A Review of Watershed Restoration Practices and Partnerships in the Toronto region

Elise Mackie

September 5th, 2018

A Major Paper Submitted to the Faculty of Environmental Studies in partial fulfillment of the requirements for the degree of Master in Environmental Studies, York University, Toronto, Ontario Canada.

Foreword and Acknowledgement

This Major Research Paper (MRP) is written as a partial component for the completion of my degree of Master in Environmental Studies (MES) at York University. This program is a self-directed and interdisciplinary program, which allows for supportive and diverse learning opportunities in the field of Environmental Studies. The subject of this major research paper is within the scope of the MES program, my Plan of Study (POS), and the research proposal pertaining to MRP. Having taken technical courses in ecological restoration, I found there was a need to further examine not only the scientific aspects of the practice but also the economic, social and political aspects. Since September 2017, I have been expanding my knowledge on the subject of ecological restoration, and specifically watershed restoration in an effort to become a well-rounded restoration practitioner. At the beginning, I had little knowledge of the political and economic side to ecological restoration. Accordingly, through the courses I took and through the research I conducted in May, April and June of this year, I have been able to expand significantly on my understanding of these factors. I embarked on the research phase for the MRP, and had the opportunity to engage with watershed restoration experts working in the field. This helped with the presentation of a well-researched and revealing paper. I would like to thank my supervisor from the University, Mark Winfield, who provided meaningful insights, tremendous support, and strong aims that were instrumental to the completion of this paper. I would also like to thank my advisor Peter Timmerman for his forward-thinking and influential views on the subject; and finally, the always supportive Elinor Perkins willing to lend advice and informative books from her personal collection.

Table of Contents

Abstract

With the continued urbanization of cities through the Great Lakes Basin, the continued degradation of these areas will occur without substantial efforts to restore the natural environment. The research in this paper explores the sustainability of the watershed restoration project implemented in the Toronto region of Ontario Canada. It is assessed through the use of four indicators: Land and Water Acquisition, Adaptive Management, Funding Process, and Public Participation and Community development. The lessons learned through the research, interviews, and analysis of four watershed restoration case studies in the Toronto region help to inform and improve on the methods and tools used for watershed restoration projects across the Great Lake Basin. The normative UPE framework used to assess the sustainability of watershed restoration projects uncovered some significant issues in the entire watershed management framework. This combined with pragmatic methods and tools like adaptive management, provides insights and information concerning the intricate relationship between watershed restoration and the social, political and economic sphere. The recommendations for future watershed restoration work include enacting a streamlined watershed restoration communication centre, a standardizing an adaptive management framework through consistent funding tactics, and implementing innovative public engagement tools. This is all to help advance the sustainability of the watershed restoration projects, and the overall health and sustainability of the Toronto region watersheds. This might ultimately shift us from an era of watershed degradation in the Toronto region to an era of watershed restoration and help mitigate the impacts from urbanization through sustainable watershed restoration projects.

Keywords: Watershed restoration, urbanization, policy evaluation, urban political ecology, sustainability indicators

PART 1: DEFINING RESTORATION AND THE NORMATIVE APPROACH

1. INTRODUCTION

An especially memorable descriptor for a watershed is that of a bathtub where the collected water and residues are directed into to a central location (Kauffman, 2016). In the bathtub of the Toronto region one can imagine the rims coated in contaminated grim including, sewage, sediment, polybrominated diphenyl ethers, polycyclic aromatic hydrocarbons, and polycyclic musks (Melymuk et al., 2014). The adverse impacts of pollution affecting the Toronto region watersheds are especially severe, due to its industrial and agricultural past. The impacts from the release toxic contaminants from industry, and the influx of agricultural fertilizers into the region's waterways is still felt today. Furthermore, the current and unrelenting watershed issue is the rapid urbanization of the city. The transformation of land for the development of residential and commercial areas is adding to the numerous environmental pressures impacting the Toronto region watersheds. Not only is pollution an on-going issue, other broad issues include hydrological impacts like burying and infilling of rivers and streams, hydrological modifications to shorelines, the loss of native biodiversity, and the introduction of harmful invasive species.

These adverse human impacts to the water, local habitats, and the watershed system have persisted for more than a century. Consequently, over the past half-century environmental concern for the Great Lakes and its basin has increased in nearby communities. Experts studying this complex ecosystem also add to these concerns with mounting research on various issues impacting the area (Creed & Laurent, 2015). A prevailing and strengthening perspective in the academic community is that the basin's integrity is at a tenuous point and has the potential to reach a breaking point (Bails et al., 2006). These growing concerns are very present in the

Toronto region, suggested by the numerous organizations, agencies, and communities working towards improving the state of the region's watersheds.

The definition of a watershed is a geographically bound physical area that captures precipitation, filters and stores water, and regulates the amount of water released into the lower streams, rivers, lakes or oceans (Conservation Ontario & TRCA, 2015; U.S. Environmental Protection Agency, 2016). Watersheds are small or large depending on the scale and scope in consideration. The smaller watersheds (called sub-watersheds) merge to become larger watersheds. The Toronto and Region Conservation Authority (TRCA) identifies nine watershed areas located in the Toronto region, whose river systems flows into Lake Ontario. The nine watersheds delineated in the Toronto region are part of the Lake Ontario watershed, which is a sub-watershed of the Great-Lakes and Saint-Lawrence basin watershed. This sub-watershed is at its final outflow connected to the Atlantic Ocean watershed (Conservation Ontario & TRCA, 2015; Government of Canada, 2007; Government of Ontario, 2014).

1.1. Describing Ecological and Watershed Restoration

A landscape restoration is comprised of many individual ecological restoration projects in differing yet connected ecosystems. The objective of a landscape restoration is to recover environmental resiliency, and also to regain the ecosystems services created by the various interacting ecosystems. Not only does it set to recover these natural flows, but a landscape restoration can also help to re-establish the cultural values that go unfulfilled through the restoration of a single disjunctive ecosystem. In a landscape restoration the activities occur simultaneously or sequentially on selected, or all the ecosystems in the designated area (Clewell & Aronson, 2013). Watershed restoration is a landscape restoration exercise, as rather than focusing on one ecosystem, a watershed restoration links the stream, river, tributaries,

floodplains, wetland systems, stream banks, riparian habitat, and the surrounding woodland. The restoration of a watershed is the restoration of fragmented landscapes, thus prompting the regeneration of wildlife corridors, and free-flowing streams, and a diversity of native species.

The planning and practice of ecological restoration in many cases use the following common and most accepted definition (Martin, 2017). Located in the Society for Ecological Restoration handbook (p. 4) it is as follows: "the process of assisting the recovery of an ecosystem that has been degraded, damaged and destroyed" (Society for Ecological Restoration International Science & Policy Working Group, 2004). Set in 2004 by the Society for Ecological Restoration, the definition is narrow in its conception for the practice of ecological restoration (Martin, 2017; Society for Ecological Restoration International Science & Policy Working Group, 2004). Many new definitions arose over the last two decades attempting to balance the modern views on what ecological restoration accomplishes. As such, they encourage an evaluation on factors motivating the restoration of degraded ecosystems (Martin, 2017). Furthermore, to account for the long-term and latest environmental problems, the perspectives and the associated definitions of ecological restoration are shifting and broadening.

An out-dated definition of ecological restoration like the Legacy Model can hold some relevancy. This definition has the impossible objective to reach a "pre-human degradation" target state in a restored ecosystem. To reach this "pre-human" objective, requires the diligent scrutiny of the historical and pre-degraded ecosystem characteristics. This scrutiny helps provide invaluable information concerning the future state of the restored ecosystem, thus it is still relevant to the science and practice in some degree (Clewell & Aronson, 2013). The "pre-human" objective, however, is obsolete due to climate change, the spread of invasive species,

extinctions in of flora and fauna, and many more factors that preclude the achievement of this objective.

The most current definition for ecological restoration is the Recovery Model, which removes the "pre-human" objective and defines a restored ecosystem as an area that can "develop complexity, self-organization, and resilience" (Clewell & Aronson, 2013, p. 29). In conjunction, the perspectives on ecological restoration have broadened to include the socioeconomic and cultural perspectives. Not only is it important to re-establish ecological processes and recover biodiversity, ecological restoration has the potential to regain ecosystem services that humans benefit from. Furthermore, what is increasingly important in urbanizing cities and for the citizens living within them is the inclusion of the cultural perspectives that ecological restoration promotes.

1.2. The Context of the Research

The watersheds in the Toronto region form a major part of the city's identity. The livelihoods of humans in the region have relied on the land, water, and resources that come out of the rivers, streams and adjacent land for thousands of years. They continue to be a vital component for the health of the environment, economy, and cultural well-being of the region. As human survival and economic development depend on functioning watersheds and the natural resources located in the watersheds, it is imprudent to simplify them to geographic territories. This does not capture the complexity of these vital landscapes. Humans have benefitted from, and influenced watershed resources, including the water, vegetation, and wildlife in them. We use these resources for socioeconomic, cultural, and political reasons that are critical to human well-being. Thus, watersheds have political, social and economic aspects that are intertwined with the natural environment. This paper uses the aspects from the theories of Urban Political

Ecology (UPE) to examine and offer insight into factors influencing watershed restoration in the Toronto region and accordingly the production of nature and green space in an urbanizing city.

Research by several experts in the field of restoration ecology and the practice of ecological restoration has helped outline the Political Ecology framework as it pertains to the practice of ecological restoration. In their discussions they present a broad framework to examine the practice through ecological and social dimensions (Bliss & Fischer, 2011). The authors contend "Political Ecology provides a framework for critically examining ecological restoration within its contemporary social, political, and economic context" (Bliss & Fischer, 2011, p. 139). To analyze the state of watershed restoration practices in the Toronto region, I will employ the aspects from UPE as a normative framework, along with several of its relevant concepts, tools, and methods outlined in the literature as they relate to ideal practices of ecological restoration.

A substantial information gap is apparent in the literature and research employing theories of UPE to scrutinize and offer a pragmatic analysis of green space production in urbanizing cities such as watershed restoration activities. This paper examines how useful the UPE theory is as a normative framework that allows for the examination, analysis, and identification of recommendations for enhancing the sustainability of environmental projects. The important outcome is assessing if the theoretical foundations of UPE can also inform practical shifts towards the sustainable production of green space through the use of its main concepts endeavoring to further enlighten us about nature in the city. Other research and case studies show that UPE analyses often advance a practical environmental plan. It can do this by helping identify possibilities, and recommendations for creating innovative democratic and equal socioecological opportunities (Loftus, 2012).

One such UPE theory is offering an in-depth analysis on the production of green space in the city, by assessing the decision-making dynamics between governing agencies and stakeholders as they relate to the environment and environmental projects (Angelo & Wachsmuth, 2014). This paper uses aspects of the UPE framework to specifically evaluate ecological restoration as the production of nature in the region of Toronto. From the discussions of Bliss and Fischer (2011) who focus specifically on ecological restoration, and as a foundational aspect of UPE theory, it is essential to critically examine these decision-making relations embedded in ecological restoration activities that produce green space. In western urban areas that are generating environmental projects, in-depth investigations are necessary as the magnification of power relations between stakeholders and science agencies occurs. This is due to the creation of scientific institutions with uniform and normative principles. They often present a biased understanding of the local cultural and ecological patterns (Bliss & Fischer, 2011; Weng, 2015).

This dynamic is exhibited in the institutional context of Conservation Authorities (CAs), the designated authorities that manage much of the environmental and watershed activities in Ontario and the Toronto region. The TRCA is the foremost expert of watershed management, implementing the majority (but not all) of the watershed restoration projects on public lands in the Toronto region. At first glance this institution, sometimes labeled as a "quasi-governmental" agency, exhibits the role as a managerial/facilitative entity combined with a more activist/progressive approach (Winfield, 2012). Nonetheless an examination of the current socio-political institutional context in the TRCA and other organizations implementing watershed restoration projects is necessary. The contextual composition of watershed restoration practices

in the Toronto region is unclear, paralleled by an unclear setting for sustainable environmental management.

1.3. Main Inquiry on Watershed Restoration

The above section provides a rather idealistic view of ecological restoration practices, one that could be strived for during the planning, implementation, and monitoring of the projects. Much is written concerning the ways in which to conduct a restoration project, and many projects claim to incorporate all the differing perspectives. Over the past several decades since the infamous Report of the World Commission on the Environment and Development: Our Common Future, many countries, governments, institutions, and organizations use the term sustainable or sustainable development in conjunction with watershed management (Brundtland, 1987; Kauffman, 2016). This has become an environmental policy paradigm in Ontario used by a multitude of institutions, governments, commercial agencies, non-governmental agencies, and grass-roots initiatives as a means to further their specific objectives (Winfield, 2012). In the Toronto region the foremost institution for watershed management, the TRCA, followed suit; in 2007 they titled a management document as the Rouge River Watershed Management Plan: Towards a Healthy and Sustainable Future (TRCA, Rouge Watershed Task Force, Rouge Park, & Metropolitan Toronto and Region Conservation Authority, 2007). From an ecological viewpoint, the classification for sustainability is that of a self-sustaining ecosystem that is able to maintain itself, and is one with sufficient resilience to recover to an intact state should it suffer from a disturbance. In a socioeconomic context, sustainability is the application of informed ecological principles in order to derive continual ecosystem services, without causing harm to the ecosystems providing the services (Clewell & Aronson, 2013, p. 13).

Despite the mounting awareness of the relationship between environmental change and urbanization, and a collective focus on the need for "sustainable" urban development, no substantial reduction of environmental impacts and its associated problems is apparent (Swyngedouw & Kaika, 2014). Globally, if current trends in population density continue, in 2030 urban land cover will increase by 1.2 million km^2. This is roughly triple the existing cover of global urban land (Seto, Güneralp, & Hutyra, 2012). Locally the province of Ontario has lost 80 percent of its aquatic habitat and wetlands, and presently the enhancement and restoration programs cannot make up for the current habitat losses (Sproule-Jones, Johns, & Heinmiller, 2008). In the Toronto region over the last decade the city has seen a tremendous amount of development. The residential building construction has increased almost 70% from 2010 to 2012 through the construction of large, high-rise condominium developments across the City (City of Toronto, 2015). This means that the protection and restoration of streams in these urbanizing catchments is paramount, as well as thinking outside of current channel-based approaches and restoring the adjacent riparian and remaining woodland areas (Vietz, Rutherfurd, Fletcher, & Walsh, 2016).

The central inquiry examined in this paper is whether the Toronto region employs sustainable watershed restoration practices to help mitigate the detrimental effects of urban development and land use change on the local watershed environments. I evaluate this question by using political, economic, and social indicators of sustainability as they relate to watershed restoration frameworks and practices and UPE. These indicators come from an evaluation of research into sustainable ecological restoration practices, and several UPE theories pertaining to the practice ecological restoration. I use four case studies located in the Toronto region and its watersheds to form a basis for analysis and also comparison. These case studies provide an in-

depth UPE investigation on the state of the Toronto region watershed restoration and the political, social and environmental factors that influence it. The outcome is an illustration of the complexities in watershed restoration management, the identification of successes and several shortcomings, and finally highlighting various concluding recommendations.

The paper proceeds in three sections. The following section justifies the selection of the sustainability indicators and case studies, and also explains the research methodology employed for the study. The third chapter provides a background summary of watershed restoration policy evolution, followed by a detailed evaluation of the four case studies selected. The evaluations pertain specifically to the four sustainability indictors set out in section two. Finally, a discussion into the current state of watershed restoration projects in the Toronto region along with concluding recommendations for future restoration efforts completes the paper. A literature review is located in the appendices to provide an overview of the institutional and normative factors that play into watershed management and restoration practices.

PART 2: DESCRIBING THE NORMATIVE APPROACH & METHODS

Watershed restoration is a very necessary tool to help mitigate the past, and current degraded state of the Toronto region watersheds. The growing concern for watersheds in the Toronto region and the Great Lakes Basin has bolstered efforts by varying stakeholders to promote awareness and research on the basin and explore sustainable management for the basin's ecosystems and freshwater resources. Nonetheless watershed restoration planning is not separable from an evolving framework including basic and applied research, community participation, and implementation followed by monitoring and evaluation. Whereas restoration plans always include a main goal to develop a system of restored habitats, it must also understand the inclusive goal to restore an area enmeshed in intensifying land-use plans, conservation areas, and recreational open space (Tamminga, 1994). Therefore, as adapted from Tamminga, (1994) where restoration is considered by some as the acid test for the science of restoration ecology, restoration practices that include successful and sustainable programs are also the acid test for restoration planning.

2. UPE as the Normative Approach to Watershed Restoration

Having access to nature in the city is an age-old concept, and the idea of the "green city" is not novel. In the late 1800s and early 1900s social reformers in Europe and the US advocated for planned getaways from the industrial and urbanizing city, to include weekends in the countryside, summer camps for the youth, and large public parks (Angelo & Wachsmuth, 2014). The watershed areas in Toronto provided this respite. For example, the Old Mill Toronto is a historical venue that opened in the early 1900s which offered a space to relax and have afternoon tea in the garden and dine all the while overlooking the Humber River. Since that time the region of Toronto has continued on its path of urbanization, which has made the escape-the-city

solutions difficult to accomplish. It comes as no surprise therefore that the public policies and sustainable discourse in Toronto and across the world has increasingly turned instead to making the city itself greener so as to produce a sustainable environment (Keil & Graham, 1998). Angelo and Wachsmuth (2014) argue that UPE is especially relevant when analyzing the resource flows and environmental problems such as flooding in and an urbanized context. Through their research they demonstrate that UPE is more than just the study of nature in the city, and that it helps "contribute to a new theory of urbanization that simultaneously foregrounds nature as it deemphasizes cities" (Angelo & Wachsmuth, 2014, p. 17).

Thus, this paper uses UPE as a normative approach to illustrate how watershed restoration practices should be, and compares this approach to how the Toronto region employs watershed restoration in its increasingly urbanized areas. Although watershed restoration activities are supposed to aid in the pursuits of a green and sustainable city, the actual achievement of sustainable watershed restoration practices must first be examined. To assess whether the Toronto region passes the acid test for the production of green space through a sustainable watershed restoration framework requires the evaluation of political, economic, and social indicators. The indicators chosen and their associated criteria form a sustainable watershed restoration framework set out by this paper. They are borne out of the evaluation of research into sustainable ecological restoration practices, and several UPE theories as they relate to the practice ecological restoration. Presently, the practical tools and methods, and theoretical UPE research into ecological restoration practices, illustrate several factors that enable long-term and self-sustaining watershed restoration projects. These factors or indicators for watershed restoration sustainability are as follows: (1) land and water securement (2) adaptive management (3) project funding (4) public participation and community development (table 1).

2.1. Table Summarizing the Normative Indicators for Evaluation

Normative Framework for Toronto region Watershed restoration projects			
Land and Water Securement	Adaptive Management	Long-term Commitments	Social/Stewardship factors
Adjacent lands acquisition: ● Floodplain ● Wetland ● Riparian ● Woodlands	Presence of the framework: ● Baseline knowledge ● Explore other actions ● Predicting results ● Select implementation actions ● Long-term monitoring	Source of funds for restoration: ● Federal, provincial, municipal ● Charity donors, fundraising	Maximize appropriate proactive participation with diverse and accessible communication tools ● the initial project proposal ● planning ● site preparations, ● implementation, ● long-term monitoring requirements
Procedural effort level to remove constructed in-stream barriers	Actual application: ● pre-planning baseline environmental data ● control ecosystem use ● rigorous post-project monitoring program ● collection of post-restoration data for comparison ● Recommendations for future plans	Funding stipulations: ● Duration of funding allotments ● Limitations set on appropriate use of funds	Institutionalized restoration impacts: ● Distrust/tensions, ● Lack of engagement ● Altered levels of anticipated public participation
Correlation to GAP and Parkland Dedication & Cash-In-Lieu	Evidence of renewed and innovative project planning, practices, and applications	Correlations between funding and the implementation of the adaptive management framework	Linkages to community development: ● Evidence of partnerships with community organizations

Table 1. This table presents a summary of the indicators and their associated criteria that forms the normative framework that watershed restoration projects should follow according to UPE theories and other research on the sustainability factors impacting ecological restoration

The indicators all intersect with each other in some capacity, and also intersect between the pragmatic approaches to watershed restoration practices and the theories set out in UPE. All the indicators interconnect with the funding indicator for the practical approach, and also in assessing the decision-making relations in watershed restoration practices. By assessing who the purveyors of restoration funds are, and the associated stipulations to the funding procurement, one can form a clearer picture of who is controlling the production of green space in the city. In assessing the economic side of the watershed restoration projects, the concurrent assessment of the land and water securement indicator can occur; for example, the purveyors of funds are also the agencies allowing the expansion (or not) of watershed restoration activities through permitting measures.

The public participation and community development indicator and criteria come directly from UPE theories, in that they help outline a democratic model for watershed restoration practices. The adaptive management indicator relates directly to the policy programs pursuing the sustainable production of green space in the Toronto region. Adaptive management is a pervasive framework in ecological restoration theory and its practice allows for innovation and the evaluation of restoration success. This helps develop and improve upon the science and production of the restoration projects. The critical examination of these four indicators and their associated criteria through the four case studies located in the Toronto region helps evaluate the sustainability of watershed restoration planning, implementing and long-term monitoring. Understanding the economic, political and social context that is governing environmental management is an essential piece of the UPE framework by helping describe the production of green space in an urbanizing city like Toronto (Heynen, Kaika, & Swyngedouw, 2006; Angelo & Wachsmuth, 2014).

2.2. The Watershed Land and Water Securement Indicator

The landscape of an intact watershed is a continuous and connected natural corridor, that is self-maintaining and resilient. The research into watershed management promotes restoration activities at the catchment level rather than advancing in a patchwork fashion. The reasoning is that the catchment method provides a more sustainable urban stream solution. Accordingly, research shows a continuous method helps reduce the impact of urbanization on stream morphology (Biggs et al., 2012; Vietz et al., 2016). The target is that watershed restoration should endeavor to generate continuous and connected catchment areas in the Toronto region. The concept of land and water securement along all the ecosystems in the watershed corridors is an important tool allowing for a more continuous, natural and thus sustainable environment in the city. Therefore, land and water securement is the first indicator of sustainable watershed restoration, as it actively incites the goal of a continuous natural watershed corridor.

Land acquisition includes the planned addition of lands to the project that are adjacent to the stream or river, such as the bank, riparian areas, floodplain area, and upland wetlands and woodland. Water securement looks to achieve a continuous and barrier-free waterbody, where humans, fish, and wildlife can pass freely. The Toronto region has specific regulations, policies, and programs that look to encourage land acquisition to increase green spaces in the city. This paper looks into whether these policies support land and water acquisition for watershed restoration practices. Approximately 40% of the Toronto region watershed ravines are privately owned, which impedes the environmental objective of achieving continuous, sustainable, and naturally functioning watershed corridors (City of Toronto, 2017). Therefore, the land acquisition strategies for the protection and restoration of important watershed areas are important for municipalities in the Toronto region so as to increase green space in the city.

Programs linked to land and water securement includes strategies set out in the Greenlands Acquisition Project (GAP) by the TRCA, and the Parkland Dedication & Cash-In-Lieu City of Toronto strategy.

GAP is a TRCA project working to increase land securement for the protection and restoration of lands in the region. Every five years the TRCA establishes and creates a new GAP which is submitted to the MNRF for approval. This is the typical land acquisition strategy that targets certain properties and identifies the linkages, which would subsequently increase and improve the TRCA jurisdictional land base. Increasing rates of land acquisition by the TRCA in environmentally significant areas can indicate a proactive management strategy, which looks to re-establish the continuity of the watershed system. Securing these lands helps restore the natural processes in the watershed habitat, and thus the sustainability of the watershed area.

The Parkland Dedication & Cash-In-Lieu is a City of Toronto strategy that requires the inclusion of green space planning into new city developments. However, it has several flaws in its procedural outcomes. It in fact exemplifies a reactive environmental management strategy influenced by political and economic factors. This policy requires that developers either set aside a certain amount of land for parkland, or pay a Cash-In-Lieu of parkland dedication ("Parkland Dedication & Cash-In-Lieu," 2017). It is important to understand how this policy impacts the Toronto region watersheds by assessing whether land dedication for new developments goes to watershed restoration projects or if the monetary investments are going towards a watershed restoration project in any evident capacity.

Water and aquatic habitat securement entails acquiring MNRF permits to remove the barriers within streams and rivers within the restoration area, as well as in the upstream and downstream portions. This is to enhance connectivity of the entire watershed area with the

restored area. An examination of how these policies interact and impact the watershed restoration planning, and the goals for project implementation helps us understand the political economic regime that governs this watershed practice. It also illustrates the differing power relations embedded in watershed restoration practices by identifying who chooses the land base for the application of a restoration project.

2.3. Markers of True Adaptive Management

"The decision to restore represents a long-term commitment of land and resources" (Clewell & Aronson, 2013). The second indicator used for the case study analysis focuses on the implementation of the long-term and iterative evaluation process that ecological restoration projects require: adaptive management. The four cases studies assessed in this paper each function within the social-ecological system of the Toronto region, a region that is an Area of Concern (AOC) designated by the International Joint Commission (IJC). The growing vulnerability of this region in combination with the past failures in management, requires an adaptive governance regime to help understand the uncertainty and changes produced by historical and current-day urbanization impacts. Experts across the board call for the use of the adaptive management framework in the restoration ecology field, and it is widely recommended during ecological restoration projects (Butler, Monroe, & McCaffrey, 2015; Nagarkar & Raulund-Rasmussen, 2016).

The reason for the use of this framework is that during the implementation phase of a watershed restoration project, an on-going series of management decisions or activities occur, which impacts the entire restoration site and beyond (Clewell & Aronson, 2013; Murray & Marmorek, 2003). Understanding how each decision and activity impacts the restoration area requires extensive amounts of information, data, and observations pertaining to the decision

made. This process helps strengthen future decisions and activities, due to their development by way of comprehensive research information, current data on the ecosystem responses, and regular progress evaluations of the goals and objectives (Nagarkar & Raulund-Rasmussen, 2016). Therefore, the application of adaptive management is a marker of sustainability in ecological restoration practices. Furthermore, its proactive and iterative features consequently acknowledge the long-term processes involved during the recovery of a restored watershed ecosystem (Morrison et al., 2012; Murray & Marmorek, 2003). The evaluation of this indicator occurs through assessing if an adaptive management framework is present within the plans and strategies supporting watershed restoration documents in the Toronto region.

The process of employing adaptive management comprises: evaluating existing watershed knowledge; exploring alternate actions; predicting results; selecting the actions to implement the project; monitoring the project to determine if the results match those predicted; and using these results to provide recommendations for future steps in the area (Murray & Marmorek, 2003). It is a framework which promotes continuous learning and progress and encourages the use of innovative practices and applications in former and current watershed restoration projects. Therefore, the presence and proper application of such a management method is a good sustainability indicator for the case studies under observation. An acknowledgement of the importance of adaptive management is not sufficient as evidence for the actual application. Evidence for the actual application of the method includes aspects like the gathering of pre-planning baseline environmental data, the inclusion of a control ecosystem, a rigorous monitoring program post-project implementation, the presence of post-restoration data for comparisons, and recommendations and changes to the future plans for the restored area.

2.4. Indications of Long-term Commitments to the Watersheds

Another indicator critically examined in this paper is the dynamics of governmental funding going to watershed restoration projects in the Toronto region. Studies assessing environmental funding through the UPE framework stipulate that this factor is an understudied political-economic aspect, especially in regards to the practice of ecological restoration (Borgström, Zachrisson, & Eckerberg, 2016). Through a critical examination of this indicator, interpretations of the issues concerning the sustainability of watershed restoration practices can occur. Ecological restoration generally requires extensive and long-term financial investments, since it addresses severe environmental degradation that is costly to reverse. Long-term investments dramatically increase for urban watershed restoration projects that require significant funds for planning, expertise, implementation, labor, and resources (Bernhardt et al., 2005).

A funding pattern labelled “short-termism” is documented in the research assessing funding allocations for ecological restoration projects. This funding pattern ignores the long-term processes, larger scale watershed dynamics, and crosswise watershed connections important to watershed restoration practices (Borgström et al., 2016). This produces what some researchers call a “scale mis-match”, whereby institutional constraints often lead to environmental management frameworks that do not match the scale of ecological patterns and processes. It is suggested that this is a significant reason for continued environmental degradation (Borgström, Elmqvist, Angelstam, & Alfsen-Norodom, 2006; Cumming, Cumming, & Redman, 2006).

The federal and provincial governments typically provide grant funding for environmental management, and research has shown it can be politically motivated. At the federal level, water governance is rooted in legislation, court decisions, policy directives, and

funding initiatives through many constitutional authorities. In Ontario, provincial water governance has historically promoted water use for increasing economic development within Ontario (Johns & Sproule-Jones, 2015). This indicates that environmental management works within traditional command-and control policy instruments that have been shown to dominate environmental policy generally, and potentially also watershed restoration policies (Wang, 2011).

An examination of the source, amount, and length, of funding designated for watershed restoration helps inform us on watershed restoration sustainability. This indicator also links to the successful implementation of adaptive management, as the effectual use of this process requires a source of long-term funding. The duration of funding is an important factor that helps critique the level of continuity and success for watershed restoration projects. Assessing the dynamics of watershed restoration funds helps to illustrate whether watershed restoration is a long-term investment leading us towards a more sustainable urban future or a mitigation action used for the promotion of economic development in the Toronto region.

2.5. The Watershed Stewardship Indicators

In the Toronto region an array of differing values and perspectives concerning the watersheds and Lake Ontario is present. It therefore must not be assumed that the entire Toronto region has similar social and cultural ideas about the area, especially given the diverse set of the communities that make up the population. For example, the Toronto region landscape, waters and natural resources have supported Indigenous communities, economies, and cultures for thousands of years (Williamson & Macdonald, 2013). These communities provide essential and unique perspectives vital for the improvement to watershed management in the region. Additionally, the immigrant population is a significant community emerging in the Toronto

region with distinct perspectives and values concerning the Toronto region watersheds and Lake Ontario. In Southern Ontario and the Toronto region, immigration is a major driver of population growth. Immigration accounted for two thirds of Canada's population growth between 2001 and 2006, and many chose to settle in areas around Toronto (Méthot, Huang, & Grover, 2015).

Numerous publications identify the social characteristics of ecological restoration, including articles, books and other edited works, management documents like the one by the Society for Ecological Restoration, as well as Parks Canada management handbooks (Canadian Parks Council, 2008; Clewell & Aronson, 2013; Egan, Hjerpe, & Abrams, 2011; Gobster & Hull, 2000; Higgs, 2003; Hobbs, 2004; Society for Ecological Restoration International Science & Policy Working Group, 2004). Accordingly, the final indicator analyzed in this paper is the social dimension of the watershed restoration. The factors assessed are the public participation process used for the institutional practice of watershed restoration in the Toronto region. A democratic model of participation for the discipline of restoration ecology is offered in the work of Andrew Light, a scholar in environmental ethics and policy. The model calls for maximizing the level of proactive public participation that is appropriate for a project. For example, in watershed restoration projects it is necessary to engage with water and municipal institutions, scientists and practitioners, and the community and non-governmental organizations. He argues that volunteers should be engaged in every part of the project, including the initial project proposal, planning, site preparations, implementation, and also for long-term monitoring requirements (Light, 2006).

Encouraging a direct participatory relationship between local human communities and the restoration area helps stimulate a sense of stewardship for the area. It is shown that communities that have a participatory relationship in the restoration process often help promote sustainability

in the area and are less likely to allow further degradation. In fact, ecological restoration is professed to be an example of participatory environmental management, particularly in the western urban context (Gobster & Hull, 2000; Gross, 2005; Higgs, 2003; Light, 2006). This means the potential exists in watershed restoration activities to produce a transferable democratic model in public participation, thus increasing the value of restoration activities as well as the health of the community (Weng, 2015). Participatory practices are generally in contrast with "top-down" regulations or mandates from institutionalised authorities (Weng, 2015). Research by Weng (2015) illustrates that borders get created between professional practitioners and volunteers, when the institutions defined by science claim authority over restoration projects. The symptoms of these borders include, distrust, tensions, lack of engagement, and altered levels of anticipated public participation.

Examining the methods, application, and incorporation of public participation in watershed restoration practices in the Toronto region, helps one understand the sustainability of the practices. Research conducted by Newman (2011) found that the current participatory framework for ecological restoration practices in the Toronto region lacks inclusiveness. These forms of participation all use a single means to communicate knowledge and information, and limit sections of the population from actively engaging, presenting ideas, and voicing their values concerning the project (Newman, 2011). Therefore, it is important to look at whether institutions conducting watershed restoration are engaging with alternative ways of communication with the public, other than the traditional consultation methods. Key indicators of a more inclusive participatory model that broaden community involvement, include the use of diverse and accessible communication tools. The participatory model might use community outreach tools like storytelling and story mapping sessions, community arts and murals,

animation and digital imagery of project plans, or interactive and publicly available tools and workshops. Incorporating alternative public engagement techniques into watershed restoration projects could shift the power balance, allowing for both community members and experts to contribute to watershed restoration plans (Newman, 2011).

A second factor linked with stewardship and sustainability is whether watershed restoration projects in the Toronto region incorporate aspects of community development. Evidence indicates that the inclusion of this factor increases the value and sustainability of restoration activities (Weng, 2015). The inclusion of community development into watershed restoration planning is seen through the dedication of time and resources to actively fostering partnerships and providing adequate resources to local Toronto region community groups. The four case studies are examined to assess whether their watershed restoration plans actively engage in outreach efforts, educational programming, and with social-service agencies, concerned with local watershed issues. Furthermore, by engaging with local community groups, they become empowered as main organisers in the project and essential stewards of the restored area.

3. Watershed Restoration Case Study Selection

It is evident by now that the Toronto region has experienced heavy industrialization and urbanization over the last century that has significantly impacted the region's watersheds, and the associated environments. The location for two of the selected case studies is in areas of the region classified as the most urbanized parts in the Toronto region: the Wilket Creek Rehabilitation Project, and Alfred Kuehne Stream Channel Restoration Project (Fig. 1). Located in the Don River, and the Etobicoke-Mimico watershed respectively, measurements indicate that over 90% of the surrounding area is urban (TRCA, 2010). The main goals for the projects are

similar, as they focus primarily on flood mitigation and the protection of city infrastructure during wet weather events. The main catalyst for the projects is to increase protection for the surrounding infrastructure through the restoration of a naturally functioning river system.

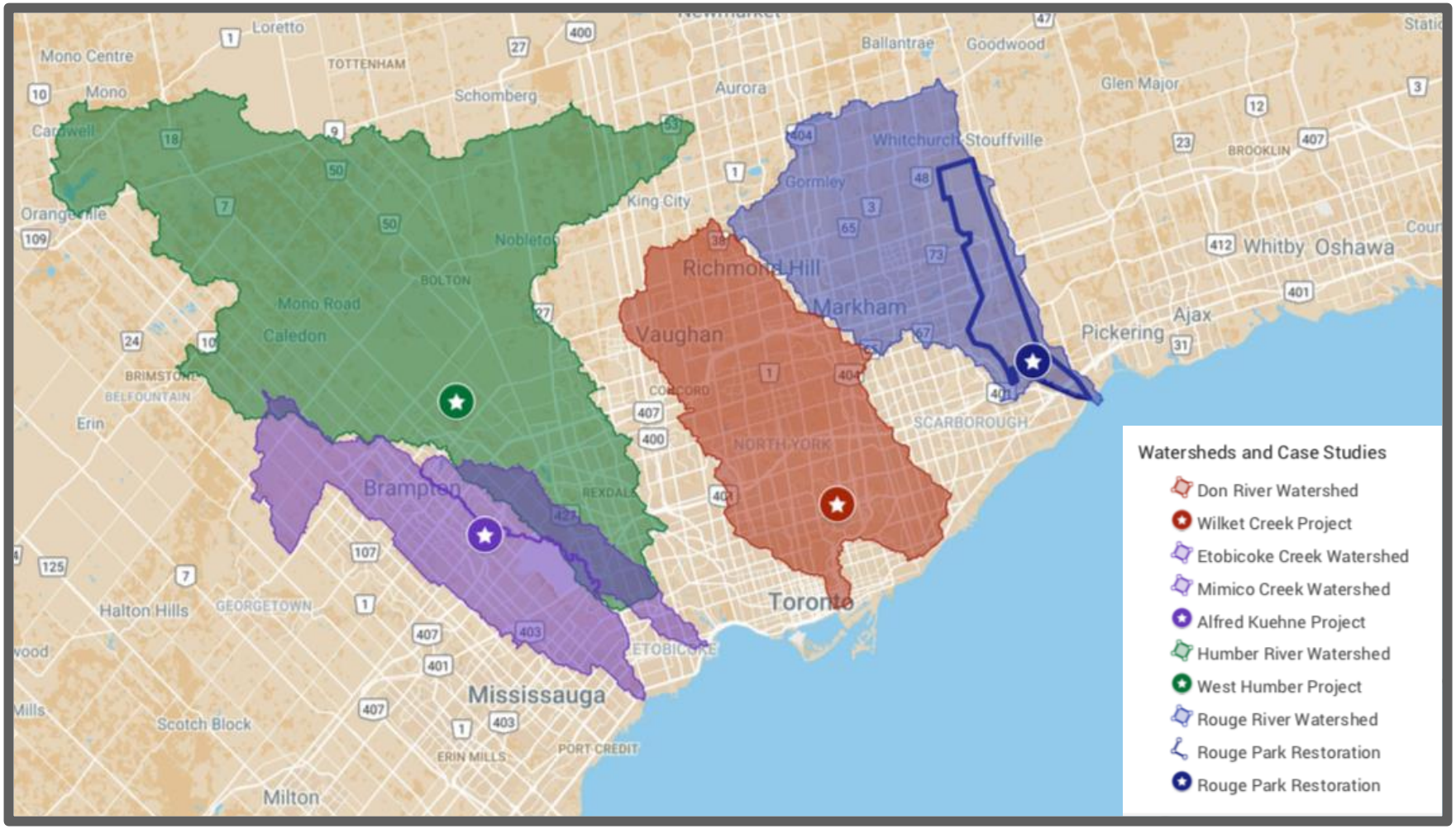

Figure 1. The locations of the four Case Studies are indicated with the circular star icon. The watersheds are outlined with a similar colour. The Etobicoke Creek Watershed is located to the west of the Mimico Watershed indemnified by the purple colour. This map was produced using google maps, with an exported public file from the TRCA file available here: https://www.google.com/maps/d/viewer?mid=1aJYRHKlmAf1rrTTsQLeNDqMdhwk&usp=sharing. The Rouge park outlined is a rough outlined indicating the park boundaries. A publicly accessible map is available at this link: Map Identifying the Location of the Four Case Studies (must open with Safari Application).

The other two case studies titled the West Humber Habitat Rehabilitation project, and the Rouge Park Restoration are located in the Humber River, and Rouge River watershed respectively. These areas have higher levels of remaining natural environments when compared to the aforementioned case studies, and the restoration objectives focus primarily on the environmental quality of the area. The objectives for these restoration projects look at factors such as native biodiversity of the flora and fauna, species at risk, tree canopy levels, and hydrological functions of the river and stream for fish species. This is not the primary focus of the first two case studies. In fact, the restoration projects for infrastructure might risk the quality of the environment, as the implementation might require significant alterations to the remaining natural environment in the area.

The rationale for selecting these four case studies includes the following aspects. Each project is located in a different watershed, specifically Etobicoke-Mimico, the Humber, the Don River, and the Rouge River watershed. A map of the project locations is provided in the Figures section of this paper. These four watersheds cover the largest area of the Toronto region, and thus help exemplify some common regional methods undertaken during of the watershed restoration planning and implementation processes. They are all projects that are currently progressing or recently completed within the last ten years. Consequently, the quantity and quality of available published information is higher and more accessible than that of older projects or projects in their preliminary stages. However, as the availability of the published information for public consumption is not adequate, the semi-structured interviews conducted as part of the research help supplement the analysis. By choosing current case studies this helps ensure the possibility of conducting the interviews with individuals recently and directly involved in the planning and implementation of the projects. The gathering of first-hand

knowledge from individuals working on the ground, adds significantly to the level of information available for the analysis. It provides information on the most current practices, tools, methods and management strategies currently used in the Toronto region.

Finally, a diverse set of stakeholders were involved in most of the case studies. The TRCA does not manage all the projects, which therefore results in a set of differing perspectives concerning the selected indicators and projects. For example, Ontario Streams manage the West Humber Rehabilitation project. They are a not-for-profit organization that focuses on stream and river restoration throughout the province. The MNRF is also in collaboration with Ontario Streams for this project. The TRCA manages The Wilket Creek and Alfred Kuehne projects, with little collaboration with other environmental organizations. The Rouge Park restoration recently changed hands from the Ontario to Environment Canada, but the level of collaboration with other vested stakeholders in this case study is particularly high, allowing for the inclusion of differing perspectives in the interview process. A table summarizing the above information is provided in the Tables section of this paper.

3.1.Table Summarizing Key Features of the Four Case Studies

Relevant information concerning the 4 Case Studies

Location (GPS coordinates)	Scope, Scale and timeline	Lead agencies	Associated Stakeholders
Rouge Park Restoration - 43.81862, -79.17224	Large scale: 47km^2 Multi-year plan	TRCA Rouge Park Alliance	Multiple watershed restoration organizations; Agricultural community
West Humber Rehabilitation - 43.79083, -79.72065	Small Scale: 0.15km^2 Annual plan	Ontario Streams (watershed restoration organization)	Ministry of Natural Resources and Forestry; Local community
Wilket Creek Rehabilitation Project -	Large scale: 15.5km^2 Multi-year plan	Toronto and Region	City of Toronto; Local community

43.72012, -79.35836		Conservation Authority	
Alfred Kuehne Channel Naturalization Project - 43.69912, -79.69327	Small scale: 0.012km^2 Annual plan	Toronto and Region Conservation Authority	City of Brampton Local community

Table 2. This table provides a summary of the relevant facts concerning the four case studies examined in this paper. The GPS coordinates were retrieved from google maps from the map produced for this paper.

4. Description of Research Methods

This research uses a combination of sources for gathering data and information, including both primary and secondary sources. I used qualitative secondary research and information to gain the knowledge and information required for the outlined indicators identified as sustainable watershed restoration characteristics. The secondary data used in this paper includes watershed management reports, journal articles, pertinent environmental assessments, governmental reviews, stakeholder reports, and project master plans. The primary research conducted for this paper took place in the form of semi-structure interviews with key informants for each case study. The people interviewed came from governmental agencies, consulting firms, and non-governmental organizations with knowledge of, and direct experience in, watershed restoration planning, assessment and monitoring.

4.1. Interview Process

I engaged with 10 different watershed expert representatives directly involved in the four identified restoration projects throughout the Toronto region. Through the interviews I assessed the following factors as they relate to the four indicators identified; (1) the political framework guiding adaptive management procedures and (2) land acquisition for watershed restoration projects; (3) the political economic factor of funding, and how this impacts the sustainability of the projects, and (4) the community engagement and development methods and practices used during the life-cycle watershed restoration projects. For the Rouge River watershed, I interviewed four selected representatives, as this watershed project represents a larger scale restoration plan compared to the other three. I interviewed two representatives for each of the three other projects identified above: Wilket Creek, West Humber River, and Alfred Kuehne. The participants were recruited through an initial web crawl of Toronto region environmental

organizations conducting the restoration projects and also online contact forms. The interviews were recorded and fully transcribed, and the interviewees were fully informed of the research outcomes. The opportunity to remain anonymous was an option. The interviews were conducted in-person if possible in a semi-structured format, or over the phone if an in-person interview was not possible.

Each interview was split up into sections focusing firstly on the project background, followed by questions on the indicators: adaptive management, land and water acquisition, community participation, and funding. This was followed by questions to identify the watershed restoration project setbacks/limitations, and also the best practices identified by the project representatives. A copy of the questions and probes is provided in Appendix A. I used a combination of questions, and topics formulated out of the preceding literature review, and analysis of the four sustainability indicators identified. The questions focused on the strategies, plans, policies, processes and steps involved in the watershed restoration project life-cycle.

The information gained from the answers to the questions and prompts helps characterize the positive aspects of the process, as well as the negative or ineffective features of the project life-cycle. The desired outcome of the interviews was to assess if a pattern of positive or negative factors exist concerning the current watershed restoration practices. Ultimately the goal is to help diagnose the underlying issues and factors which might be leading to unsustainable watershed management. Through the interviews I gained first-hand knowledge from watershed restoration experts concerning their experience planning and restoring areas of Toronto's watersheds. The interviews enhanced the knowledge base and provided a comprehensive overview of the intricate factors (i.e. political, economic, and social) influencing the watershed restoration project sustainability in the Toronto region.

PART III: THE EVALUATION

What follows is a historical summary illustrating why watershed restoration activities are required, and how this environmental management tool came to be in the Toronto region. Much of this information is drawn from the literature review in Appendix B of this paper. Following the summary is the analysis of the four selected case studies through the normative UPE framework presented, which includes the four indicators and their criteria outlined in table 1.

5. The Watershed Policies That Led to Restoration as a Tool

Watershed governance and their management is about the strategic use of watershed resources and lands (Molle, 2009). This strategic use has occurred in Southern Ontario for thousands of years beginning at the earliest period of human occupation, and continued through to the nineteenth and early twentieth centuries. Evidence exists in the archaeological records that reveal humans, the Indigenous people, settled and inhabited the watersheds and river systems in what is now called the Toronto region at least 11,000 years before the arrival of Europeans (Heidenreich & Burgar, 2011; Williamson & Macdonald, 2013). Between 500 and 1600 AD, the Indigenous groups began directly managing the land in the watershed through agricultural practices along the central north shore of Lake Ontario (Sandberg, Gilbert, & Wekerle, 2013).

As European re-settlers made their way to Southern Ontario, they also built their homes, agricultural fields, and started to create logging and water mill industries in the Toronto region watersheds. All these land-use practices commonly occurred adjacent to the river and streams, due to the ease of navigability and access to the resources. As development ramped up in the 1800s, the industry along the Lake Ontario Shoreline and within the watersheds became very important to the economy in the area. This led to the creation of a large and polluting “industrial hub” in the 1860s and ’70 (Bonnell, 2014). The legacy of this industrial and agricultural growth,

as well as the fast-paced development of the area led to the initial and wide-ranging degradation of the Toronto region watersheds. This degradation is on-going and exacerbated by the present-day urbanization that continues throughout the Toronto region.

During the rise of the industrial, and agricultural activities limited political concern centered on the degradation of the environment in the Toronto region watersheds. This limited concern shifted in the province of Ontario when local issues of flooding and flood control began impacting the Toronto region in the mid 1900s. In 1946, provincial legislation encouraged the formation of partnerships between the provincial and municipal governments related to integrated watershed management (Worte, 2016). Thus, thirty-six river-basin-based organizations formed across the province including the establishment of four Toronto Conservation Authorities: the Etobicoke-Mimico, Humber, Don Valley, and the Rouge-Duffin-Highland-Petticoat Conservation Authority. Following Hurricane Hazel, a regional approach to river management took over and the four Toronto Conservation Authorities were amalgamated to form the existing Toronto and Region Conservation Authority (TRCA) (Bonnell, 2013).

More broadly across the Great Lakes Basin political focus circled back to water quality and environmental concerns in the 1960s and 70s, largely motivated by water pollution events. The Great Lakes Water Quality Act (GLWQA) is the first binational agreement that committed both nations and their governments to take the necessary actions to restore and maintain the Great Lakes Basin (Friedman, Laurent, Krantzberg, Scavia, & Creed, 2015; Johns, 2017). With the renewal of the GLWQA in 1987, came the designation of 43 Areas of Concern (AOC) in the US and Canada, one being the Toronto region. With the identification of an AOC the IJC requires the area to develop and implement a Remedial Action Plan (RAP) (Chandler & Vechsler, 1992).

In Ontario the responsibility for the restoration of degraded areas, and progress of the RAP and AOC falls to the federal and provincial governments (TRCA, 2016a). The management and implementation of a RAP, however, requires the cooperation of numerous governments and departments, organizations and agencies, business and industry, academic institutions, and the public. The responsible authority for the Toronto region AOC is the TRCA, who established an interdisciplinary team to evaluate the environmental conditions, restoration activities, and results pertinent to the RAP (TRCA, 2016a).

Following the 1987 GLWQA renewal, between 1990 and 2010 water policy progress fell off the political trends for both nations, marking a period of apathy (Friedman et al., 2015; C. Johns, 2017; C. M. Johns & Sproule-Jones, 2015; Sproule-Jones et al., 2008). In the mid-1990s, environmental agencies in both countries encountered declining governmental priority and associated funding cuts (Botts, Muldoon, Botts, & von Moltke, 2018). This apathy was also found in Ontario between 1990 and 2005 under the Conservative government when significant cuts to the Ministry of the Environment and CAs occurred. For a full description of this period of apathy refer to Appendix B.

The factor that brought water back into the jurisdictional agenda was the Clean Water Act in 2006, and from 2009 to 2012 the GLWQA was renegotiated. It went on to further address protecting and restoring the Great Lakes Basin based on current and emerging environmental issues. The 2012 GLWA aims to improve coordination and collaboration with stakeholders identified in the agreement, including First Nations and Métis organizations, businesses, NGOs, and the public. By fostering better coordination and collaboration, the GLWQA of 2012 looks to advance the restoration and protection of "water quality, ecosystem health, and associated habitats and species in the Great Lakes Basin" (International Joint Commission, 2012, p. 8).

Ontario also published the Ontario Great Lakes Strategy (OGLS) in 2012, which aims to join the existing policies and agencies together, in order to generate more effective planning and methods for the protection, conservation, and restoration of the Great Lakes ecosystems.

Most recently in 2015 Ontario enacted the Great Lakes Protection Act (GLPA) (Government of Ontario, 2012, 2015; Johns & Thorn, 2015). The Act requires the Minister to set targets, establish monitoring and reporting programs, and appoint members to the Great Lakes Guardians Council (GLGC). The GLGC sets out to improve the capacity of the provincial government to better synchronize programs protecting and restoring the Great Lakes (Abouchar & Petersen, 2015). The GLPA also intersects with the OGLS in that it authorises the strategy by necessitating a progress review and evaluation every three years (Government of Ontario, 2015).

Due to the historical degradation of the Toronto region watersheds, watershed restoration is identified by the water government policies as being a vital tool for to the management, production, and improvement of the local environment. As such a multiplicity of water governance actors exist in the Toronto region, many of which have restoration as a specific mandate within the policy programs. The following is a brief summary of the actors involved in the four case studies examined in the following section.

6. Agencies Implementing the Watershed Restoration

Within the federal government at minimum 20 departments and agencies have mandates related to water. Eight have strong water-related mandates including: Agriculture and Agri-Food Canada, Environment Canada, Fisheries and Oceans Canada, Health Canada, Indigenous and Northern Affairs Canada, Natural Resources Canada, Transport Canada and the department of Foreign Affairs and International Trade (Morin & Cantin, 2009). Additionally, fourteen Ontario ministries also carry responsibilities for water, including three that are central to Great Lakes

water governance: (1) the Ministry of Agriculture, Food and Rural Affairs (2) the Ministry of Environment and Climate Change, and (3) the Ministry of Natural Resources and Forestry (MNRF) (Bakker & Cook, 2011).

The MNRF is the department reviewing plans and permitting works within and adjacent to streams and rivers, thus is an integral stakeholder in the planning process and implementation of watershed restoration projects. The involvement of municipalities like the City of Toronto in watershed restoration projects involves mainly the management of city infrastructure during floods (Bakker & Cook, 2011). The Government of Ontario provides the policies and frameworks to the municipalities concerning land-use planning, and natural resource management within the political boundaries of the province.

6.1.Conventional Watershed Management Agencies

Across Ontario the 36 CAs are the agencies in charge of planning, implementing, and funding many watershed restoration projects. Considered as "quasi-governmental" agencies, CAs are structured on a watershed basis and involved in watershed management. They form partnerships with the government, landowners and other organizations to support integrated watershed management approaches, and as mentioned have responsibilities for coordinating a RAP in AOCs (Conservation Ontario, 2015). They thus deliver many services and programs to protect and restore the Great Lakes Basin.

The TRCA is the primary watershed manager and restoration planning entity in the Toronto region. This CA has a large capacity to implement watershed restoration projects and delivers many services and programs to manage help manage the Toronto region watersheds. They include planning and implementing large-scale restoration projects, as well as mitigating flood damage to city infrastructure through watershed rehabilitation strategies. The TRCA forms

wide-ranging partnerships with governments at all levels, other CAs, private landowners, and other organizations to support watershed management strategies like ecological restoration (Conservation Ontario, 2015).

6.2. Non-Governmental and Grassroots Entities

In addition to the political and institutional complexity, a variety of other stakeholders are also involved in watershed management endeavors across the Toronto region. The diverse set of stakeholders involved in watershed restoration in the Toronto region help provide support to the projects by way of expertise, funding and volunteerism. The focus of each organization can range from concern for specific issues like invasive or native aquatic species, to more holistic concerns like considering the cultural values linked to the environment and waterbodies. Many of these organizations like Ontario Streams and Swim Drink Fish Canada help plan and implement, and fund watershed restoration projects throughout the region.

The involvement of Indigenous peoples and First Nations in the Toronto region is also exceedingly important due to their relationship to the land, watersheds, and the Lake Ontario waters (Bakker & Cook, 2011). Being the first settlers of the land and waters in this region, necessitates a meaningful inclusion and collaboration efforts in all watershed management projects. Additionally, the active involvement of the growing immigrant communities residing in the Toronto is also important for the future proliferation of these watershed restoration practices.

I have classified the four case studies into two distinct categories. The Rouge Park Restoration and the Humber River Rehabilitation project are considered, “restoration projects for restoration sake”. These projects focus namely on the environmental health of the watershed, and look to improve the state of the Toronto region watershed as a whole. These projects engage directly with restoration organizations, and the TRCA’s Restoration Projects group. The Wilket

Creek Rehabilitation project, and Alfred Kuehne Channel Restoration project fall into the category of watershed restoration for the protection of city infrastructure. These projects are conducted by the TRCA Restoration and Infrastructure division. Throughout the interviewing process the division of these categories became apparent, and the reasoning for distinguishing the projects is also apparent subsequent case study analysis. It is clear that projects for "restoration sake" follows a significantly different planning and implementation structure than restoration projects for the protection of city infrastructure.

7. ROUGE PARK RESTORATION

7.1. Case Description

Rouge Park is the largest nature park in all of Toronto measuring approximately 47km^2. It also encompasses roughly 13% of the Rouge River watershed and the Rouge River. The Rouge River Watershed itself spans 336km^2, including all the adjacent lands linked to the Rouge River and Little Rouge River (TRCA et al., 2007). The 13% of the Rouge River watershed located in Rouge Park is crucial to Ontario's Greenbelt. This area of the Rouge River watershed must follow Ontario's Greenbelt Plan for land planning and resource management (Province of Ontario, 2005). While the Greenbelt Plan does not protect the park as a whole, the park must follow some of the terms of the Rogue River watershed and Little Rouge River watershed.

Along with the limited protection offered, another crucial factor is the allocation of lands within the park for wide-scale restoration projects. The area in the park undergoing restoration is proposed to provide an ecological corridor linking the environmental systems of Lake Ontario to the Oak Ridges Moraine in the Toronto region (Province of Ontario, 2005). Consequently, an evaluation of watershed restoration projects in the Toronto region would be incomplete without the assessment of the restoration work in Rouge Park that transpired through the 1994 Rouge Park Management Plan and the 2001 Rouge North Management Plan. The addition of this case study in this review of watershed restoration is necessary to broaden the assessment of sustainability in the Toronto region. This is due to a couple of factors, such as; in the 1994, and 2001 Park Management Plans focus extensively on ecological and watershed restoration, and secondly, the Rouge Park has a long tradition of public engagement and stewardship (Gill, 2017; Parks Canada, 2014; Ramsay-Brown, 2015).

The importance of the Rouge River watershed to the Toronto region is due to the historical, cultural, and environmental influences tied with the river. These influences are what spurred a passionate local community to secure the formation of the park between 1994 and 1995. They had the goal to protect one of the only undeveloped areas left in the Toronto region (Gill, 2017). The group of community members formed a grassroots citizen-led organization titled Save the Rouge Valley System, which then petitioned the government of Ontario to protect the land. In 1995, an endowment from the Federal government to Rouge Park allowed for the creation of the Rouge Park Alliance (RPA). The RPA included members of the federal, provincial, and municipal governments, the TRCA, as well several non-profit groups including Save the Rouge Valley System. This multi-stakeholder alliance managed the park with the vision to ensure that it remained a refuge for natural environments as well as a for the residents of the Toronto region.

As such the RPA produced two Park Management Plans in 1994 and 2001. In these plans a significant portion was comprised of watershed restoration applications for the Rouge River watershed segment in the park. The visions, goals, and objectives in the Rouge Park plans focus on several key areas including restoration to improve biodiversity, sustainable functions, health, and resilience. In fact, the 1994 Rouge Park Management plan specifies that restoration efforts must "provide ecological linkages; increase the size and viability of natural areas; improve the health of disturbed areas; increase biological diversity; and improve general landscape quality" (Province of Ontario, 1994, p. 26). Furthermore, the primary objective for the Rouge Park North Management Plan is to "restore or enhance ecological health and function, and terrestrial and aquatic habitats" (Rouge Park, 2003, p. 6 Chapter 4). The Rouge Park Management Plan and

Rouge North Management Plan provided progressive support for the restoration plans in 13% of the Rouge River watershed represented in Rouge Park (TRCA, 2008b).

It is important to note that in 2010 a review of the park's governance, organization, and financial structure announced several requirements for a new Rouge Park management model. The review stated that the previous Rouge Park governance and financial model was neither functional nor sustainable. Consequently, the managing body of the park the RPA recommended a Rouge National Urban Park as the preferred solution for stronger leadership and accountability within the park. Furthermore, a public opinion poll indicated that 88% of the respondents supported instituting Rouge Park under the leadership of Parks Canada (Parks Canada, 2012).

In 2011, the Federal Government through Parks Canada began negotiations with the Province to transfer the provincially owned portions of Rouge Park, and in 2014 Parks Canada released a draft management plan for the park. However, in March 2015, the Province of Ontario refused the transfer of land due to concerns of insufficient ecological protection. Furthermore, over the past 4 years groups have called upon Parks Canada to update the management plans to include the decades of conservation decisions made in pre-existing plans for the park and adjacent ecosystems (Draaisma, 2017; Environmental Defence, 2017; Parks Canada, 2014). In 2016 the amendment of the ecosystem provisions of the Rouge National Urban Park Act transpired. This stated that the maintenance and restoration of ecological integrity in the park through the protection of natural resources and natural processes must be the first priority of the Minister when considering all aspects of park management (Swaigen, 2016).

Changes addressing the other requests outlined have not yet occurred. Regardless of these requests made by the interested stakeholders, in October 2017, the Government of Ontario transferred and released the Rouge Park lands to Parks Canada. Parks Canada now directly

manages and has an interest in nearly 80 per cent (62.9 km^2) of the 79.1 km^2 Rouge National Urban Park land base (Parks Canada Agency, 2017b). The emphasis on the restoration of the park continues with Parks Canada as the managing body, and $15 million dollars is dedicated to the future conservation and restoration projects in the park (Parks Canada Agency, 2017a). The following analysis of the Rouge Park case study is of the 1994 and 2001 park restoration plans and projects, as the release of the Rouge National Urban Park management plan has yet to occur.

7.1.1. Land and Water Acquisitions for Watershed Restoration

The lands within the Rouge Park are mostly undeveloped and therefore include intact environments like floodplains, wetlands, and riparian habitat through most of the Lower Little Rouge. This includes the mouth of the river and the provincially significant coastal wetland under Rouge Park management. This wetland feature is unique to the watershed and provides shoreline protection, critical habitat to local wildlife, and refuge and spawning sites for many aquatic species. The quality of these environments remains high because, since the inception of Rouge Park the park size has increased through land acquisitions and many significant restoration projects have been implemented. The planning framework includes a long-standing vision to establish a protected nature reserve stretching from Lake Ontario and going north to the Oak Ridges Moraine. The framework also emphasises the creation of a continuous trail system and areas dedicated to the preservation of near-urban agriculture (TRCA, 2010b). This illustrates that the planning and implementation framework for restoration activities are at a catchment level, more so than on a fragmentary basis.

The TRCA managed much of the land in the southern portion of the Rouge Park. However, the TRCA did not include Rouge Park in their Greenlands Acquisition Project (GAP) strategy. Nevertheless, the park used similar models and techniques to the TRCAs GAP

strategies. In many cases, the Rouge Park land acquisition tactics were dealt with on an individual property basis. The TRCA would identify a property near Rouge Park for acquisition, and would express interest to the owner, whether it was Provincial or Federal land or an area owned by Transport Canada. Following the expression of interest, the TRCA would begin negotiations with the other agencies to assess if a land transfer of the identified property was feasible.

The City of Toronto was a big contributor to the land acquisitions of Rouge Park, principally due to the need to protect source waters located in the park. The municipality provided funding to the TRCA so as to purchase properties in the park, specifically properties located in the headwaters and outside the city boundaries. Funding for the purchase of property also came from Richmond Hill for areas located in the headwaters of the Humber River and Rouge River watershed divide in the Oak Ridges Moraine. No clear link or evidence indicates that this funding came from the City of Toronto Parkland Dedication and Cash-in-lieu program, which is supposed to limit the loss of green spaces in the urbanizing city. For the remaining land in Rouge Park not managed by the TRCA, the RPA overlooked the acquisition of the identified area. However, due to the limited resources and staffing the TRCA often acted as the property agent. Thus, all of the financial administration would be retained at the TRCA, including the property management and legal dealings for the purchase of lands. This also occurred if provincial lands were turned over into the park. The agreements would come through TRCA as a property agreement and arrangement.

Land acquisition for the Rouge Park was an ongoing endeavor with notable additions, including when the province of Ontario transferred a piece of property in their ownership to the park in recognition of the Canadian Hero Bob Hunter. This portion of land is called the Bob

Hunter Memorial Park in recognition of this environmental champion. The growth of the park is an important indicator of sustainability for the Rouge River watershed. Even though Rouge Park did not fall under the GAP strategy, Rouge Park implemented other methods to acquire land for protection and restoration.

However, it is evident that the TRCA controlled much of the land base in the park and therefore had control over the majority of the watershed restoration planning and implementation. This is a limiting factor as it relegates all the restoration activities into the normative, and biased, framework employed by the TRCA. This notion is furthered through the analysis of the public participation and community development indicator. Another limiting factor seen in this case study, as well as the other three is the, management, and mitigation of in-stream barriers so as to increase aquatic habitat connectivity. The identification of in-stream barriers has yet to occur in Rouge Park. Nonetheless, thirty-three prioritized structures for in-stream barrier management exist outside the park in the Rouge River watershed rivers and streams (TRCA, 2010b). Plans for the mitigation or removal for the majority of these barriers are not yet available for the public to comment on.

7.1.2. Adaptive Management

A concern for the lack of quality woodland habitat exists for Rouge Park due to the historical logging, water mill industries, and an extensive agricultural legacy in the area. Therefore, much of the restoration project proposals, planning, and work for the area focus on the implementation of the terrestrial restoration for the woodland within this watershed area. Initially when the restoration work began 20 years ago adaptive management was not formally implemented, and the reviews for the restoration work indicated a mix of failures and successes. The failures occurred mainly due to the inadequate survival of native tree and flora plantings,

owing to a large deer population browsing on the newly planted seedlings, as well as inadequate soils for deciduous trees. As time passed the TRCA and RPA employed technical experts to review and provide recommendations for changes within restoration work proposals. As the projects were implemented a review and monitoring period ranging from one to three years assessed the success of the restoration work. These assessments helped inform some necessary alterations for following round of restoration project proposals.

The perspective from the TRCA and the RPA concerning the use of the adaptive framework is one of success over the years, wherein the presence and actual application of the framework helped inform future restoration proposals and planning. However, from the viewpoint of the restoration organizations submitting the restoration work proposals to the RPA, the adaptive management loop has yet to be closed. The argument is that the adaptive management framework employed for the restoration of the Rouge River watershed in the park is limited in scope. The project scope and subsequent project monitoring focused almost entirely on increasing the tree numbers through volunteer plantings in the park, as part of the woodland restoration in the watershed. This means, the metrics used to measure the project success almost exclusively came from counting the number of trees planted, and in conjunction counting the volunteer numbers for the planting events. The metrics are thus very limited in their environmental scope.

Furthermore, the monitoring and management over the at most three-year period following the project completion is insufficient to qualify as a successful restoration project, indicating that a pattern of "scale-mismatch" is present in the adaptive management framework. A monitoring program lasting 5 to 10 years better indicates whether the project was a failure or success, especially for a woodland restoration project. Nonetheless, the allocation of funds for

long-term monitoring is uncommon. Moreover, gaining funds for additional work in a "restored" site that failed to meet the objectives outlined is also uncommon. This issue is not unique to small-scale restoration organizations. The well-funded and resourceful TRCA Restoration Projects group also faces the same issue. Currently, no program exists to support any long-term monitoring of their restored sites. For example, during watershed restoration activities in the Rouge, the project manager must deliver on a certain number of factors such as wetlands restored per square metre. Following the project implementation, the restricted number of funds and resources remaining may go towards monitoring the site for the following year.

Representatives of the restoration organizations indicate that the documentation of watershed restoration project "failures" is detrimental to the funding procurement for future Rouge Park restoration projects. Since funding allocations never go towards improving a "completed" project, no incentive exists to monitor the site post restoration. Furthermore, in most cases the evaluators of the restoration projects are those who implemented the project in the first place. Therefore, the assessment and reporting of an unsuccessful restoration project is doubtful, especially since the allocation of funds for future restoration projects is dependent on the reporting of a successful restoration project outcome within the one to three-year monitoring period.

7.1.3. Governmental Funding for Projects

The Rouge Park provides a unique model for the review of the restoration funding framework, in that the undertakings to restore the lands had a fluctuating amount of core funding year after year. The core funding came from the Federal government which created an endowment of 10 million dollars provided to the park with the primary objective being restoration. It was held by the Waterfront Regeneration Trust, and was invested in secure

investments (i.e. GIC, term deposits, bonds). The annual interest garnered from the 10 million dollars went towards restoration projects in the park. The park thus maintained the capital funding, and in some years was able to put $300,000 to $400,000 towards restoration projects. To access these funds the restoration organizations working in the park fulfilled an annual application process. The approval for the distribution of funds came from the RPA following the review of the applications by specific park representatives. If the organization received a sum of funds from the park to proceed with a project, they were often leveraged as capital to help acquire other grants available for restoration work in the park. However, the return on investments from the capital funding fluctuated substantial by each year impacting the restoration planning and project implementation.

This is a unique case because in many other conservation lands outside the Rouge Watershed the land managers must submit a capital request to the Municipal partners to undertake restoration projects on the lands. Receiving funding for a project that requires several years to complete is not always a guarantee. Furthermore, the amount is also not annually fixed, thus limiting the restoration organizations to a seasonal application cycle in the spring, summer, and fall. For the Rouge Park project the consistent funding framework provided by the Federal endowment meant that each year the process of restoration planning and implementation improved. The securement of the capital funding led to a steady increase in momentum, and consequently steady interests by several stakeholders involved in the restoration of Rouge Park including the TRCA. This helps to avoid the frustrations associated with the typical funding framework, such as having to reapply annually for funds of which receive no allocation guarantee to the park. Finally, it also helped familiarize and improve the adaptive management framework applied during the restoration of Rouge Park.

Nonetheless, for the other smaller organizations operating in the park that have limited capacity when compared to the TRCA, the annual application process for access to the core funding created more competition rather than collaboration. This is because all the organizations interested in restoring Rouge Park had to apply to the same grants. Furthermore, to gain access to other external grants, the organization applying must have the funds available to match. Therefore, an organization with full-time staff and public funding like the TRCA is much more likely to gain access to the internal grants as compared to smaller organizations. The smaller organizations were frequently tasked to fundraise so as to gain the initial monetary value and be granted access to the funds provided by the Rouge Park endowment investments. This process is challenging for smaller scale organizations like Friends of the Rouge, and other organizations also heavily devoted to the restoration of Rouge Park.

7.1.4. Public Participation and Community Development

The public participation and community development processes within Rouge Park linked to the restoration work are another facet that improved overtime, similarly to the implementation of the adaptive management framework. The tensions between the organizations implementing the restoration work and the farmers who leased the parkland in the region has guided long standing consultation and mediation processes. In the 1970s approximately 5000 acres of Pickering land was expropriated for an airport that was never built. The land became part of Rouge Park in 1995, and during the first decade the Rouge Park management took much of the remaining farmland out of production so as to complete the planned restoration projects. The reasoning for this was to help realise the provincial plan that mandates the establishment of a 600-metre corridor in the Park's North end. This plan focuses on the restoration of the watershed, and as such the restoration organizations became opposed to the agricultural land

practices as these are seen as two incompatible practices. This led to on-going tension and conflicts between the agricultural community and the restoration organizations working in the park.

Restoration of the park was only one of many mandates for the management of the park, but it became the main focus for many of the community restoration groups. This subsequently led to the marginalization of the agricultural community and deficient agricultural and educational park mandates. The agricultural community in the park voiced their concerns over the loss of their livelihood as the restoration plans for the lands continued to expand. To manage the differing stakeholder perspectives the park implemented the typical formal engagement and public consultation methods. This included annual public meetings where the TRCA presented the general updates for the future plans in the park. The engagement by the public at these meetings included the right to form a delegation and speak to a particular issue within the plan. Technical experts were also engaged to help facilitate the meetings by presenting different concepts and ideas.

As tensions grew between the agricultural community and the restoration partners the park started to implement focus groups, facilitated by the TRCA. In addition to these group meetings, the park managers instigated special meetings with the farmers “around the kitchen table” so as to understand the farming interests, and present on the interests of the restoration organizations. The outcome of these focus groups, special meetings, and also with adaptive management practices, was the understanding that park management must remain open-minded and have regard for the agricultural community residing in the park. Adaptive management helped develop better agricultural protection policies, as well as integrate the restoration with the agricultural practices of the community.

Over the years, Rouge Park funded extensive restoration efforts in the Rouge Marsh complex and throughout riparian areas in the watershed. The other restoration efforts within the park watershed attempted to re-establish woodlands throughout the park. Completion of the projects occurred through partnerships and collaborations between several groups (i.e. the TRCA, Friends of the Rouge watershed, Ten Thousand Trees, Save the Rouge Valley Foundation, TD Canada Trust Friends of the Environment, Toronto Zoo, and the Tamil Community). These collaborations helped restore extensive areas of forest, wetlands and meadows in Rouge Park. Additionally, other programs encouraged private landowners to restore and manage the natural cover on their lands. These programs included the Rural Clean Water Program, Canada-Ontario Environmental Farm Plan, Oak Ridges Moraine Environmental Enhancement Fund, Greenbelt Farm Stewardship Program, and the TRCA's Private Land Stewardship Programs (TRCA, 2008).

Due to the immense focus on ecological restoration in the initial years of the park management, the development of public engagement and community development programs for restoration activities occurred at a high level. During planting events for example, upwards of 2000–3000 volunteers at a time engaged in park restoration activities. It is said that the "the number of volunteers and interested participants in the Rouge Park and its community participation out numbers all of the rest of the public and community participation in Parks Canada". Other programs included a winter bird count, and a Trail Ambassador Program. During the bird count activity specialists led community groups and volunteers through the park. This fulfilled the educational component of the park, and also complemented the restoration projects. Trained volunteers also led the Trail Ambassadors' Program, creating guided hikes to help educate the public about the different environmental features of the park. This is a great example

of a community-driven and community-led opportunity, which is building the capacity and skills for individuals engaged in Rouge Park. These skills are also applicable outside the park, thus also benefiting the community as a whole.

7.2. Conclusions

The watershed restoration of Rouge Park has some sustainable indicators and criteria, but is also lacking in certain key areas. Firstly, Rouge Park implemented a strong land acquisition program, which encouraged the expansion of the watershed restoration lands into all the necessary environments (i.e. stream/river, riparian, floodplain, wetlands, and woodland). Even though no connections to the GAP, and the Parklands Dedication and Cash in Lieu programs existed, the park endeavored to expand the land base continuously until the transfer to Parks Canada occurred. Secondly, the park also developed and implemented a holistic public engagement and community development agenda. They managed to work closely with two seemingly opposed groups, the restoration organizations and the farmers, to achieve both mandates to restore the watershed and protect the agricultural lands.

On the other hand, the implementation of an effective adaptive management framework is questionable. The metrics used by the park managers measuring the success of the restoration are narrow due to the main focus being the number of trees planted and the number of volunteers engaged for the planting. This is not an accurate or precise way to gauge a success of the restoration work that has a myriad of objectives that focus on many other environmental aspects. Furthermore, the absence of a long-term monitoring program within the park presents a significant problem for the sustainability of the restoration project. This is most likely due to the restrained capacities of the restoration organizations working in the park. The desire to conduct long-term monitoring exists, but achieving it has yet to occur for any organization. Finally, the

competitive and non-collaborative nature of the granting structure, and the instability of the annual funding framework is another missing sustainability indicator. Overall, the Rouge Park restoration provides some great examples of sustainable watershed restoration practices, yet does not fulfil all the criteria and thus is not deemed to be a sustainable watershed restoration project.

8. THE WEST HUMBER RIVER HABITAT REHABILITATION PROJECT

8.1. Case Description

The Humber River watershed is over 900 km² and is the largest of the major watersheds in the boundaries of the Toronto region. The headwaters of the watershed begin in the Oak Ridges Moraine and Niagara Escarpment, and diverges across the land into hundreds of rivers, streams, and tributaries along its course. Three identified sections of the Humber watershed serve as distinct sub-watersheds, that contain different habitats suitable for differing species. Vital habitat for the Atlantic salmon remains in the Upper Main Humber and East Humber sub-watershed areas. The West and East Humber branch off below the upper portion, and the West Humber flows through Brampton. The West Humber is distinct to the East and Main section of the watershed as it is suitable for the species called the Redside dace, and not for the Atlantic salmon. Over the last twenty years the interests and restoration planning in the Humber River watershed has evolved. It began with the Fisheries Management Plans, followed by the restoration at a reach level and strategies linked to endangered species, to finally the present system of Fisheries Management Zones (FMZ) and the push for landscape level restoration planning.

The Fisheries Management plan developed in 1995 and then published in 2005 guided much of the former rehabilitation work in the Humber River watershed. The 2005 plan identifies the intent to implement restoration projects restoring habitat for species-at-risk, like the Atlantic salmon and the Redside dace. The West Humber Rehabilitation Project commenced when Ontario Streams began the Kilmanagh Creek assessment in 2008, guided by the 2005 Fisheries Management plan, which strongly promoted habitat restoration for the endangered Redside dace. The restoration project proposal, planning, and implementation for this section of the West

Humber River is a cooperative effort between Ontario Streams, the MNRF, and the City of Brampton. Located along the Kilmanagh Creek, which flows through Campbell's Cross hamlet is the West Humber River Habitat Rehabilitation Project. Ontario Streams restored and enhanced approximately 4 km of Kilmanagh Creek from Castlemore Road to Countryside Drive. The rehabilitation activities included but were not limited to: debris jam and beaver dam removal, stream bank stabilization, riparian plantings, and garbage removal. Ontario Streams undertook this work using volunteers from the Ontario Stewardship Rangers and Sandalwood Heights Secondary School students. This project is now within the monitoring phase.

It is important to note that since 2005 much of the fisheries management planning and restoration for the Humber River watershed has stalled. This is due to the changes enforced by the province, eliminating the use of specified fisheries watershed plans and management strategies, and moving to a planning framework targeting the landscape scale perspective. The province divided the area around the Great Lakes into 20 Fisheries Management Zones (FMZ). Following this change, the next step was to appoint advisory councils for each FMZ to conduct assessments and produce management plans for the FMZs. The publication of these plans has yet to occur, resulting in planning delays for restoration work conducted by organizations such as Ontario Streams, the TRCA, and the Atlantic Salmon Restoration Program implemented by the Ontario Federation of Anglers and Hunters (OFAH). The rehabilitation work conducted by Ontario Streams in the West Humber watershed is one of the most recently completed restoration projects that occurred.

8.1.1. Land and Water Acquisitions for Watershed Restoration

The land base of the West Humber Rehabilitation project fortuitously includes a wide expanse of area adjacent to the stream, comprising of effective riparian and woodland habitat.

Nevertheless, for projects like the West Humber Rehabilitation that focus primarily on improving endangered fish habitat, the next step is to remove in-stream barriers and connect vital fish habitat to other vital areas. In-stream barriers can cause habitat fragmentation, sediment transport, or altered water temperatures, all of which make the environment and habitat unsuitable for certain fish species (TRCA, 2008a). By removing a culvert or dam the expansion of available aquatic habitat occurs, therefore improving the sustainability of a project. For this case study, removing in-stream barriers surrounding the project is just as important as acquiring and restoring other watershed lands near the restoration project site.

In-stream barriers are very common in the Humber River, that has potentially over 1200 barriers identified through air photo interpretation. Within the West Humber over 280 potential barriers are in existence (TRCA, 2008). Through discussions with the MNRF, as well as with organizations implementing restoration projects, restrictions on the expansion of aquatic habitat is due to the liability and administrative difficulties surrounding removing in-stream barriers. This causes significant impediments for restoring endangered fish habitat and the West Humber watershed as a whole. Any work within a stream that includes a proposal to remove a barrier requires a permit from the MNRF. However, in many cases the application and review of a permit does not distinguish between a small culvert and large dam removal, thus causing significant wait times when trying to acquire a permit. Since the distinction is non-existent, a small easily removable concrete structure falls under the River Improvement Act Review used for large-scale dam removal. This makes the process extremely unpredictable for small organizations working on an annual funding basis and applying for a permit to remove a small barrier. The risk of losing the annual funding for the project is high if the organization does not receive the permit in time for the project timelines. The Great Lakes Guardian funds from the

Ministry of Environment and Climate Change recognized the need for flexibility in such cases and thus allowed for project funding to roll over to the following year if a permitting issue halted a restoration project. Overall, the lack of a province-wide plan to remove ancient and inoperable in-stream barriers is a significant sustainability issue to restoration projects in the Humber River watershed as a whole.

8.1.2. Adaptive Management

Ontario Streams worked closely with schools and community groups to do some selected monitoring of plant survival and bank stabilization after the completion of the project. However, the extent to which Ontario Streams is able to close the adaptive management cycle for all the project objectives is restricted. In fact, for many small not-for-profit restoration organizations the capacity to apply the adaptive management framework for projects such as the West Humber Rehabilitation is limited by permitting, funds, and land ownership. For the practitioners and coordinators of the restoration project, the method for monitoring restoration projects includes namely informal visits to the project site in the following years. Commonly, individuals formerly involved with the project conduct site visits due to their passion and interest in the outcome, as the resources for a formal monitoring plan are often non-existent.

Similarly to the Rouge Park restoration project, a particular monitoring metric used for the adaptive management of the West Humber project centered on assessing native plantings and tree survival, as well as the amount of garbage removed from the area. The monitoring conducted was a volunteer-led activity, and facilitated the citizen-science and outreach goals for the project. However, the survival of the riparian and woodland plantings is a subset of the principal restoration goal, which is to create suitable habitat for the endangered species, i.e. the Redside dace. Objectively the monitoring and assessment of population levels for the Redside

dace in the rehabilitated stream reach is paramount. It is also important to have rigorous baseline data to understand the species population levels prior to the site rehabilitation so as to compare the population levels after the project implementation. Nonetheless the application of fisheries monitoring is at a coarse level in the Humber River watershed, resulting in inadequate project baseline data for the Redside dace population levels. For the entirety of the watershed, at most three fisheries monitoring stations exist. Furthermore, the monitoring occurs once every three years following the Ontario Stream Assessment Protocol (OSAP) which assesses the fish communities, biomass information, and benthic invertebrates present at the monitoring station.

Updating the watershed restoration work plan for the annual projects implemented in the watershed, occurs with the use of this limited data collected at the monitoring stations. The annual work plan is also predicated on assessing the typical maintenance required for the project site, as well as the replacement (of trees) and the maintenance needs outlined following the site monitoring. During the interviews it was stated that some innovative monitoring methods have been implemented this year, to improve the collection of baseline data for the areas restored for fish habitat. This is to document the use of the area prior to the restoration and following the site rehabilitation using an underwater videoing system.

These innovations for collecting baseline data did not exist during the planning and implementation of the West Humber Rehabilitation Project. Thus, for the groups monitoring this site, it might be difficult to say whether this project met its objectives to improve habitat for the Redside dace and the overall condition of the watershed. Significant levels of baseline data provide control information for pre-restoration stream health conditions. The comparison of this control information to the post-restoration stream conditions helps indicate whether a successful restoration project occurred. It helps to illustrate whether the project goals are met, thus allowing

for site maintenance and the revision of future site plans. Following this adaptive management cycle ultimately leads to the implementation of a sustainable watershed restoration project.

8.1.3. Governmental Funding for Projects

For the past twenty-five years until now the distribution of funds for habitat restoration projects for endangered species, including the project in the West Humber occurs on an annual basis. The annual work plan thus changes from year to year depending on the amount of funds received, as well as the content of the project outcomes specified by the granting agency. Moreover, the annual priorities for the area and related project outcomes shift accordingly, so for several years the projects might focus on the Redside dace and shift the following years to another species of interest. Overall the annual funding source is relatively stable, yet a drawback identified is that funds are seldom afforded for long-term monitoring after the restoration project is complete. This is a particular drawback for species-specific sites and community-based projects such as the West Humber Rehabilitation Project.

Each year the project managers solicit other agencies and governmental entities for funding support, starting as early as October for the following spring and summer. The typical entities providing funds for restoration work include federal grants from Environment Canada and the Department of Fisheries and Oceans (DFO), and provincially from the MNRF, and the Ministry of Environment and Climate Change. Other financial contracts are also made with the municipalities, as well as in the private sector. For instance, the West Humber Rehabilitation Project received support from the DFO, MNRF, and the City of Brampton. Private sources included: Community Fish and Wildlife Involvement Program, Species at Risk Stewardship Fund, WalmartEvergreen Green Grants Program, the Habitat Stewardship Program, and the Great Lakes Green Community Fund (Ontario Streams, n.d.).

The uncertainty of the annual funding scheme is a significant project limitation especially concerning the objectives linked to the long-term recovery of a species at risk, like the Redside dace. The experts in the field identify a need for increased funding certainty when endeavoring to manage the recovery of a target species. It is very difficult to manage, plan, and operate sustainable restoration projects that are deprived of funding commitments past the typical annual cycle. One solution presented is to shift to a five-year plan with long-term governmental support. This might allow the restoration organizations with significant levels of expertise, like Ontario Streams and the TRCA, to set the stage for long-term recovery plans. A longer-term funding scheme would provide some degree of certainty, therefore providing a stable starting point for many watershed restoration organizations.

8.1.4. Public Participation and Community Development

The West Humber Restoration Project is an environmental project that demonstrates collaborative efforts during the implementation and monitoring of the project area. The collaborative efforts administered by Ontario Streams provided venues for the inclusion of local communities, educational programming, and community development during the project lifecycle. It is apparent that Ontario Streams is an advocate for community awareness and stewardship activities that promote the protection and restoration of habitats for at-risk species. The community had the opportunity to partake in the site cleanups, led by individuals volunteering their time to improve the health of the local environment. Furthermore, the opportunity to help monitor and participate in citizen-science monitoring projects adds to the sustainability of the project. The continual engagement of volunteers and community members stimulates a sense of stewardship for the project area, thus helping mitigate issues with garbage pollution and other types of vandalism.

Throughout their work in the West Humber, Ontario Streams worked with stewardship groups, government agencies, and volunteers to raise awareness for the rehabilitation project. A variety of community groups helped with completion of the project including the Sandalwood Heights Secondary School. The intentional inclusion of school groups as part of a community development initiative through watershed restoration projects is continuing to gain popularity. By actively fostering educational opportunities for the youth in the community, Ontario Streams is helping develop skills and opportunities for individuals beyond the West Humber Rehabilitation project and within the local community.

One challenge identified when implementing collaborative restoration projects such as the West Humber Rehabilitation project is engaging in effective communications of ideas between the stakeholder and agencies involved. When multiple organizations and agencies are working together in an area, communication is essential for the advancement of restoration projects. For the Humber River watershed, the planning and implementation of a restoration project is very site specific due to the multitude of different ecosystems, species, and landscapes. Communication is essential for information sharing between organizations, and consequently helps ensure the appropriate restoration work is implemented for the project location.

8.2. Conclusions

While the West Humber Rehabilitation Project effectively fulfilled the public participation and community development indicator for watershed restoration sustainability, the other three indicators assessed had significant issues for the future sustainability of the project. In assessing the sustainability criteria against the information provided for the West Humber Rehabilitation project, it is apparent that key indicators are missing. The most pertinent indicator missing is the advancement of the water securement planning beyond the localized project site,

so as to reconnect the significantly fragmented Humber River watershed. Removing in-stream barriers like small culverts is very helpful for the Redside dace fish species as well as for the watershed as a whole. Thus, one suggestion is to encourage community groups and the TRCA to work towards large-scale planning for in-stream barrier removal. However, for organizations like OFHA that are currently working on this issue, the procedural and administrative backlog to acquire the relevant MNRF permits presents significant problems for project outcomes. Until the MNRF is able to distinguish between a large dam removal proposal and a small inactive culvert removal, in-stream barriers will continue to be a significant sustainability issue for watershed restoration work in the West Humber.

Another important criterion missing from the case study is the presence of an actual and effective adaptive management framework. One advantageous step for the planning of forthcoming restoration projects is that efforts are underway to improve the collection methods of baseline data for projects in the West Humber. The effectual application of these methods, along with the implementation of the adaptive management cycle, might lead to sustainability improvements for future restoration projects. Finally, the absence of a funding scheme for restoration planning and implementation opportunities beyond an annual project lifecycle is particularly detrimental to the sustainability of the West Humber restoration efforts. This requires a shift from the "short-termism" of the current funding approach, to one with the appropriate longevity for the habitat restoration of a species at-risk. Only then can watershed restoration sustainability occur within the projects implemented by organizations like Ontario Streams.

9. WILKET CREEK REHABILITATION PROJECT

9.1. Case Description

Due to the history of rapid development and urbanization in the Don River watershed, this area provides a model exemplifying the watershed degradation and impacts on local channels and river catchments linked to land use changes (Barr, 2017). The Don River watershed in its entirety is a heavily urbanized zone, and is approximately 80% developed (TRCA, 2015). Wilket Creek is a small creek within this watershed with a catchment area of 15.5 km2. It is the third case study discussed, and is currently undergoing a full-channel restoration as part of a long-term plan. Heavily urbanized areas border the creek; thus, it is an isolated creek with no remaining natural tributaries flowing in or out. The inputs into the creek come mainly from the city infrastructure including storm and combined sewer outfalls along the valley (Parish Aquatic Services, 2015). Within the catchment approximately 93% of the land comprises of community infrastructure, like residential housing, shopping centers and schools, and industrial land use. The remaining 7% land use in the catchment is forested, primarily along the riparian zone of the Wilket Creek channel (Parish Aquatic Services, 2015). Consequently, this area is important for the surrounding community, as it is one of the only nearby locations with direct access to natural green space. Yet, during the implementation of this project much of this area undergoing restoration became inaccessible to the public.

The development in the Wilket Creek catchment took place in the 1960s when storm water management was not a priority. This resulted in no evident storm water management practices in the watershed (Toronto and Region Conservation Authority, 2015). The creek flows through three parks (i.e. Wilket Creek Park, Edward Gardens, and Winfields Park), and is adjacent to affluent neighbourhoods in the Toronto region, specifically the Bridle Path and Don

Mills developments. The average annual income for 52.6% of the households in these neighbourhoods was over $200,000 in the 2016 neighbourhood census (Statistics Canada, 2016). Following the three extreme flooding events in 2005, 2008, and 2013 that caused extensive channel erosion, the city approached the TRCA Infrastructure and Restoration division to begin channel reconstruction for flood mitigation in the creek. Subsequent to the second flooding event in 2008 it was determined that the area required a comprehensive study and long-term rehabilitation plan.

The main goal of the study and plan was to reduce the energy of the water travelling through the watercourse, therefore involved developing methods to protect the surrounding city infrastructure, and prevent erosion of the stream banks (TRCA, 2015). In conjunction with the infrastructure work, a secondary project objective is to enhance the natural ecosystem, and also improve the aesthetics and green space of the area. The regions adjacent to Wilket Creek are high risk areas due to the abundance of public infrastructure situated along the creek, including a sanitary sewer. In 2010 the City of Toronto initiated a geomorphic assessment of the creek as part of a Municipal Class Environmental Assessment (MCEA) process. This process characterizes the creek and prioritizes the restoration of the different stream sections in relation to the risk level at each site. Since the completion of the Geomorphic Master Plan, the TRCA Restoration and Infrastructure division has restored two of the nine stream sections slated for restoration. During the implementation of the restoration works, the area is closed off to the public.

9.1.1. Land and Water Acquisitions for Watershed Restoration

Due to the nature and location of the Wilket Creek Rehabilitation project, the chances of expanding the restoration land base beyond the narrow riverbed and public park land, and into the privately-owned land is minute. This limitation is not unique to this case study. Other urbanized areas in the inner city of the Toronto region also require watershed restoration for the protection of city infrastructure. However, the location of this infrastructure is typically overtopping or right next to the stream requiring restoration, thus severely limiting the project plans and methods. When the City of Toronto developed, it built its city infrastructure and assets over top of the rivers, and presently the Toronto region is experiencing ongoing and unforeseen flooding issues during heavy precipitation events. Due to the need for rapid flood mitigation tools during these precipitation events, the two completed restoration works in Wilket Creek initially occurred in the two sections of publicly owned land. The upstream areas slated for restoration are within the private property lines of the households bordering the creek, and thus is causing legal and administrative delays that are impacting the implementation of the following restoration works in the creek.

Many of the properties located on the banks of Wilket Creek contain valuable ecological riparian and woodland systems. To gain access to the privately own lands, the TRCA has as its task to form agreements with the property owners, often requiring extensive amounts of legal work. This is due to the limited capacity of the TRCA to enact the GAP “Fee Simple” option, which is to purchase and transfer the land into its jurisdiction. The next option to acquire land is using Conservation Easements where the landowner can grant specific or limited rights of use. These easements “provide protection of a resource or resources found on a particular piece of property” (TRCA, 2016b, p. 22).

The next best option, and likely the one used for the Wilket Creek project is to gain access to the lands through the GAP Access Easements option. This option grants the TRCA "specific or limited rights of use granted by an owner. Such rights are registered on the title and are binding on future owners" (TRCA, 2016, p. 22). These easements allow the TRCA to develop public access points, and also complete restorative (i.e. hazard mitigation) on the private lands. When probed about the Parkland Dedication and Cash-in-Lieu program, no evident connection exists between this program and the Wilket Creek project. Since the project funding comes from the City of Toronto through tax-payer dollars, the notion that some funds come from this program is plausible. However, this assumption concerning the possible funding connection requires further investigations.

While assessing the water securement indicator for the Wilket Creek case study, again the criteria fell short when compared to the requirements for watershed restoration sustainability. The identification of a weir that is preventing fish passage in the Windfields Park area is a significant concern for the sustainability of the project. The removal of this in-stream barrier is proposed as part of the improvements plans for the area, and its removal is necessary to improve the sustainability of this watershed restoration project. However, no proposals or future plans outlining the timeline for the removal of this in-stream barrier are publicly available at this time. Additionally, public proposals for the restoration of upstream areas linked to the Wilket Creek case study does not exist. Extending the restoration efforts to the upstream areas of the watershed helps further manage storm water runoff and future flooding incidents. Overall, this project does not meet the criteria for a sustainable watershed restoration, as the limitations to land acquisition and water connectivity are high.

9.1.2. Adaptive Management

Throughout the interviews with individuals involved in the Wilket Creek case study, it is evident that the use of the adaptive management cycle is not specifically set out during the project planning. However, because the Wilket Creek project is under a Municipal Class Environmental Assessment, it requires gathering extensive amounts of data for the baseline, implementation, and post-construction monitoring phases for the entire project area. In fact, it is recommended that this type of monitoring should become standardized for all of the future restoration projects, even those that do not fall under the MCEA process. For the Wilket Creek project the baseline collection phase took place during the initial site assessment, and assessed a variety of factors such as property information, flora and fauna, the ecology, land classifications, water data and more. The collection of data came from a broad range of sources, thus produced extensive data that aided in the planning of the required project approach. It also informed the project coordinators of the permitting requirements. The baseline data collection phase is thus a critical phase for any watershed restoration project.

The timeframe for the collection of baseline data for the Wilket Creek project took a couple of months to complete. Much of the baseline data collected for this project came from readily available data produced by other TRCA projects. In some cases, a project requires an ecological assessment, particularly if the presence of an endangered species is documented within the project area. The timeframe for an ecological assessment shifts to an annual cycle so as to observe seasonally active species. Whether the timeline for the collection of baseline data is several months, or a year, it is a crucial to the planning of a restoration project. It enables project managers to measure progress over the life of the project (Bash & Ryan, 2002). The accurate assessment of a successful watershed restoration project requires year-round data specifically for

the project site. Without a full year of site-specific baseline data collected prior to the restoration, the project might have insufficient information to conduct a rigorous evaluation of the restoration performance. This is due to the natural variability and unanticipated environmental conditions that might confound the restoration success criteria identified in the project objectives (National Academies of Sciences, Engineering, and Medicine, 2017).

One apparent advantage that the TRCA Restoration and Infrastructure division has in comparison to other TRCA Restoration Project groups and small-scale organizations is the capability to complete systematic long-term monitoring of all the projects they complete. For the watershed restoration sites like Wilket Creek, the TRCA has a monitoring department that conducts site assessments, measuring factors like the function of the erosion control structures, as well as the riparian plantings associated with the project. In fact, the riparian plantings executed in conjunction with infrastructure restoration projects are assigned an "asset id" and are monitored year after year to ensure the quality of this environmental "asset" is maintained. The research indicates that by assigning the tree plantings an "asset id", provisions for the maintenance of these watershed restoration applications increase. In all, the adaptive management framework of Wilket Creek partially meets the criteria set out in this indicator. The main limitation is the potential "short-termism" of the initial baseline monitoring season.

9.1.3. Governmental Funding for Projects

The City of Toronto identified the need for the Wilket Creek Rehabilitation project after three large scale floods occurred along the creek. As such the City of Toronto contracted the project to the TRCA, who are then tasked to come up with a budget estimate of how much the rehabilitation project will cost. The TRCA then presents a selection of plans, processes, and implementation proposals to the city, providing several alternative scenarios (e.g. do nothing

versus full-scale restoration). The TRCA also provides the city with multiple options and recommendations on how to proceed. In this case the "do nothing" alternative was not a viable option, and the city decided to proceed with the current rehabilitation project underway.

In most cases, the TRCA presents several project options, and provides the predicted cost for all the options. Since the city provides public funding for these infrastructure protection projects, a balance must be achieved between implementing the most cost-effective solution with the most environmentally sound project. If the TRCA succeeds in presenting a viable option to the city, the city determines whether the project funds are available to implement the project. After the completion of the specific project, the city is no longer involved in the project. Thus, the funds for the long-term monitoring of the Wilket Creek project comes from the TRCA capital funds, presented to the TRCA monitoring department on an annual basis. Overall, this characteristic of providing funds for every part of the project life cycle indicates that restoration projects for infrastructure protection exhibit more sustainable characteristics than restoration projects for restoration sake. This is most likely due to the fact that city infrastructure has a price tag associated with it, whereas natural ecosystems, and endangered species do not. It would be wise however to extend this characteristic into restoration projects for restorations sake, as these projects also help protect city infrastructure. Restoration projects that re-establish ecosystems within the watershed are considered a best management practice not only for the environment but also help mitigate flooding, erosion, and sedimentation similarly to the restoration projects for focused on infrastructure.

9.1.4. Public Participation and Community Development

In contrast to the Rouge Park restoration and West Humber Rehabilitation projects, restoration projects for city infrastructure do not demonstrate a wide-ranging framework to

engage the surrounding community and interested organizations. Because most of these projects, including the Wilket Creek Rehabilitation, proceed through the MCEA process, public participation campaigns fall within the very narrow protocols set out in the process. This means that the primary method of engagement includes formal methods of community engagement. The use of these formal engagement methods typically leads to disengagement and a lack of interest from the surrounding community.

The public engagement process for the Wilket Creek project included compiling a list of local citizens and interest groups, government agencies, and NGOs and allowing them to come and comment on the project information either during a public meeting or through a letter. Additionally, public information centers were installed in public areas, allowing interested community members the chance to learn about and comment on the Wilket Creek plan and provide recommendations. At these locations community members could provide feedback pertaining to the assessment and alternative options presented for the project plan. If concerns arose through this engagement method, the TRCA was able to address them prior to having the project finalized.

Through the interviews and discussions, it seems the relevant community groups who take an active interest in other restoration projects in the Don River watershed did not take an active interest in this project. This disengagement and disinterest by the local community, indicates that the Wilket Creek project does not exhibit in a substantial way the criteria for sustainable watershed restoration for the public participation and community development indicator. Furthermore, the location of the Wilket Creek restoration project is within a heavily used area; with proper engagement the potential for significant community push back was high following the disclosure by the TRCA that a compete closure of the area was necessary.

Nonetheless, it seems as if efforts to improve the public engagement methods for this project are underway, most notably with the interactive map provided on the TRCA, Wilket Creek webpage (TRCA, 2015). When on the page, the public is able to scroll along the stream map and gather information for each phase of the restoration project. However, the public engagement and community development criteria require additional improvements, so as to meet the sustainability criteria identified in this paper.

9.2. Conclusions

Overall the Wilket Creek Rehabilitation Project does not meet the criteria outlined for a sustainable watershed restoration project. Two particular drawbacks are apparent, and are typical drawbacks associated with TRCA restoration projects for infrastructure. One is the deficient capacity of the project to procure adjacent lands and water for restoration, and the second missing indicator is the public engagement and community development efforts. However, the watershed restoration experts now recognize that the public engagement and community development methods require updates and improvements. Throughout the interview process, discussions on new and innovative plans for public engagement often arose, specifically concerning the social media and interactive side of the projects.

The two indicators that exhibited some of the sustainability criteria outlined in this paper are firstly the adaptive management indicator; and secondly the capability to procure secure and long-term funding for the project and post-project monitoring timeframes. The use of the MCEA framework helps set out protocols and processes that strengthen the agenda for gathering extensive baseline and monitoring data. The only issue is the inconsistency of the pre-monitoring timeframe. This requires the standardization of the baseline data gathering timeframe at each restoration site, substantiated by the restoration area size and data quality and availability, so as

to avoid falling into the “scale-mismatch” conundrum. Furthermore, the stable state of funds for the entirety of the restoration project, as well as for the monitoring of the site afterwards is another checkmark for the Wilket Creek project on the sustainability checklist. This stable state of funds is not seen in restoration projects slated as projects for “restoration sake”. However, movement towards applying these monitoring programs to these other restoration projects is important for the sustainability of Toronto region watersheds as a whole.

10. THE ALFRED KUEHNE CHANNEL NATURALIZATION PROJECT

10.1. Case Description

Many of the catchments in the Toronto region have experienced urbanization and channel modifications similar to those discussed above, including the Alfred Kuehne catchment. The Alfred Kuehne Channel Naturalization Project located in the Etobicoke and Mimico creek watershed is the final case study evaluated for this research project. The headwaters of both these watersheds begin on the south slope of the Oak Ridges Moraine and spread through the suburbs, towns and industrial areas of Brampton, Caledon, Mississauga and Toronto and into Lake Ontario (TRCA, 2010a). The landscapes in the Etobicoke and Mimico Creek watersheds have changed dramatically over the past 200 years, and continue to rapidly change in recent decades due to the industrialization and urbanization of the area. As of 2010, 71% of the watershed area is urban, with only 13.8% natural cover remaining. The condition of this remaining natural cover is either in fair or poor, and it is found mainly within the river valleys or stream corridors (TRCA, 2018).

In Brampton and Caledon approximately one third of the watersheds house industrial facilities, including the Pearson Airport and a significant number of other heavy industries. These heavy industries developed through the 1970s and 1980s in the absence of research-based knowledge and information concerning the natural flooding mitigation processes of a watershed. Instead, the construction of concrete channels and the infilling of streams and creeks occurred, so as to remove water from the area as quickly as possible. Along the way the planning process forgot about the natural features of the watercourses, and much of the Etobicoke and Mimico Creek watersheds are completely disconnected from the adjacent ecosystems, including their floodplains, riparian areas, and the woodland habitats.

Due to the aging concrete infrastructure remaining in the rivers and creeks, and the perpetuation of residential developmental in the area, storm water management and flooding are significant concerns. These concerns inspired the implementation of the Alfred Kuehne Channel Naturalization Project instigated by the City of Brampton and the TRCA to help revitalize the area, and help mitigate the negative impacts from storm water runoff. Located in a highly urbanized area of Brampton, the project includes the restoration of a 1 km stream reach containing several highly eroded and failing concrete lined structures within the watercourse. The main goal for the project was to reduce the energy of water traveling through the watercourse by restoring the area using natural channel principals and floodplain enhancements. A difference between this infrastructure project and that of Wilket Creek is that no residential homes are directly adjacent to the area, thus making the implementation a natural stream design viable along the whole restoration location. This allows for the addition of natural features such as woodland plantings, undercut stream banks, and vital riparian habitat.

10.1.1. Land and Water Acquisitions for Watershed Restoration

The land acquisition indicator for the Alfred Kuehne project follows a similar pattern to the Wilket Creek project, except for one advantage. Because no residential areas exist within the restoration area, the TRCA implemented this project with ease. This is because they had the ability to implement the restoration designs throughout the entire site at once, rather than through the phased approach employed for Wilket Creek. When residential areas are near or within a proposed restoration area, the proposed plans require suitable consultation with the landowners. This requires substantial time and resources so as to properly consult with the residents and acquire permission to restore the land, necessitating the phased planning and implementation

approach. The Alfred Kuehne Channel Naturalization Project did not require a phased approach thus allowed for a smoother project implementation process.

In an ideal situation the TRCA looks to purchase the surrounding land required for a full-watershed restoration, but what is evident throughout all the case studies is that this is not always possible due to limitations in funding, and capacity. In the case of Alfred Kuehne project, the required next steps so as to meet the land and water securement indicator is to implement additional projects upstream and downstream. Connecting and networking together other watershed restoration projects further mitigates the impacts of an urbanizing area on the watershed conditions. However, the research conducted for this project indicates that the TRCA has vacated the project area entirely.

The Alfred Kuehne project ranked as the highest priority site based on several indicators, such as connectivity to other sites and biodiversity levels. However, since the implementation of the project 10 years ago no other nearby projects have been proposed, planned or implemented. Furthermore, in the Etobicoke and Mimico creeks, the construction of many in-stream barriers has resulted in the increase of secondary in-stream barriers over time. To improve the sustainability of the Alfred Kuehne project requires substantial additional work in the up-stream and downstream habitats, along with the removal of the many in-stream barriers.

10.1.2. Adaptive Management

As in the Wilket Creek project, a specified adaptive management framework and plan does not exist for the Alfred Kuehne case study. However, the active use of the adaptive management cycle occurred during the planning, implementation, and monitoring of the initial restoration works that focused on reintegrating the natural features of channels and river into the system. This reintegration of natural features is precisely what the Alfred Kuehne project

achieved. Throughout the 1990s when the realization that the channeling and hardening of rivers and stream in fact exacerbated flooding issues, the TRCA began piloting the use of natural stream features to help mitigate the impacts of flooding. These pilot projects, called proof-of-concept, occurred in the upper Mimico watershed, as this area had the appropriate amount of space available to implement and test the methods. Through these proof-of-concept projects the TRCA demonstrated that after the project implementation, the renaturalization of the area provided adequate environments for the proliferation of native flora and fauna in the area. This is in addition to providing effective water conveyance and flood mitigation for the restored area.

The TRCA demonstrated that these projects mitigate flooding, while also benefiting the natural environment through their wide-ranging monitoring cycle implemented by the TRCA monitoring department. This unit monitors a large number of metrics set out by the Ontario Stream Assessment Protocol (OSAP) such as geomorphology, bank stability, hydrology, benthic invertebrates and more. It is a provincial standard for watershed restoration project assessments used by the Toronto region network of restoration organizations. For the past 15 years this TRCA monitoring program has run on a rotational basis in the nine Toronto region watersheds. Every three years, the TRCA monitors three watersheds through the OSAP, and any newly implemented construction or naturalization activity by the TRCA falls into this monitoring cycle. The OSAP outlines criteria to help gauge whether a restoration project successfully met its objectives.

10.1.3. Governmental Funding for Projects

As in the Wilket Creek project this project is publicly funded, and received the funds for the assessment, planning, and project implementation from the City of Brampton and the TRCA. The main issue for the Alfred Kuehne project is analogous to the other three case studies. The issue is the fact that the appropriate funds required for the initiation of long-term monitoring programs is insufficient. The experts in the field, and the individuals helping plan, implement, and monitor these sites all indicate a need for better long-term funding programs to effectively evaluate their watershed restoration projects. In some cases, the permits issued as part of a project condition require monitoring of the restored site after the project implementation. Nonetheless the permit authorization for monitoring is for at most three years after site construction, indicating again a pattern of funding "short-termism" for restoration projects that require long-term evaluations.

Unfortunately, it seems that the funds for the restoration project implementation take away from the monitoring funds. As soon as one project is deemed complete, the requirement is to begin the planning and implementation of the next project. This leaves many project coordinators, and passionate individuals in the watershed restoration field visiting their sites outside of the restoration program. Even after the completion of the official the monitoring program specified in the project outline, the need to monitor the site continues to exist. This is to ensure that projects such as the Alfred Kuehne Channel Naturalization Project are in fact adding the sustainability of the Toronto region watersheds.

10.1.4. Public Participation and Community Development

For the implementation of restoration projects like the Alfred Kuenhe project with a significant amount of in-stream construction and thus the use of heavy-equipment, the involvement of the community tends to be limited. Eventually, after the in-stream work is complete, the project is handed over to the stewardship and watershed groups for the planting of the site. This is also when the educational groups and the public liaison departments are invited into the project, and when the restoration and infrastructure department move onto the next project. Many watershed restoration experts argue that restoration projects should always include a community outreach and public participation component. For example, the project coordinator might set aside an area that could be effectively planted by the construction contractor, but is planted by the local volunteers as part of the engagement process for the community.

For projects with the primary objective of protecting city infrastructure, the use of the Environmental Assessment (EA) framework for public consultations on the project proposals and plans occurs even if the project does not require an EA. This is because the EA process helps outline the most important rationales that necessitate the watershed restoration project. The process incorporates the scientific and technical background required to effectively implement a watershed restoration project and also compel public consultation and engagement. One interesting engagement tool used by the TRCA for the Alfred Kuehne case study was the production of a short video documenting the construction activities on the site. It also captured several flooding events during the construction phase, which inevitably helped illustrate the effectiveness of the rebuilt natural features (*Alfred Kuehne Stream Restoration Project*, 2013). Overall, the project lacks significant public engagement and community development initiatives, particularly when assessing the long-term timeline of the project. Little monitoring and

maintenance work through community engagement process has occurred since the implementation of the project 10 years ago.

10.2. Conclusions

For the overall sustainability of the Alfred Kuehne Channel Naturalization project, the only indicator that potentially met the criteria outlined is the effective implementation of the adaptive management framework. The long-standing work conducted by the TRCA with the use of pilot projects, and proof-of-concept projects allowed for the implementation of an operative watershed restoration project in the Alfred Kuehne creek. However, all the other indicators are lacking in the sustainable watershed restoration criteria. The efforts by the TRCA to expand the adjacent land and water base of the project, so as to increase the connectivity and the sustainability of the project, are absent. Furthermore, acquiring funding for long-term monitoring of the site, a feature desired by many of the experts interviewed for this paper, is also lacking. Finally, even though the public participation and community develop criteria are present to some degree, in comparison to the other case studies like Rouge Park it is insufficient in its application. Overall the sustainability of the Alfred Kuehne case is questionable when using the criteria outline in this paper.

11. DISCUSSION

The analysis above illustrates that within the Toronto region some progress in restoring and maintaining the health of the nine watershed ecosystems is occurring. Nonetheless the watershed restoration practices require further advancement and investments in all the sustainability indicators to maintain and improve upon the profiled watershed restoration projects as well as future projects to be implemented. Lake Ontario and the connected Toronto region watersheds is an AOC, thus exhibits severely degraded watershed ecosystems. This area crosses multiple jurisdictional boundaries in Canada and the US, and also exhibits some of the highest population densities in North America. The watersheds in the Toronto region are not only important for the health and resilience of the city and its residents, but also impact the health and resilience of the external communities and areas downstream to the Toronto region. These watersheds are connected to the largest freshwater source in the world the Great Lakes, thus the region has significant global environmental importance.

As in the Toronto region, most other cities across Canada and the US formed within the watersheds connected to the Great Lakes. Similarly, the development of the industrial sector, agricultural lands, and continued urban development in the Toronto region have led to immense amounts of environmental degradation, a situation which is paralleled in other regions on the Great Lakes. The Toronto region continues to experience large-scale development and urban expansion, impacting the watersheds within these areas. This has resulted in increased frequency and risk of flooding, water pollution from storm and waste water runoff, increased erosion and sedimentation, loss of habitat for flora and fauna, loss of green space for recreation, and many other impacts. Over the past 20 years, the population of the Toronto region has grown tremendously, and it is the fastest-growing region in the province of Ontario. This growth is

expected to continue. By 2041, the population will increase by 2.9 million to reach 9.6 million people (Ontario Ministry of Finance, 2017). To accommodate this growth and development, we must critically look to decrease and mitigate impacts on the region's watersheds and their natural areas. The following sections illustrate the best management practices currently used, the limitations to the watershed restoration practices employed in the Toronto region. Following this are several concluding recommendations for improving the sustainability of watershed restoration projects.

The utility of the aspects drawn from the UPE theory and used as a normative framework for the way in which watershed restoration should be, allowed for the examination, analysis, and identification of recommendations for enhancing the sustainability of environmental projects. These UPE aspects, combined with pragmatic methods like adaptive management, and tools for land and water securement, provides insights and information concerning the intricate relationship between watershed restoration and the social, political and economic sphere within the Toronto region. Adaptive management is a persistent tool present throughout the interview discussions, and further research in the use of this pragmatic framework in the political, economic, and social side of watershed restoration would be productive.

11.1. Best Practices and Highlights of Watershed Restoration

A best-management practice for watershed restoration projects frequently identified by the individuals interviewed for this research paper includes furthering the development of tools for enhanced public engagement during the project planning, implementation, and monitoring. In the case studies characterized as "restoration projects for restoration sake" the active engagement of the surrounding community was often a catalyst for much of the work conducted during these restoration projects. Not only can it be a catalyst for restoration work, it also encourages a

democratic model of participation in the discipline of restoration ecology (Light, 2006). Volunteer engagement during every part of the restoration project provides a direct participatory relationship between the local communities and the restoration area. This relationship helps stimulate a sense of stewardship for the area and often promotes sustainability in the area, helping prevent further degradation.

As for the watershed restoration projects for the protection of city infrastructure, they require the enrichment of public engagement methods and tools, particularly due to the "top-down" style of these projects. The Wilket Creek and Alfred Kuehne projects are rooted in the scientific authority of the TRCA, thus draw a figuratively and sometimes literal border between the professional practitioners and the volunteers. This is the case at Wilket Creek where public access to a heavily used natural area is currently severely restricted. The creation of these borders results in disengagement of the community, and altered levels of anticipated public participation, predominantly seen in the Wilket Creek case study. To enhance the stewardship and sustainability of the Wilket Creek and Alfred Kuehne restoration projects, fostering accessible and inclusive public participation events, and community development practices in the surrounding community is vital.

Since the introduction and description of adaptive management it has been acknowledged as a better solution to the trial and error approaches commonly used for complex environmental management challenges such as river erosion and flooding in urban city environments (Allen, Fontaine, Pope, & Garmestani, 2011). During the discussions from the interview probes for adaptive management, it can be concluded that the majority of the restoration experts acknowledge that this iterative framework is essential for the best management and sustainability of the watershed restoration projects in the Toronto region. This is worth highlighting as an

effective and imperative framework to use for restoration activities. Currently, the research into the four case studies as well as other research has documented that adaptive management is often not as successful in practice as in theory (Allen et al., 2011; Allen & Gunderson, 2011; Murray & Marmorek, 2003).

The restoration organizations and the TRCA attempted to close the adaptive management loop in the Rouge Park and West Humber restoration projects. This was unsuccessful, however, due to barriers such as a lack of secure funding, restricted resources for executing proper site monitoring, and narrow approaches to site monitoring borne out of funding stipulations. For the other two case studies, the formal inclusion of adaptive management into the project planning did not occur. However, its extensive use throughout the project planning and monitoring provides important information for other restoration projects. The superior capacity of the TRCA to implement long-term monitoring of the restoration projects for city infrastructure provides a model and method for adaptive management that should be built-into restoration projects for restoration sake. At the end of the day all the watershed restoration projects throughout the Toronto region are networked together through the upstream and downstream rivers, creeks, riparian areas, and woodland. This is regardless of their differing objectives to protect city infrastructure, or to restore a natural ecosystem. It is imperative to monitor these networked restoration sites in a standardized fashion so as to enable the effectual implementation of the adaptive management framework throughout the entire region.

11.2. Limitations and Identified to Watershed Restoration

Certain research demonstrates that when fragmentation exists between the relevant agencies and organizations associated with watershed management practices, a multitude of management challenges arise during the planning and implementation of environmental and related ecological restoration projects (Bakker & Cook, 2011; Cook, 2014). In other policy reviews of Great Lakes governance, it is shown that a multiplicity of water governance actors does not create a problematic water governance system, but without an effective coordinating mechanism, policy fragmentation and conflicting administration might occur. This can result in ineffectual, time-consuming, and costly management methods like work duplication, for watershed and environmental projects (Bakker & Cook, 2011; Cook, 2014; Dore, 2015; Friedman et al., 2015).

During the research into the watershed restoration project case studies, it became evident that the fragmentation of the relevant agencies creates significant issues for the sustainability of restoration projects, especially ones pursuing water securement through the removal in-stream barriers. The permitting issues associated with the MNRF, and in-stream barrier removal is a significant issue for the water securement indicator and the sustainability of restoration works within all of the Toronto region watersheds. Furthermore, the problem of fragmentation also causes communication difficulties between agencies as well as within agencies and their differing departments. This is the case with the TRCA, where it became evident that the Restoration Projects group focusing on restoration for restoration sake rarely interacted with the Restoration and Infrastructure division focusing on city infrastructure work. The sharing of data within and between restoration agencies is paramount to the successful implementation of restoration work, as well as the maintenance and sustainability of the project in the long run.

Finally, the most common watershed restoration project limitation identified by the majority of the watershed experts interviewed for this paper is the continued urbanization of the Toronto region. The negative impact from the rapid rate of urbanization in the Toronto region watersheds is wide-ranging and multifaceted, and the necessary restoration work to counteract the environmental degradation is insufficient. The ways in which urbanization impacts Toronto's urban rivers and Lake Ontario includes severe water quality issues, waste and storm water pollution, and increased flooding from storm water runoff. The contamination of the water within the watersheds occurs from the household, and industrial storm water overflows (Melymuk et al., 2014; Nazzal, Rosen, & Al-Rawabdeh, 2013).

The hydrological and geomorphological impacts from urbanization like the human creation of in-stream barriers mean that the watersheds and rivers become further disconnected from floodplains and adjacent habitats. Climate change is altering temperature and precipitation regimes, increasing the prospect of extreme flood events. The removal of riparian vegetation results in reduced bank stability thus increasing erosion. The elimination of adjacent woodlands for suburbs is leading to increases in water temperatures and is making the area inhospitable to native fish. Impacts to native habitats in watershed areas include habitat loss and degradation. Invasive aquatic species also impact water quantity, and degrade the quality and complexity of aquatic ecosystems (Tulbure & Johnston, 2010; Wittmann et al., 2014). To avoid and mitigate these issues requires sustainable watershed restoration practices within the Toronto region watersheds that include all the indicators and associated criteria specified in this paper. The concluding remarks for this paper include several recommendations on how to further integrate the sustainability indicators into watershed restoration projects.

12. CONCLUDING RECOMMENDATIONS

Rather than continuing to degrade these vital areas of the Toronto region, it is time to enter an era of watershed restoration by incorporating innovative and progressive watershed restoration project methods and tools. It is important to build upon and incorporate several best management practices into the watershed restoration network and restructure the factors limiting the restoration of watersheds in the Toronto region. The lessons learned from the review of the case studies provide some guidance on ways in which to improve on the current methods used for watershed restoration planning, implementation and monitoring.

Firstly, it is crucial that watershed restoration organizations and agencies share, communicate, and form partnerships horizontally and vertically to further expand the network of ongoing restoration work throughout the Toronto region. These strategic partnerships and joint research initiatives with key stakeholders will help combat the fragmentation that exists in watershed management, and improve the sustainability of the restoration initiatives. It would be beneficial for the TRCA to encourage communication and data sharing within its own agency between the Restoration Projects group and the Restoration and Infrastructure division. The TRCA is also an important agency that brings together the communities throughout the Toronto region, to help foster information and knowledge sharing. To further this work would require a governing body which communicates directly with all the organizations proposing restoration work within the Toronto region. In fact, this governing body already exists; the Great Lakes Guardian Commission (GLGC) established in 2015 (Abouchar & Petersen, 2015). The intent of the GLGC is to streamline communications between all restoration organizations so that we deal with the fragmentation of the system. Over the next several years a review of the GLGC activities would help establish if this framework is improving the capacity of the provincial

government to better synchronize programs restoring areas of the Great Lakes and the Toronto region. This would help indicate whether we are improving upon the sustainability of the watershed restoration projects.

Secondly, it is paramount for the federal and provincial governments of Canada to propose and formulate a plan to reconnect where possible the watersheds, rivers, tributaries and streams to themselves and the surrounding habitats. The two ways to achieve this is by removing a significant portion of the obsolete in-stream barriers, and continuing to support land acquisitions for restoration. Currently, little evidence exists within the MNRF and FMZ plans concerning in-stream barriers, and as the region continues to urbanize the maintenance and restoration of the remaining natural spaces within the watersheds is exceedingly important. The organizations conducting restoration work in the effort to protect native and endangered species like the Atlantic salmon, and Redside dace state that to succeed in future restoration efforts water and land securement is crucial for the long-term sustainability of their projects. Furthermore, the recreation of a connected and networked watershed system aids in combatting the urbanization impacts, which is essential in the Toronto region.

The recommendation to enhance the use of the adaptive management framework so that the organizations and agencies planning and implementing watershed restoration projects are able to close the loop, goes hand in hand with the conundrum of short-term funding afflicting the restoration work. For the TRCA and other organizations undertaking this work in the Toronto region, the use of a consistent adaptive management framework and a standardized protocol requires consistent and secure funding throughout the entire cycle of the project. This begins with the baseline monitoring for the project planning, and ends with significant monitoring of the site after the project is complete. It also requires expanding the monitoring metrics from trees

planted and volunteers engaged, to a broad set of environmental indicators so as to better gauge the success or failure of a restoration project. The definition of significant monitoring is site-specific, but the current timeline of at most three years is insufficient to gain precise knowledge concerning the success or failure of a restoration project. I would further suggest having an outside body such as the GLGC evaluate the success of the watershed restoration projects is necessary so as to eliminate the biased nature of the current evaluation framework which is negatively tied to the funding framework.

Finally, it is vital that the watershed restoration public engagement and community development initiatives evolve into a broader and inclusive framework coinciding with the diverse nature of the Toronto region. The inclusion of joint research initiatives by the TRCA and relevant organizations such as Swim Drink Fish Canada, and Ontario Streams, might lead to watershed restoration projects that further expand the knowledge of local watershed values and incorporate innovative and progressive engagement tools. For example, a Swim Drink Fish Canada watershed campaign titled the “Watermark Project” provides important information on recreational water use and value in the Toronto region through the use of a storytelling platform (Lake Ontario Waterkeeper, 2016). Furthermore, effective cooperation and communication enable the transference of knowledge and the furthering of a democratic environmental decision-making model that includes diverse views from other environmental organizations, municipalities, communities, politicians, developers and private land owners. By working cooperatively with key stakeholders, restoration organizations and agencies attain greater consideration for their vital work. It is imperative for the future of the Toronto region watersheds that all the relevant stakeholders are aware of just how important these areas to maintaining and protecting the identity of the Toronto region.

The lessons learned through the research, interviews, and analysis of the four watershed restoration case studies in the Toronto region can help inform and improve on the methods and tools used for watershed restoration projects. Furthermore, the normative framework used to assess the sustainability of watershed restoration projects uncovered some significant issues in the entire watershed management framework. The use of aspects from the UPE theory combined with pragmatic methods and tools like adaptive management, provides insights and information concerning the intricate relationship between watershed restoration and the social, political and economic sphere within the Toronto region. Enacting a streamlined watershed restoration communication centre, a standardized adaptive management framework through consistent funding tactics, and innovative public engagement tools will all help advance the sustainability of the watershed restoration projects, and the overall health and sustainability of the Toronto region watersheds. This might ultimately shift us from an era of watershed degradation in the Toronto region to an era of watershed restoration where we are mitigating the impacts of urbanization through sustainable watershed restoration projects. Nevertheless, as restoration is a retroactive and reactive endeavor, this requires a substantial shift in the way in which the Toronto region continues to urbanize. Bold shifts from the current grey city infrastructure to significant and meaningful research, planning, and implementation into greener urban spaces in urban cities is vital to the landscapes and watersheds that we live on.

References

Abouchar, J., & Petersen, N. (2015). Third Time Lucky As Great Lakes Protection Act Is Finally Passed. Retrieved February 13, 2017, from http://www.mondaq.com/canada/x/435862/Environmental+Law/Third+Time+Lucky+As+Great+Lakes+Protection+Act+Is+Finally+Passed

Alfred Kuehne Stream Restoration Project. (2013). Retrieved from https://www.youtube.com/watch?v=Sr0eyxAygCQ

Allen, C. R., Fontaine, J. J., Pope, K. L., & Garmestani, A. S. (2011). Adaptive management for a turbulent future. *Journal of Environmental Management*, *92*(5), 1339–1345. https://doi.org/10.1016/j.jenvman.2010.11.019

Allen, C. R., & Gunderson, L. H. (2011). Pathology and failure in the design and implementation of adaptive management. *Journal of Environmental Management*, *92*(5), 1379–1384. https://doi.org/10.1016/j.jenvman.2010.10.063

Angelo, H., & Wachsmuth, D. (2014). A Critique of Methodological Cityism: Urbanizing urban political ecology. *International Journal of Urban and Regional Research*, *39*(1), 16–27. https://doi.org/10.1111/1468-2427.12105

Bails, J., Beeton, A., Bulkley, J., DePhilip, M., Murray, M., Regier, H. A., & Scavia, D. (2006). Prescription for Great Lakes Ecosystem Protection and Restoration: Avoiding the Tipping Point of Irreversible Changes. Retrieved from http://www.miseagrant.umich.edu/downloads/habitat/Prescription-for-the-Great-Lakes-08-2006.pdf

Bakker, K., & Cook, C. (2011). Water Governance in Canada: Innovation and Fragmentation. *International Journal of Water Resources Development*, *27*(2), 275–289. https://doi.org/10.1080/07900627.2011.564969

Barr, D. (2017). *Wilket Creek: urbanization, geomorphology, policy, and design*. The University of Western Ontario. Retrieved from https://ir.lib.uwo.ca/etd/4578/

Bash, J. S., & Ryan, C. M. (2002). Stream Restoration and Enhancement Projects: Is Anyone Monitoring? *Environmental Management*, *29*(6), 877–885. https://doi.org/10.1007/s00267-001-0066-3

Bernhardt, E. S., Palmer, M. A., Allan, J. D., Alexander, G., Barnas, K., Brooks, S., … Sudduth, E. (2005). Synthesizing U.S. River Restoration Efforts. *Science*, *308*(5722), 636–637. https://doi.org/10.1126/science.1109769

Biggs, R., Schlüter, M., Biggs, D., Bohensky, E. L., BurnSilver, S., Cundill, G., … West, P. C. (2012). Toward Principles for Enhancing the Resilience of Ecosystem Services. *Annual Review of Environment and Resources*, *37*(1), 421–448. https://doi.org/10.1146/annurev-environ-051211-123836

Bliss, J. C., & Fischer, A. P. (2011). Toward a Political Ecology of Ecosystem Restoration. In D. Egan, E. E. Hjerpe, & J. Abrams (Eds.), *Human Dimensions of Ecological Restoration* (pp. 135–148). Washington, DC: Island Press/Center for Resource Economics. Retrieved from http://link.springer.com/10.5822/978-1-61091-039-2_10

Bonnell, J. (2013). Bringing Back the Don: Sixty Years of Community Action. In *HTO: Toronto's Water from Lake Iroquois to Lost Rivers to Low-flow Toilets*. Coach House Books.

Bonnell, J. L. (2014). *Reclaiming the Don: An Environmental History of Toronto's Don River Valley*. University of Toronto Press.

Borgström, S., Elmqvist, T., Angelstam, P., & Alfsen-Norodom, C. (2006). Scale mismatches in management of urban landscapes. *Ecology and Society*, *11*(2).

Borgström, S., Zachrisson, A., & Eckerberg, K. (2016). Funding ecological restoration policy in practice—patterns of short-termism and regional biases. *Land Use Policy*, *52*, 439–453. https://doi.org/10.1016/j.landusepol.2016.01.004

Botts, L., Muldoon, P. R., Botts, P., & von Moltke, K. (2018). The Great Lakes Water Quality Agreement: Its Past Successes and Uncertain Future Lee Botts, Paul Muldoon, Paul Botts, and Konrad von Moltke. In *Knowledge, Power, and Participation in Environmental Policy Analysis*. Routledge. https://doi.org/10.4324/9781351325721

Brundtland, G. (1987). *Report of the World Commission on Environment and Development: Our Common Future.* Retrieved from http://www.un-documents.net/our-common-future.pdf

Butler, W. H., Monroe, A., & McCaffrey, S. (2015). Collaborative Implementation for Ecological Restoration on US Public Lands: Implications for Legal Context, Accountability, and Adaptive Management. *Environmental Management*, *55*(3), 564–577. https://doi.org/10.1007/s00267-014-0430-8

Canadian Parks Council. (2008). Principles and guidelines for ecological restoration in Canada's protected natural areas. Retrieved from http://www.pc.gc.ca/docs/pc/guide/resteco/guide_e.pdf

Chandler, J. G., & Vechsler, M. J. (1992). The Great Lakes-St. Lawrence River Basin from an IJC Perspective. *Can.-USLJ*, *18*, 261. Retrieved from http://heinonline.org/hol-cgi-bin/get_pdf.cgi?handle=hein.journals/canusa18&section=29

City of Toronto. (2015). *2014 Operating Budget* (Corporate Report). Retrieved from https://www1.toronto.ca/City%20Of%20Toronto/Strategic%20Communications/City%20Budget/2014/PDFs/Public%20Book/Operating%20Summary%20-%20Final.pdf

City of Toronto. (2017). *Toronto Ravine Strategy*. Toronto, ON. Retrieved from https://www.toronto.ca/wp-content/uploads/2017/10/9183-TorontoRavineStrategy.pdf

Clewell, A. F., & Aronson, J. (2013). *Ecological restoration: principles, values, and structure of an emerging profession* (2nd ed). Washington, DC: Island Press.

Conservation Ontario. (2015). *Conservation Authorities: Partners of Choice* (Conservation Ontario Annual Report 2015). Newmarket, ON. Retrieved from http://conservationontario.ca/images/Annual_Reports/2015COAnnual_Report_FINAL.pdf

Conservation Ontario, & TRCA. (2015). Toronto and Region Watersheds: Report Card 2013. Retrieved from https://trca.ca/wp-content/uploads/2016/04/2173_WatershedReportCards_Jurisdictional_rev14_forWeb.pdf

Cook, C. (2014). Governing jurisdictional fragmentation: Tracing patterns of water governance in Ontario, Canada. *Geoforum*, *56*, 192–200. https://doi.org/10.1016/j.geoforum.2014.07.012

Creed, I. F., & Laurent, K. L. (2015). The Great Lakes Futures Project. *Journal of Great Lakes Research*, *41*, 1–7. https://doi.org/10.1016/j.jglr.2014.12.017

Cumming, G., Cumming, D. H. M., & Redman, C. (2006). Scale Mismatches in Social-Ecological Systems: Causes, Consequences, and Solutions. *Ecology and Society*, *11*(1). https://doi.org/10.5751/ES-01569-110114

Dore, M. H. (2015). Water Policy in Ontario. In *Water Policy in Canada* (pp. 57–87). Springer International Publishing. https://doi.org/10.1007/978-3-319-15883-9_4

Draaisma, M. (2017, June 18). As politicians try to highlight Rouge Park, environmentalists call for a better plan. *CBC News*. Retrieved from https://www.cbc.ca/news/canada/toronto/paddle-the-rouge-environmental-demands-1.4166475

Egan, D., Hjerpe, E. E., & Abrams, J. (2011). *Human dimensions of ecological restoration: integrating science, nature, and culture*. Washington, DC: Island Press.

Environmental Defence. (2017, June 16). Protecting Rouge National Park requires a new Management Plan [press release]. Retrieved July 7, 2018, from https://environmentaldefence.ca/2017/06/16/protecting-rouge-national-park-requires-new-management-plan/

Friedman, K. B., Laurent†, K. L., Krantzberg, G., Scavia, D., & Creed, I. F. (2015). The Great Lakes Futures Project: Principles and policy recommendations for making the lakes great. *Journal of Great Lakes Research*, *41*, 171–179. https://doi.org/10.1016/j.jglr.2014.11.026

Gill, J. (2017). *The Rouge Uncovered: Community Participation, Urban Agriculture and Power Dynamics in the Creation of Canada's first National Urban Park* (PhD Thesis). University of Toronto (Canada).

Gobster, P. H., & Hull, R. B. (2000). *Restoring nature: perspectives from the social sciences and humanities*. Washington, D. C: Island Press.

Government of Canada, E. and C. C. C. (2007, January 9). Watershed Assessments. Retrieved March 15, 2018, from https://www.ec.gc.ca/eaudouce-freshwater/default.asp?lang=en&n=D72B6AF9-1

Government of Ontario. (2012). *Ontario's Great Lake Strategy*. Retrieved from https://dr6j45jk9xcmk.cloudfront.net/documents/896/5-1-5-great-lakes-strategy-en.pdf

Government of Ontario. (2014, March 14). Great Lakes watershed locator [Text]. Retrieved March 15, 2018, from https://www.ontario.ca/environment-and-energy/great-lakes-watershed-locator

Government of Ontario. Great Lakes Protection Act, Pub. L. No. Ontario Bill 66 (2015). Retrieved from https://www.ontario.ca/laws/view

Gross, M. (2005). Ecological restoration as a real-world experiment: designing robust implementation strategies in an urban environment. *Public Understanding of Science*, *14*(3), 269–284. https://doi.org/10.1177/0963662505050791

Heidenreich, C., & Burgar, R. (2011). Native settlement to 1947. In B. Roots, D. Chant, & C. Heidenreich (Eds.), *Special Places: The Changing Ecosystems of the Toronto Region* (pp. 63–75). Vancouver: UBC Press.

Heynen, N., Kaika, M., & Swyngedouw, E. (2006). *In the nature of cities: urban political ecology and the politics of urban metabolism*. London: Routledge. Retrieved from http://site.ebrary.com/id/10163743

Higgs, E. (1997). What is Good Ecological Restoration? *Conservation Biology*, *11*(2), 338–348.

Higgs, E. (2003). *Nature by Design: People, Natural Process, and Ecological Restoration* (1 edition). Cambridge, Mass: The MIT Press.

Hobbs, R. J. (2004). Restoration ecology: the challenge of social values and expectations. *Frontiers in Ecology and the Environment*, *2*(1), 43–48. https://doi.org/10.1890/1540-9295(2004)002[0043:RETCOS]2.0.CO;2

International Joint Commission. (2012). The Great Lakes Water Quality Agreement of 2012. International Joint Commission. Retrieved from http://ijc.org/files/tinymce/uploaded/GLWQA%202012.pdf

Johns, C. (2017). The Great Lakes, Water Quality and Water Policy in Canada. In S. Renzetti & D. P. Dupont (Eds.), *Water Policy and Governance in Canada* (pp. 159–178). Springer International Publishing. https://doi.org/10.1007/978-3-319-42806-2_9

Johns, C. M., & Sproule-Jones, M. (2015). Water policy in Canada and the Great Lakes case. In *Environmental policy in Canada* (4th ed.). Toronto: Oxford University Press.

Johns, C. M., & Thorn, A. (2015). Subnational diplomacy in the Great Lakes region: toward explaining variation between water quality and quantity regimes. *Canadian Foreign Policy Journal*, *21*(3), 195–211. https://doi.org/10.1080/11926422.2015.1035296

Kauffman, C. M. (2016). *Grassroots Global Governance: Local Watershed Management Experiments and the Evolution of Sustainable Development*. Oxford, New York: Oxford University Press. Retrieved from http://books1.scholarsportal.info.myaccess.library.utoronto.ca/viewdoc.html?id=/ebooks/ebooks3/oso/2016-12-17/1/9780190625733-Kauffman#tabview=tab0

Keil, R., & Graham, J. (1998). Reasserting nature: constructing urban environments after Fordism. In B. Braun & N. Castree (Eds.), *Remaking Reality: Nature at the Millennium*. London, UNITED KINGDOM: Routledge. Retrieved from http://ebookcentral.proquest.com/lib/utoronto/detail.action?docID=235337

Lake Ontario Waterkeeper. (2016). About. Retrieved July 30, 2018, from https://www.watermarkproject.ca/about

Light, A. (2006). Ecological citizenship: The democratic promise of restoration. *The Human Metropolis: People and Nature in the 21st-Century City [Full Book]*, 169.

Loftus, A. (2012). *Everyday Environmentalism: Creating an Urban Political Ecology*. Retrieved from https://www.torontopubliclibrary.ca/detail.jsp?Entt=RDM2880432&R=2880432

Martin, D. M. (2017). Ecological restoration should be redefined for the twenty-first century. *Restoration Ecology*, *25*(5), 668–673. https://doi.org/10.1111/rec.12554

Melymuk, L., Robson, M., Csiszar, S. A., Helm, P. A., Kaltenecker, G., Backus, S., … Diamond, M. L. (2014). From the City to the Lake: Loadings of PCBs, PBDEs, PAHs and PCMs from Toronto to Lake Ontario. *Environmental Science & Technology*, *48*(7), 3732–3741. https://doi.org/10.1021/es403209z

Méthot, J., Huang, X., & Grover, H. (2015). Demographics and societal values as drivers of change in the Great Lakes–St. Lawrence River basin. *Journal of Great Lakes Research*, *41*, 30–44. https://doi.org/10.1016/j.jglr.2014.11.001

Molle, F. (2009). River-basin planning and management: The social life of a concept. *Geoforum*, *40*(3), 484–494. https://doi.org/10.1016/j.geoforum.2009.03.004

Morin, A., & Cantin, B. (2009). *Strengthening Integrated Water Resource Management in Canada* (Policy Research Initiative). Ottawa, Ontario. Retrieved from http://www.horizons.gc.ca/sites/default/files/Publication-alt-format/2009-0009-eng.pdf

Morrison, K. E., Parkes, M. W., Hallstrom, L. H., Neudoerffer, R. C., Bunch, M. J., & Venema, H. D. (2012). *Ecohealth and watersheds: watersheds as settings for health and well-being in Canada*. Winnipeg, Man.: Network for Ecosystem Sustainability and Health: International Institute for Sustainable Development. Retrieved from http://www.deslibris.ca/ID/232232

Murray, C., & Marmorek, D. (2003). Adaptive management and ecological restoration. *Ecological Restoration of Southwestern Ponderosa Pine Forests (Freiderici P, Ed). Washington, DC: Island Press*, 417–428. Retrieved from http://biology.illinoisstate.edu/rcander/BSC337/Reading%20Assignment%20Two/Murray%20and%20Marmorek%20Adaptive%20Management.pdf

Nagarkar, M., & Raulund-Rasmussen, K. (2016). An appraisal of adaptive management planning and implementation in ecological restoration: case studies from the San Francisco Bay Delta, USA. *Ecology and Society*, *21*(2). Retrieved from http://www.ecologyandsociety.org/vol21/iss2/art43/

National Academies of Sciences, Engineering, and Medicine. (2017). Chapter 3: Restoration Project Monitoring. In *Effective Monitoring to Evaluate Ecological Restoration in the Gulf of Mexico*. Washington, DC: The National Academies Press. Retrieved from https://doi.org/10.17226/23476

Nazzal, Y., Rosen, M. A., & Al-Rawabdeh, A. M. (2013). Assessment of metal pollution in urban road dusts from selected highways of the Greater Toronto Area in Canada. *Environmental Monitoring and Assessment*, *185*(2), 1847–1858. https://doi.org/10.1007/s10661-012-2672-3

Newman, A. (2011). Inclusive Urban Ecological Restoration in Toronto, Canada. In D. Egan, E. E. Hjerpe, & J. Abrams (Eds.), *Human Dimensions of Ecological Restoration* (pp. 63–75). Washington, DC: Island Press/Center for Resource Economics. Retrieved from http://link.springer.com/10.5822/978-1-61091-039-2_5

Ontario Ministry of Finance. (2017). *Ontario Population Projections Update, 2016–2041* (Ontario and its 49 Divisions).

Ontario Streams. (n.d.). *West Humber River Rehabilitation Project*.

Parish Aquatic Services. (2015). Wilket Creek Channel within Wilket Creek Park Rehabilitation Study to Address Erosion Hazards Threatening Infrastructure and Wilket Creek Geomorphic Systems Master Plan. Submitted to: Toronto and Region Conservation Authority and Toronto Water, City of Toronto. Retrieved from https://trca.ca/conservation/erosion-risk-management/restore/wilket-creek-rehabilitation-project/#masterplan

Parkland Dedication & Cash-In-Lieu. (2017, December 15). Retrieved February 13, 2018, from https://www.toronto.ca/city-government/planning-development/application-forms-fees/building-toronto-together-a-development-guide/parkland-dedication/

Parks Canada. (2012). *Proposed Rouge National Urban Park Concept* (Rouge National Urban Park Initiative). Parks Canada Agency. Retrieved from file:///Users/elisemackie/Desktop/concept_rouge_national_urban_park.pdf

Parks Canada. (2014). Rouge National Urban Park Management Draft Plan. Retrieved from file:///Users/elisemackie/Downloads/Rouge_Plan_Draft_EN.pdf

Parks Canada Agency, G. of C. (2017a, June 12). Parks Canada announces $15 million in conservation and restoration projects in Rouge National Urban Park - Rouge National Urban Park. Retrieved March 23, 2018, from https://www.pc.gc.ca/en/pn-np/on/rouge/info/nouvelles-news/nouvelles-news-arch/201507-conservation

Parks Canada Agency, G. of C. (2017b, October 25). Historic Rouge National Urban Park Land Transfer - Rouge National Urban Park. Retrieved July 7, 2018, from https://www.pc.gc.ca/en/pn-np/on/rouge/info/nouvelles-news/20171021-ontario

Province of Ontario. (1994). *Rouge Park Management Plan*. Retrieved from http://www.rougepark.com/about/plans/mgmt_plans.php

Province of Ontario. (2005). The Greenbelt Plan, 63. Retrieved from http://www.mah.gov.on.ca/AssetFactory.aspx?did=11171

Ramsay-Brown, J. (2015). *Toronto's Ravines and Urban Forests: Their natural heritage and local history*. James Lorimer & Company.

Rouge Park. (2003). *Rouge North Management Plan: A Strategy to Guide the Realization of the Rouge Park from Steeles Avenue to the Oak Ridges Moraine*. Rouge Park.

Sandberg, L. A., Gilbert, L., & Wekerle, G. R. (2013). *The Oak Ridges Moraine battles: development, sprawl, and nature conservation in the Toronto Region*. Toronto, ON: University of Toronto Press. Retrieved from http://www.library.yorku.ca/e/resolver/id/2515014

Seto, K. C., Güneralp, B., & Hutyra, L. R. (2012). Global forecasts of urban expansion to 2030 and direct impacts on biodiversity and carbon pools. *Proceedings of the National Academy of Sciences*, *109*(40), 16083–16088.

Society for Ecological Restoration International Science & Policy Working Group. (2004). *The SER International Primer on Ecological Restoration*. Tucson: Society for Ecological Restoration International. Retrieved from www.ser.org

Sproule-Jones, M., Johns, C., & Heinmiller, B. T. (2008). *Canadian Water Politics: Conflicts and Institutions*. McGill-Queen's Press - MQUP.

Statistics Canada. (2016). Preliminary Neighbourhood Census Profile 41. Bridle Path-Sunnybrook-York Mills. *Social Development, 2016 Census of Population*, 6. Retrieved

from https://www.toronto.ca/ext/sdfa/Neighbourhood%20Profiles/pdf/2016/pdf1/cpa41.pdf

Swaigen, J. (2016, June 30). Working to protect greenspace in urban areas. Retrieved July 8, 2018, from https://www.ecojustice.ca/rouge-national-urban-park/

Swyngedouw, E., & Kaika, M. (2014). Urban Political Ecology. Great Promises, Deadlock… and New Beginnings? - (L'ecologia política urbana. Grans promeses, aturades… i nous inicis?). *Documents d'Anàlisi Geogràfica*, *60*(3). https://doi.org/10.5565/rev/dag.155

Tamminga, K. (1994). Towards a Holistic Systems Approach in Restoration Planning. In *6th Annual Conference of the Society for Ecological Restoration, Lan*.

TRCA. (2008a). *Humber River State of the Watershed Report*.

TRCA. (2008b). Rouge River Watershed Plan Towards a Healthy and Sustainable Future Implementation Guide.

TRCA. (2010a). Etobicoke and Mimico Creeks Watersheds Technical Update Report. Retrieved from http://www.trca.on.ca/protect/watersheds/etobicoke-mimico-creek/emwtu2011/02-StudyArea-PhysicalSetting.pdf

TRCA. (2010b). Rouge River Watershed Fisheries Management Plan, 230.

TRCA. (2015). Wilket Creek Rehabilitation Project: Project Background. Retrieved March 8, 2018, from https://trca.ca/conservation/erosion-risk-management/restore/wilket-creek-rehabilitation-project/

TRCA. (2016a). Areas of Concern and Remedial Action Plans. Retrieved March 20, 2017, from http://www.torontorap.ca/about-the-rap/

TRCA. (2016b). Greenlands Acquisition Project for 2016-2020. Toronto and Region Conservation Authority. Retrieved from https://trca.ca/wp-content/uploads/2016/04/GAP_2016.pdf

TRCA. (2018). Watershed Features - Etobicoke & Mimico. Retrieved July 17, 2018, from https://trca.ca/conservation/watershed-management/etobicoke-mimico-creek/watershed-features/

TRCA, Rouge Watershed Task Force, Rouge Park, & Metropolitan Toronto and Region Conservation Authority. (2007). *Rouge River watershed plan: towards a healthy and sustainable future*. Toronto: Rouge Park, Toronto and Region Conservation.

Tulbure, M., & Johnston, C. (2010). Environmental Conditions Promoting Non-native Phragmites australis Expansion in Great Lakes Coastal Wetlands. *Wetlands*, *30*(3), 577–587. https://doi.org/10.1007/s13157-010-0054-6

U.S. Environmental Protection Agency. (2016, December). EPA Healthy Watersheds Program: Integrating Watershed Assessment and Protection across EPA. Office of Water. Retrieved from https://www.epa.gov/sites/production/files/2015-10/documents/2009_08_05_nps_healthywatersheds_highquality_hwi.pdf

Vietz, G. J., Rutherfurd, I. D., Fletcher, T. D., & Walsh, C. J. (2016). Thinking outside the channel: Challenges and opportunities for protection and restoration of stream morphology in urbanizing catchments. *Landscape and Urban Planning*, *145*, 34–44. https://doi.org/10.1016/j.landurbplan.2015.09.004

Wang, X. (2011). Exploring trends, sources, and causes of environmental funding: A study of Florida counties. *Journal of Environmental Management*, *92*(11), 2930–2938. https://doi.org/10.1016/j.jenvman.2011.07.002

Weng, Y.-C. (2015). Contrasting visions of science in ecological restoration: Expert-lay dynamics between professional practitioners and volunteers. *Geoforum, 65*, 134–145. https://doi.org/10.1016/j.geoforum.2015.07.023

Williamson, R. F., & Macdonald, R. I. (2013). A resource like no other: Understanding the 11,000-year relationship between people and water. In W. Reeves & C. Palassio (Eds.), *HTO: Toronto's Water from Lake Iroquois to Lost Rivers to Low-flow Toilets*. Coach House Books.

Winfield, M. (2012). *Blue-green province: the environment and the political economy of Ontario*. Vancouver: UBC Press. Retrieved from http://myaccess.library.utoronto.ca/login?url=http://books.scholarsportal.info/viewdoc.html?id=/ebooks/ebooks3/upress/2013-08-25/1/9780774822381

Wittmann, M. E., Jerde, C. L., Howeth, J. G., Maher, S. P., Deines, A. M., Jenkins, J. A., … Lodge, D. M. (2014). Grass carp in the Great Lakes region: establishment potential, expert perceptions, and re-evaluation of experimental evidence of ecological impact. *Canadian Journal of Fisheries and Aquatic Sciences*, *71*(7), 992–999. https://doi.org/10.1139/cjfas-2013-0537

Worte, C. (2016). Integrated watershed management and Ontario's conservation authorities. *International Journal of Water Resources Development*, 1–15. https://doi.org/10.1080/07900627.2016.1217403

Appendix A: Interview Guide used for the 10 Interviews conducted

Subject	Questions	Probes
Personal context and role	How have you been involved in the development process for the watershed restoration project?	● Role/level of involvement, how you got involved? Length of time/Approx. start? ● How many organizations/agencies were involved in the planning? ● Interaction with policy developers
Perceptions of Planning Process	Is the project considered restoration, mitigation, or other (please specify)?	● Could you give a brief background description of your project? ● What is the project's main goals and objectives? ● How would you gauge your project's success so far?
	Is your project, completed, in constructions, or planned?	● How has the implementation been going? Fast or slow? ● Process good? ● Outcome (plan) good or different from your expectations?
Adaptive management present in Watershed restoration	Does the project have an adaptive management plan and framework?	● Could you describe how your project uses adaptive management? Is it specified in the planning documents? ● Could you describe your project's monitoring methods?
	Are you satisfied with the adaptive management plans and methods?	● Does the focus on the right aspects? ● Are there any issues? Why/why not? ● What types of pre-restoration monitoring were conducted? (how long, when, what time period)
	Has the adaptive management plan ever been revised? If so why?	● Is there a structured monitoring program in place? ● Monitoring, funding, volunteer capacity, public participation?
Land Acquisition for watershed restoration	Could you describe how the lands for your project were acquired?	● Which policies or programs help organizations acquire land for restoration? ● Did the City help with its Parkland dedication or cash-in-lieu strategy? ● What other organizations and agencies helped with land securement?
	Do you have plans to extend this project into	● If so describe them? Does this include all environments, like instream, riparian and

	other adjacent lands?	also woodlands? ● Are there limitations to acquiring land? ● How important is land acquisition to this watershed restoration project?
Public Participation	Could you describe any public or stakeholder engagement?	● How involved? (Formal, informal; part of committee, attending meetings etc.) ● Pre-planning (community based), planning and/or implementation and/or monitoring?
	What kind of methods of public participation did you find most effective?	● Did public participation methods inform the general public effectively? ● Were the public participation methods made accessible to the best ability?
	Was there an effort to align the project with community development program in the community?	● Did the person/people you approach benefit from the project personally? ● Is it linked to community well-being (ecosystem services), or community services (training, skill development, networking? ● Were you successful in building these collaborative relationships? ● What did these relationships accomplish?
	What could be done to better reach out to a broader range of communities, individuals, other stakeholders?	● "Representative" of community? (In which ways?) ● Has a diverse group of people and perspectives from your community been brought into the development process? ● What efforts were made during the project planning, implementation, and monitoring?
Perceptions of Funding:	Could you describe how this project and its long-term monitoring is funded?	● Is core funding available for projects like these? Governmental funding, not-for-profit funding agencies? ● What other organizations, and agencies do you partner with to help get funding?
	What is the length of time that this restoration project received funding for?	● Is it an acceptable amount of time, or just right, or lacking in longevity? ● What would be an appropriate length of time required for proper implementation?
	Is the funding adequate to achieve the goals and objectives for the watershed restoration project?	● Does funding allow for long-term monitoring, and adaptive management of the restoration site? ● Does funding allow for further work if the project monitoring indicates a need for more restoration work?

Setbacks or reason for failure:	What are the main setbacks that the project has encountered so far?	● What do you think has led to, or held back, progress?
Best Practices:	Are there any best practices you can identify that have led to success in planning or carrying out the project?	
Final thoughts	● Do you have any final comments you would like to share? ● What do you think of the development plan overall? ● Are you proud of this development? Why/Why not?	

Appendix B: Literature Review

The Evolution of Watershed Law and Management Policies

Water and its management generally engage a large and diverse set of users and groups because it can freely cross the borders of the social and political lines. It is constantly moving and connected to the land and air in its watersheds, which spread across vast geographic zones. Watersheds are landscapes where human and natural histories intertwine over time in varying ways creating many differing management methods which can engender complexity. To gain an informed perspective in the current state of watershed restoration projects in the Toronto region, it is necessary to understand the history of users and groups managing the area, and the legislation and policies dictating watershed restoration practices. The first part of my research reviews the past ways in which humans interacted with the watersheds and the resources within them. Included in the review is a description of how the management, laws, and regulations impacting the jurisdictions surrounding the Great Lakes, and more specifically the Toronto region watersheds came to be. Finally, a summary of the current bodies executing restoration projects begins to illustrate the complex network of stakeholders involved in the management of the Toronto region watersheds.

Indigenous Water Governance in the Area Examined

Even though water governance along watershed lines has existed for centuries at points around the world, over the last several decades a popular global movement has occurred rescaling water governance to the watershed level (Molle, 2009). Watershed governance and the management of them are about the strategic use of watershed resources and lands. This strategic use has been occurring in Southern Ontario for thousands of years. Evidence exists in the archaeological records that reveal humans, the Indigenous people, settled and inhabited the

watersheds and river systems in what is now called the Toronto region at least 11,000 years before the arrival of Europeans. This strategic use of the resources began at the earliest period of human occupation, and continued through to the nineteenth and early twentieth centuries (Heidenreich & Burgar, 2011; Williamson & Macdonald, 2013).

In the earliest periods evidence from archaeological sites indicates that the Indigenous populations of the area where nomadic and would set up seasonal dwellings, camps, and small family groupings in specified areas. The resources they relied upon from the watershed habitats included the spawning fish from the rivers and streams, as well as caribou and deer from the surrounding ravine woodlands (Williamson & Macdonald, 2013). Between 500 and 1600 AD, the Indigenous groups began directly managing the land through of agriculture along the central north shore of Lake Ontario. The expansion of agricultural lands led to an upsurge of the population throughout the region, then followed by the establishment of more permanent camps and villages in the area (Sandberg et al., 2013).

The use of the term re-settlers, resettled, and resettlement, described by Sandberg et al., 2013 (p. 41) is to specify that Europeans did not settle an unoccupied land, but resettled areas owned and cultivated by the Indigenous populations already residing in the region. Around the time of the resettlement by Europeans, the Indigenous populations dramatically decreased due to foreign disease, and a war with the Five Nations Iroquois from the southern part of Lake Ontario. Following this, the Five Nations Iroquois formed two villages in the Toronto region, near the mouths of the Humber and Rouge rivers. The significance of these areas was their connection to the canoe-and-portage routes as well as the rich salmon fisheries in these rivers (Sandberg et al., 2013; Sousa, 2013; Williamson & Macdonald, 2013). At the time of the European resettlement and up until 1793 both the Mississaugas and the Iroquois First Nations actively used Garrison

Creek, a centrally located waterbody in the Toronto region, for social gathering and fishing (Sousa, 2013).

What is important to note in this brief review of early human settlement in the Toronto region is that water, and the proximity to water played an immensely important role in the positioning of human occupations. The Toronto region lakefront was an important strategic location for the navigation of the region, accessing necessary resources, and governing the established regional social and economic networks along the watersheds, rivers, and streams in the region (Williamson & Macdonald, 2013). Natural resources like spawning fish, hunting grounds, and irrigation for agricultural fields, was crucial in the proliferation of Indigenous populations throughout the region. This age-old connection to water is central to understanding how to properly restore, conserve, and protect this most fundamental human resource for the future of the Toronto region.

An Era of Watershed Exploitation and Ensuing Constitutionalizing of Water

A look at the constitutionalizing of water laws and policies requires a look in tandem at how re-settlers exploited, altered, and used the watershed land and natural resources. European re-settlers also built homesteads and industries in the Toronto region watersheds adjacent to the river and streams for the ease of navigability and the resources. As development ramped up in the 1800s, the industry along the Lake Ontario shoreline became very important to the economy in the area. Because of the abundance of traversable waterbodies most of the city's major trade was by boat. This changed however after the construction of the railway in the mid 1800s along the waterfront of Lake Ontario. This instance of city development cutting the region's rivers and streams from the Lake Ontario continued with the development of the road systems. This played

a large role in the destruction and disappearance of the Toronto region rivers and creeks (Sousa, 2013; Waterfront Toronto, 2016).

Industrial growth continued throughout the city in the 1860s and ’70 and created a large and polluting “industrial hub” (J. L. Bonnell, 2014). As space became even more limited at this time, a lake-filling campaign began and continued until the late 1950s when the current day Toronto region shoreline was achieved (Hardwicke & Reeves, 2013). In the Etobicoke-Mimico watershed in the city of Brampton numerous manufacturing and commercial facilities developed in the mid 1900s, creating a second “industrial hub” overtop of many of the rivers and streams in this area of the Toronto region (Interview 3).

Industrial growth led to tremendous changes to and loss of natural areas in the Toronto region watersheds Further compounding the issues include the construction of river bank facilities for water-power generation and timber harvesting. Water-powered mills and associated industries became essential to the formation of city infrastructure, and were extremely prevalent on the majority of watersheds in the Toronto region. By 1824, the Don river watershed alone had 26 water-powered mills on its river banks. The impacts from this time of have has long-lasting impacts including permanent alterations to flow of the rivers, inhibiting fish migrations leading to extirpation of species, major deforestation of old growth woodlands, and water contamination by the dumping the sawdust and other mill waste directly into the rivers and streams (Miemeda, 2013).

The legacy of agricultural industry continues to cause a myriad of issues in local watersheds. The loss of wetlands and flood plains is largely due to agricultural practices of draining the wetland ecosystems. The proliferation of water irrigation and water diversions in rivers and streams for agricultural production also leads to the alteration in the water flow

including, a draw down in the flow, and also flashy and flooding streams. Furthermore, pollution from agricultural runoff of fertilisers, pesticides, and herbicides, that flowing into the rivers and streams, can cause observable as well as unforeseen problems. This includes environmental problems like the eutrophication of lakes, and permanent changes in the composition of flora and fauna in aquatic habitats respectively (Botts et al., 2018). Wetlands are an integral part of watersheds, forming areas for water retention and filtration, as well as locations of high biodiversity. The Toronto region has suffered massive losses of wetlands, where on average 96.7 per cent of former wetlands no longer exist (Wilson, 2008). Thus, restoration of these watershed habitats is paramount for providing a sustainably functioning watershed.

It is clear that during the rise of the industrial, and agricultural activities limited political concern centered on the degradation of the environment in the Toronto region watersheds. This is in part due to the lack of research and knowledge documenting the severity of the degradation to the regions' watersheds. This story is similar to many other major cities in Canada and the US that were also industrializing on the shores of the Great Lakes and in the upstream watersheds. As such, in the early 1900s Canada and the United States (US) began to incorporate water and the local waterbodies into the constitution, legislation, and policies. The International Joint Commission (IJC) established in 1909 between Canada and the US brought some awareness to environmental issues impacting the regions water bodies. In 1912, the IJC was the first water governing body to voice environmental concern for water pollution, followed by studies in 1914 on the water quality. Elevated levels of typhoid were found in the Great Lakes, coming from untreated sewage discharges (Benidickson, 2016). However, following this episode, little international or federal political effort transpired for the following 60 years. Neither country implemented policies or programs endeavoring to improve the overall environmental health of

the Great Lakes and surrounding watersheds (Friedman, Laurent, Krantzberg, Scavia, & Creed, 2015).

In the Province of Ontario and the municipalities in the Toronto region the political story diverges slightly from the international political regime. Water policies and regulations continued to evolve locally through the mid 1900s. Focused specifically on the local issue of flooding and flood control, the political and economic regimes identified the issues associated with the large alterations to the watersheds, rivers, and streams for development of residential, commercial, and industrial areas. As the Toronto region population grew in the early 1900s, impacting the natural resources and encroaching in on the unpredictable floodplains of watersheds, new management strategies emerged. In 1946 provincial legislation encouraged the formation of partnerships between the provincial and municipal governments related to integrated watershed management (IWM) (Worte, 2016). Thirty-six river-basin-based organizations formed across the province including the establishment of four Toronto CAs: the Etobicoke-Mimico, Humber, Don Valley, and the Rouge-Duffin-Highland-Petticoat Conservation Authority. Following Hurricane Hazel, a more reginal approach to river management took place and the 4 CAs were amalgamated to form the existing Toronto and Region Conservation Authority (J. Bonnell, 2013).

More broadly across the Great Lakes basin political focus circled back to water quality and environmental concerns in the 1960s and 70s, largely motivated by water pollution events. Starting in 1970, a number of important pieces of legislation and agreements formed like the Canada Water Act (CWA) (Environment Canada, 2007). This act among other things looks to establish federal-provincial actions to tackle water quality and resource management goals and also limit phosphates in detergents (Government of Canada, 1985; McGucken, 1989). In 1971

the Government of Ontario and the federal government signed the first intergovernmental Canada-Ontario agreement (COA) Respecting the Great Lakes Basin Ecosystem ((Environment Canada & Ontario Ministry of the Environment, 2007; C. Johns, 2017). The US Clean Water Act of 1972 closely followed the COA, and in the same year Canada and the US signed the Great Lakes Water Quality Agreement (GLWQA).

The GLWQA is the first binational agreement that commits both nations and their governments to take the necessary actions to restore and maintain the Great Lakes basin (Friedman et al., 2015; C. Johns, 2017). In 1978 the GLWQA restoration commitment was strengthened with inclusion of a definition for the "ecosystem approach". This alteration required the identification and management of water quality issues for the whole ecosystem, with the prospect of creating a more integrated approach to watershed management ((IJC) International Joint Commission, 1994). In accordance with the agreement another renewal of the GLWQA occurred in 1987. During this renewal, an agenda describing the features of severely environmentally degraded zones of the Great Lakes region allowed for the designation of 43 Areas of Concern (AOC) in the US and Canada.

Designated AOCs occur with higher frequency in large urban areas due to the high levels of industrial pollution, sewage treatment plants, landfills, and other discharges entering the waterways (Dore, 2015b). Thus, it comes as no surprise that the Toronto region is categorized as an AOC. With the identification of an AOC the IJC requires the area to develop and implement a Remedial Action Plan (RAP). The protocols that an AOC must follow looks to help rehabilitate the overall ecosystem. The desired approach outlined in the protocol is to develop a geographically focused plan that uses more localized remediation mechanisms (Chandler & Vechsler, 1992). The COA thus becomes important in that it recognizes the importance of

ecological restoration. The agreement called for the restoration of degraded areas, specifically the AOC in Canada that were identified in the 1987 GLWQA. The COA also called for the conservation and protection of human and ecosystem health in the Great Lakes areas ((EC) Environment Canada & (OMoE) Ontario Ministry of the Environment, 2007).

In Ontario the COA assigns joint responsibility for the restoration of degraded areas, and progress of the RAP and AOC to the federal and provincial governments ((TRCA) Toronto and Region Conservation Authority, 2016a). The management and implementation of a RAP, however, requires the cooperation of numerous governments and departments, organizations and agencies, business and industry, academic institutions, and the public. The responsible authority for the Toronto region AOC is the TRCA, who has established an interdisciplinary team that evaluates environmental conditions, activities, and results pertinent to the RAP ((TRCA) Toronto and Region Conservation Authority, 2016a).

What is illustrated above is the establishment of a significant water policy framework between Canada and the US, and within Canada and Ontario at all governmental levels. The framework directly includes the use of ecological restoration as a watershed management tool with the establishment of the AOC. Foundational water laws and policies were developed between the 1970s and 1980s, and several achievements arose concerning point source water pollution and RAPs (Botts & Muldoon, 2005). The incorporation of provincial CAs as organizations separate from the government, whose directives relate directly to water and watershed management is another vital aspect for watershed restoration projects in the Toronto region.

A Diminution of Water Management but Increasing Land-Use Planning

Many political-science researchers assert that between 1990 and 2010 water policy fell off the political trends for both nations, marking a period of apathy (Friedman et al., 2015; C. Johns, 2017; C. M. Johns & Sproule-Jones, 2015; Sproule-Jones et al., 2008). In the mid-1990s, environmental agencies in both countries encountered declining governmental priority and associated funding cuts (Botts et al., 2018). This apathy also in Ontario between 1990 and 2005 under the Conservative government when significant cuts to the Ministry of the Environment and CAs occurred, thus causing delays in the development of environmental water policies in Ontario (C. M. Johns & Sproule-Jones, 2015)(Winfield & Jenish, 1999). Between 2000 and 2010 the COA expired, and even after its resigning and recurrent progress reporting.

Additionally, in the year 2000 large changes occurred in Ontario's Ministry of Natural Resources and Fisheries (MNRF) department concerning the Great Lakes fisheries management protocols. The localized programs and protocols for situated planning, management, and restoration framework for each waterbody, shifted to a landscape scale effort (Interview 5; Kerr, 2010). Prior to this shift numerous advances in fisheries management and watershed restoration occurred through a collaborative network, including the federal and provincial agencies as well as anglers, commercial fishers and academia. The Strategic Planning for Ontario Fisheries (SPOF) produced at this time shaped policy development for watershed restoration activities. It established fishery assessment units, produced district fisheries management plans, and promoted ecosystem-based fisheries management. It also encouraged the development of several provincial monitoring protocols, and provincial policy priorities including wetlands and land-use planning initiatives (Kerr, 2010).

Since the early 2000s the most significant undertaking involved the designation of new Fisheries Management Zones (FMZ) through the Ecological Framework for Fisheries

Management (EFFM) in the efforts of creating a landscape level management system. This change streamlined regulations and created FMZ Advisory Councils for the development and implementation of resources monitoring programs for extensive portions of the Great Lakes (Kerr, 2010). However, to date the FMZ Advisory Councils have yet to release representative management and watershed restoration plans for these integral parts of the Great Lakes watershed including the FMZ 16 where the Toronto region is located. The agencies and organizations focused on watershed restoration and management thus have little provincial guidance on the environmental measures required for remediating currently degraded areas (Interview 5).

Throughout the period of diminution in water policy and associated sectors, the Toronto region generated four provincial land-use planning and policy initiatives that positively influenced watershed management. Firstly, the Niagara Escarpment Plan was established in 1985 and amended in 1994 and 2005. The Oak Ridges Moraine Conservation Plan came into effect in 2002, and in 2005 the province created the Greenbelt Plan. This plan set aside almost 800,000 hectares for protection and conservation of the remaining natural areas in the 2006 provincial Growth Plan for the Greater Golden Horseshoe (GGH) (Crombie, 2015). The functioning ecosystems in this sector of land provides countless beneficial ecosystem services that support human life, the environment, and the economy. For example, the Greenbelt protects important ecological and hydrological systems that provide natural flow regulation, flood mitigation and water filtration (Wilson, 2008).

The combination of these plans was called a “landmark initiative for the region” (Crombie, 2015, p. 20). These four plans provide a framework for sustainable population growth, while also protecting vital resources like water resources and watersheds (Wilson, 2008).

However, the report calling this a “landmark initiative”, also calls for the strengthening and further amendments to these plans in order to reach the broad objectives outlined. In the most urbanized watersheds, the woodlands and forest cover are severely degraded and surface water quality continues to be poor due to the effects of land use activities such as pollution, soil erosion, and a deficiency of forest cover (Crombie, 2015).

Renewal of Watershed Policy Initiatives in Ontario

The defining factor that brought water back into the jurisdictional agenda was the Clean Water Act in 2006. It established a statue connecting wide-ranging factors in the Great Lakes basin, and by the late 2000s water and environmental policies were seemingly prioritized in Ontario. In the past 10 to 15 years, the renewal and creation of new statutes including the Ontario Water Resources Act, the Safe Drinking Water Act, and the Nutrient Management Act fall in line with this prioritization. From 2009 to 2012 Ontario became involved in the renegotiation of the GLWQA, and also published the Ontario Great Lakes Strategy (OGLS) in 2012. The renegotiated GLWQA in 2012 further addresses protecting the basin based on current and emerging environmental issues. It intends to improve coordination and collaboration with stakeholders identified in the agreement, including First Nations and Métis organizations, businesses, NGOs, and the public. By fostering better coordination and collaboration, the GLWQA of 2012 looks to advance the restoration and protection of water quality, ecosystem health, and associated habitats and species in the Great Lakes basin ((IJC) International Joint Commission, 2012, p. 8).

Finally, and most recently in 2015 Ontario enacted the Great Lakes Protection Act (GLPA) (Government of Ontario, 2012, 2015; C. M. Johns & Thorn, 2015). The Act requires the Minister to set targets, establish monitoring and reporting programs, and appoint members to the

Great Lakes Guardians Council (GLGC). The GLGC sets out to improve the provincial government's capacity to better synchronize programs protecting and restoring the Great Lakes (Abouchar & Petersen, 2015). The GLPA also links to the OGLS in that it authorises the Strategy by necessitating a progress review and evaluation every three years (Government of Ontario, 2015). The OGLS aims to join the existing policies as well as agencies together, in order to generate more effective planning and methods for the protection, conservation, and restoration of the Great Lakes ecosystems. The government of Ontario released its first progress report for the OGLS in 2016. The report identifies new concerns in the Toronto region such as microplastics and climate change ((MECC) Ministry of the Environment and Climate Change, 2016). Nonetheless, a review of the watershed restoration plans and projects that are helping mitigate the current impacts of urbanization is missing.

It is surmised that the resurgence of water policy on the political agenda, and the renewed policy development has had positive effects on the water quality and environment in the basin (Botts et al., 2018; C. Johns, 2017). On the other hand, the complexity of watershed management is very apparent from the above evaluation watershed related legislation. The foundation of the Toronto Region watershed management framework is through a multiplicity of laws, regulations, policies, and land-use policies and plans spread across the international, federal, provincial, and municipal government and a myriad of other governmental entities. Because of this multi-level governance system, a shared responsibility for stewarding watershed restoration in the Toronto region forms between various governments and ministries, local, national and international agencies, and other important stakeholders. Some research demonstrates that when fragmentation exists between the relevant governmental agencies, many diverse challenges arise during the management of environmental issues and the related ecological restoration projects (Bakker &

Cook, 2011; Cook, 2014). In other policy reviews of Great Lakes governance, it is shown that a multiplicity of water governance actors does not make for a problematic water governance system, but without an effective coordinating mechanism, policy fragmentation and conflicting administration might occur. This can result in ineffectual, time-consuming, and costly management methods like work duplication, for watershed and environmental projects (Bakker & Cook, 2011; Cook, 2014; Dore, 2015b; Friedman et al., 2015). The following section describes the approaches used to assess whether this legislative framework is generating sustainable watershed restoration projects in the Toronto region, or whether the abovementioned issues are impacting this important tool to combat the environmental degradation from city urbanization.