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Riparian wetland conservation: A case study of phosphorous and social return on investment in the Black River watershed

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ABSTRACT

This paper applies a social return on investment (SROI) analysis to the issue of wetland conservation in the Black River watershed of the Lake Simcoe basin in southern Ontario, Canada. Watershed hydrologic modeling applied to wetland loss and restoration scenarios in the study area provides local estimates of the ecosystem service provision related to phosphorus removal. Locally appropriate monetary values are applied to these services to gauge the cost effectiveness of conservation funding at two levels: phosphorous reduction capacity alone and then incorporating a suite of ecosystem services. A SROI analysis indicates that phosphorous reduction services provide a 0.045 ratio of benefits to costs and therefore alone do not justify expenditure on wetland conservation, though they supplement the function of the local Water Pollution Control Plant (WPCP). When the SROI includes other ecosystem services the ratio ranges from 3.60 (retention) to 0.15 (full restoration). This example highlights the value of wetlands in providing phosphorous reduction and additional ecosystem services (ES) in a financially viable manner to address watershed eutrophication problems in Lake Simcoe.

1. Introduction

Southern Ontario is one of the most densely populated regions of Canada and is facing increasing development pressure from agricultural, urban and sub-urban expansion (Government of Ontario, 2014a). The conversion of natural forest and wetland ecosystems in the area occurred in the past due to the benefits derived from increased urban, industrial agricultural production and in recent years due to the attraction of rural cottage lifestyles and resultant supporting infrastructure in the form of transportation corridors, stores and the services industry. While households, businesses and society have received financial benefit from this conversion, it has come at a cost to ecosystem health. Lakes and rivers across southern Ontario are suffering from nutrient loading, resulting in loss of recreational opportunities and water quality. Phosphorous loading from agriculture and urban runoff has been identified as a major cause of this environmental problem and a major public health issue. The Lake Simcoe basin north of Toronto is a prime example and the eutrophication of the lake highlights the pressing need for action to limit phosphorous loading (Government of Ontario, 2010).

In this paper we explore the possibility of investment in riparian wetland[1] conservation as a natural alternative to expensive technological solutions to mitigate and correct phosphorous loading in Lake Simcoe. Using locally specific biophysical data on phosphorous reduction by riparian wetlands, we employ a social return on investment (SROI) approach specifically intended to incorporate social and environmental values into an economic analysis[2] that is conceptually familiar to policy makers and the general public. Using a case study from the Black River watershed of the Lake Simcoe basin in southern Ontario, we pose two research questions:

1) Do wetland ecosystems in this area present a viable financial and social option to limiting phosphorous levels in Lake Simcoe?

2) Is investment in wetland conservation an environmentally and economically viable use of public funds?

The paper will describe the case study area from southern Ontario

Abbreviations: SROI, social return on investment; WPCP, Water Pollution Control Plant; NPV, net present value; SWAT, Soil and Water Assessment Tool; NSC, Nash-Sutcliffe coefficient; TN, total nitrogen; TP, total phosphorous

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[1] Non-riparian wetland loss in the watershed was not included in this analysis.
[2] SROI has been used effectively by various organizations, including the New Economics Foundation in the UK and the Canadian Evaluation Society.

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and the Black River watershed; provide an overview of social return on investment and watershed hydrological modeling methods; and present results from a "phosphorous" return on investment and then social return on investment. These results will be further discussed in the context of wetland conservation policy in Ontario specifically and Canada generally. Conclusions will be drawn and recommendations made.

1.1. Background

Natural ecosystems provide the foundation of a functioning human society. We rely on our landscapes for the food that feeds us, the materials that house us, and the clothes that cover us and for the water that we drink. Expanding human populations and increasing consumptive demand has strained these ecosystems and compromised the ecological integrity of the natural world (Millennium Ecosystem Assessment, 2005). Dramatic agricultural and urban expansions have significantly altered the landscape. The Millennium Assessment estimates that 60% of global ecosystems are being used at an unsustainable rate (Millennium Ecosystem Assessment, 2005).

Wetlands have been identified as one of the most ecologically diverse and productive ecosystems on the planet (Millennium Ecosystem Assessment, 2005). They are also one of the most threatened by advancing economic development and climate change; 64% of the world's wetlands have disappeared since 1900 (Dixon et al., 2016) and there has been a 40% decrease in a global sample of wetlands since 1970. This trend is also observed in Canada. Since European settlement in the 1800s, it is estimated that approximately 20 million hectares of wetlands in Canada have been drained for agricultural purposes and the total loss from human development is considered to be approximately 70% of historical levels (Olewiler, 2004). In southern Ontario more than 2 million hectares of wetlands in the 1800s comprised nearly 25% of the total land area. By 2002, 72% (1.4 million hectares) of these wetlands had been converted to other uses (Ducks Unlimited Canada, 2010). This loss has occurred despite increasing commitments by governments internationally, such as the Ramsar intergovernmental treaty on wetlands implemented in 1975; nationally, such as the 1991 Canadian Federal Wetland Policy (Government of Canada, 1991); and provincially and locally (Government of Ontario, 2014b, 2016; Grand River Conservation Authority, 2005).

Advancing scientific understanding of the ecosystem functions from wetlands has quantified what were more general assumptions: nutrients from the water are removed when they pass through wetlands; carbon is sequestered by vegetative growth; and natural water bodies regulate water-flow on the landscape. These services impact the communities in different ways and at different spatial and institutional scales (Hein et al., 2006). Local individuals and communities suffer from contaminated water, lost productive and recreational values; regional impacts accrue from regulation services such as water quality and ecological health; and international stakeholders derive benefit from regulation services and biodiversity (Hein et al., 2006). Thus the loss of natural ecosystems such as wetlands is no longer the sole concern of environmentalists and policy makers - eutrophication of recreational lakes, increased flooding and contaminated drinking water sources have brought the issue into the "backyards" of many communities across Canada (Olewiler, 2004) and impacts individuals, communities and governments in different – yet important ways.

In economic theory the concept of ecosystem services (ES) began in the late 1970s with the utilitarian framing of ecosystem functions to enhance public interest and advocacy towards biodiversity conservation (Gómez-Baggethun et al., 2009). An important international guide on the economic valuation of wetlands is found in Barbier et al. (1997) and several studies conducted have been conducted within Canada (Liu et al., 2008; Pattison et al., 2011; Rooney et al., 2015; Yang et al., 2010, 2016). Despite the increasing conceptual role that ecosystem services play in the scientific literature and policy dialogue, practical and cost-effective methods to monetize ecosystem services to inform public policy are limited due to financial and time constraints. Contingent valuation studies require extensive public surveys and careful technical design (Carson, 2011; Pattison et al., 2011) and reverse auctions require extensive public engagement and research expertise (Boxall et al., 2013; Hill et al., 2011). An appropriate way to incorporate ES understanding within policy decisions is ongoing.

2. Study area: Black River watershed

Our study area is a representative watershed in Ontario that has locally, national and international relevance. Ontario is endowed with natural ecosystems that provide many essential environmental and economic services to the provincial and local economies (Wilson, 2008). Of these ecosystems, wetlands have been identified as the single most important source of natural capital (Troy and Bagstad, 2009), providing a broad sweep of ES. These include improving surface water quality, ensuring sustainable drinking water sources, mitigating the impacts of climate change, mitigating the impacts of drought and floods, providing habitat for wildlife and maintaining and enhancing biodiversity.

The Lake Simcoe basin north of Toronto has been subject to particularly high levels of conversion to agricultural and urban development. Currently wetlands cover 38,974 ha (12%) of the total land base, including swamp, marsh, shallow water with vegetation, fen, and shrub bogs (Wilson, 2008). As in other parts of southern Ontario, this represents a significant decrease from historical numbers. In the study area – 323 km^2 Black River watershed (see Fig. 1), riparian wetland areas decreased from 11,237 ha in the year 1800–7590 ha in 2008, representing a loss of 3647 ha or about half of the existing wetlands (Yang et al., 2016). These historical wetland areas have been primarily replaced by urban development, agricultural expansion, rural cottage properties, urban brown fields, and transportation corridors (Ducks Unlimited Canada, 2010). Drainage policy, which was implemented in the early 1900s and is still in use today, accelerated the conversion to agricultural use[3] (Government of Ontario, 2016) to provide food for expanding urban populations. Lake Simcoe's proximity to Toronto has further increased the demand for enhanced transportation and service infrastructure from the approximately half million resident commuters and weekend cottage owners (Government of Ontario, 2014a).

Addressing wetland loss was not a policy priority in the watershed until high levels of phosphorous were discovered in Lake Simcoe itself. The resulting eutrophication served to negatively impact the recreational fishery and boating industry, causing concern amongst property owners around the lake and recreational users alike (Government of Ontario, 2008, 2010). A direct link was identified between the loss of wetland ecosystems and the severe eutrophication of the lake (Yang et al., 2016). Nutrient loading, primarily due to phosphorous from agricultural runoff and urban wastewater, is having a negative impact on water quality and recreational activities. Concern over this degradation led to public outcry (Government of Ontario, 2010) and various conservation initiatives at the local (Kennedy and Wilson, 2009), provincial (Government of Ontario, 2008, 2010) and international levels (Werick, Lupi, and Leger, 2006). Ultimately, the Ontario government implemented a phosphorous reduction strategy in 2010 (Government of Ontario, 2010). The Lake Simcoe Phosphorous Reduction Strategy targeted 44 t/year as the maximum level of phosphorous to enter the Lake from all sources (Government of Ontario, 2010).

[3] The Ontario Ministry of Agriculture website currently states that "Profitable returns from farmland depend on effective drainage. A farmer may be convinced of the need for improved drainage but the complications that may arise when he considers undertaking such work often delay action" (Government of Ontario, 2016).