierrefonds-West, it would be beneficial to protect the forest and pasture ecosystems that offer the greatest value in terms of climate regulation, air quality, pollination and biodiversity habitat. A basic survey and characterization of the Pierrefonds-West area would help prioritize the conservation efforts accordingly.

4.2 Guiding land use planning

On a broader level, ecosystem services and natural capital should become a central and pivotal argument to consider when planning land use in an urban setting. As the Dupras thesis as shown, urban sprawl in linked to great losses in terms of ecosystem services and economic value. Future development will prove to be a challenge when it comes to protecting these ecosystems services, especially when considering the recent projections of growth.

In this sense, it is important to use economic value to better plan in order to protect the services with the most value. Land use planning could therefore avoid the loss of ecosystems with higher ecosystem service value and aim development and urban sprawl in ecosystems with less ecosystem value.

In the same way, measures can be taken to protect certain services provided by ecosystems even if urban development is done. Protecting forest cover within a housing project for example can partially preserve services related to climate regulation, air quality and biodiversity habitat. The same can be said about wetlands which could provide water regulation services within a developed area. Preserving open spaces and pastures within urban areas partially protect pollination services, as well as cultural and recreational values for the community.

4.3 Guiding compensation and restoration efforts

When development is unavoidable, known data on ecosystem services and natural capital value would serve as a basis for compensation. In fact, measures could then be taken to

compensate artificially for the affected services. For example, water regulation basins and other measures could be deemed necessary in an area in which these services where provided naturally by wetlands. Replanting trees in public areas and parks can also help compensate for the loss of services pertaining to climate regulation and air quality.

4.4 Recommendations regarding the Pierrefonds-West target area

Considering the aforementioned points of discussion, recommendations can be formulated to the Green Coalition and other stakeholders regarding the future of the Pierrefonds-West area:

- Raise awareness of the public with regards to the economic value of ecosystem services within the Pierrefonds-West target area;
- Use ecosystem services of the Pierrefonds-West area such as climate regulation, air quality, pollination and biodiversity habitat as arguments when communicating with local and regional stakeholders;
- Prioritize conservation efforts for ecosystems that contribute the highest in ecosystem services within the Pierrefonds-West area;
- Ensure that city planners consider ecosystem services when planning land use within the Pierrefonds-West area and that these concerns are taken into consideration using proper cost/benefit analysis;
- Ensure that measures are taken to compensate and restore ecosystem services that could be lost following any development within the Pierrefonds-West area.

5 CONCLUSION

The current study as allowed us to evaluate the economic value of the services provided by the natural ecosystems located within an area targeted for development in Pierrefonds-West. Based on available GIS data, the current land uses within the target area was evaluated. In total, the 180 hectare study area is composed of 41.95 hectares of rural woodland, 138.13 hectares of pastures and range land and 4.11 hectares of rural wetlands. Using data from a recent doctorate thesis based on peer reviewed and proven research in this field, economic values were assigned to various ecosystem services such as air quality, climate regulation, water provisioning, waste treatment, erosion control, pollination, biodiversity habitat, nutrient cycling, nutrient cycling, disturbance prevention, aesthetics and recreation. In total, the study evaluates that the current natural ecosystems are providing services that accounts for a total economic value of more than 285 000 dollars per year.

The results could be used as a basis for raising awareness of the population as well as for ensuring that these values are taken into account by stakeholders in the planning process for the target area. The results of this current study could be used in a formal essay presented to the stakeholders in order to share the Green Coalition's position regarding the proposed development project and to recommend various measures that should be taken to protect this area. Other issues can also be taken into account when analyzing the proposed project and added to this essay, such as transportation, housing, agriculture land, biodiversity, heat-islands and protecting the Anse-à-l'Orme corridor. These various issues could all be considered in a broad cost/benefit analysis.

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APPENDIX 1: LIST OF PEER REVIEWED STUDIES USED FOR EVALUATING THE ECONOMIC VALUE OF ECOSYSTEM SERVICES

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