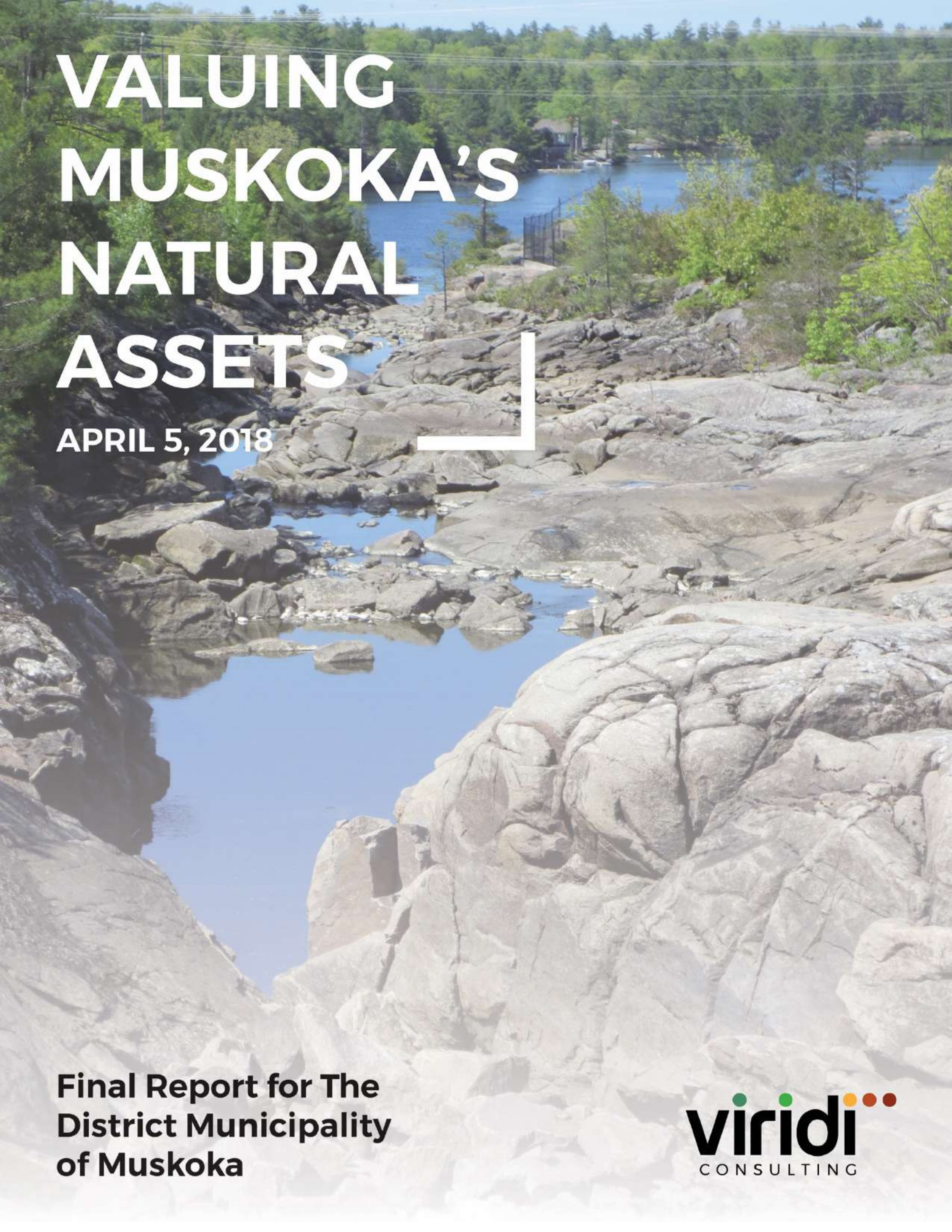

VALUING MUSKOKA'S NATURAL ASSETS

APRIL 5, 2018

Final Report for The District Municipality of Muskoka

viridi CONSULTING

April 5, 2018

Will Towns
Planner
District of Muskoka
(705) 645-2100 ext.472
Will.towns@muskoka.on.ca

Dear Mr. Towns,

RE: Valuing Muskoka's Natural Assets

Viridi Consulting is pleased to submit this report to the District of Muskoka, which provides a preliminary valuation of all natural assets within the Muskoka River Watershed and northern portions of the Severn River and Black River Watersheds. In addition, we have provided recommendations for the District to consider in order to protect these assets using regional regulatory frameworks.

Viridi Consulting assembled this report after conducting a three phase study, which has been outlined in this report. It is our hope that the District of Muskoka realize the economic potential of their natural capital and ecosystem services, and incorporate the appropriate policies and programs to safeguard these assets during future growth.

It has been an absolute pleasure working alongside the District of Muskoka throughout the scope of this study, particularly Will Towns. Viridi Consulting would also like to thank Dr. Jeremy Pittman, a faculty member at the University of Waterloo's School of Planning, for his continued guidance throughout our study.

We thank the District of Muskoka for providing Viridi Consulting with the opportunity to conduct this study. Should there be any questions in regard to this submission, please feel free to contact me. I can be reached by phone at (519) 569-9613 or by email at srmiller@edu.uwaterloo.ca.

Best Regards,

Viridi Consulting

Stuart Miller
Project Manager

ACKNOWLEDGEMENTS

The completion of this study could not have been achieved without the support and assistance from our client, Will Towns and the District of Muskoka. We would like to thank everyone from the District of Muskoka and Muskoka Watershed Council who made this research and valuation study possible.

We would also like to thank our mentor, Dr. Jeremy Pittman from the School of Planning at the University of Waterloo. Dr. Pittman helped guide us throughout the duration of this study and provided our team with his invaluable knowledge surrounding ecosystem services and research.

We thank our professor, Dr. Kevin Curtis from the School of Planning at the University of Waterloo. His feedback and encouragement throughout the development of our research and findings was greatly appreciated.

Viridi Consulting acknowledges and appreciates everyone who provided their time and energy to help assist with the development of the valuation of natural assets within the District of Muskoka.

TEAM PERSONNEL

STUART MILLER *Project Manager*
As Viridi Consulting's Project Manager, Stuart will provide project oversight to ensure milestones are met and deliverables exceed the District's expectations. He has extensive experience in assessing and analyzing his client's needs as well as providing needed direction. Prior to joining Viridi Consulting, Stuart served as a business analyst with the Ontario Ministry of the Environment and Climate Change where he helped lead the development of many new online environmental approval programs. His expertise includes deliberation, process analysis, research, and spatial analysis.

APRIL BEST-SARARAS *Senior Policy Planner*
As Viridi Consulting's Senior Policy Planner, April will utilize her exemplary planning research and policy development expertise to formulate natural asset policy recommendations for the District's policy documents. To assist in formulating possible recommendations, April will help conduct a thorough analysis of current knowledge in valuing natural assets in Canada. April has gained invaluable knowledge in municipal land use planning with the Town of Bracebridge and City of Kitchener Planning Divisions; as well as provincial GIS model development, mapping and analysis with the Ontario Ministry of Agriculture, Food and Rural Affairs. In addition to her research, policy development, and data analysis skills, April's organization, verbal and written communication, and time management skills are invaluable to Viridi Consulting's project initiatives

DOMINIK SIMPSON *Policy Planner + Creative Director*
Dominik is the Policy Planner + Creative Director at Viridi Consulting. He is a candidate for Bachelor of Environment Studies, Honours Co-operative Planning at the University of Waterloo, and specializes in Urban Design. Through his experiences in community-based urban design, as well as an understanding of environmental protection policies working with the Ministry of Environment and Climate Change, Dominik brings a forward approach to planning for natural spaces, ensuring they are attractive and preserved. Similarly, Dominik has gained a multitude of experience working in municipal and provincial public sectors, allowing him to understand the needs of various communities in Ontario. In addition to aiding in research and policy development, Dominik's attention to detail and interest in graphic design will assist in executing the objectives of Viridi Consulting.

MIKE KELLER *Junior Planning Analyst*
Mike is a Junior Planning Analyst at Viridi Consulting. He is a candidate for the Bachelor of Environmental Studies Honours Co-operative Planning at the University of Waterloo, and is experienced with environmental data research and analysis. Previously, Mike worked for the Ontario Ministry of the Environment and Climate Change where he developed a soil database to represent typical greenfield concentrations of contaminants. During this time, he gained knowledge of environmental planning and policy in Ontario. Additionally, Mike has experience with creating and organizing geodatabases with ArcGIS, through his work experience with a municipal transit agency.

JAYLIN XIN *GIS Data Analyst*
Jaylin is a GIS Data Analyst at Viridi Consulting. She is currently completing her final term at the University of Waterloo for Honours Planning, with a specialization in GIS. Prior to joining Viridi, she has worked at different government organizations and involved in multiple GIS projects of environment protection and resource conservations. Her expertise includes environmental planning research, data mining, web development and maintenance, map creation, as well as site and spatial analysis with the application of GIS. Jaylin will be able to provide a thorough investigation on the findings to determine the optimal solution and conclusion.

ANSON CHAU *GIS Technologist*
Anson is a GIS Technologist at Viridi Consulting. He is completing his final term at the University of Waterloo for Honours Planning, specializing in GIS and land development. Anson has worked many GIS-related positions in the government, including The Regional Municipality of York, the City of Toronto and Environment Canada. He has 3 years of experience working with GIS software and applications and has a large understanding of how the software works and its limitations. He has the ability to perform spatial analysis, multi-criteria analysis, watershed analysis and create meaningful graphics from the results. Anson will be an asset to Viridi Consulting in terms of data configuration and performing the required geo-processes.

EXECUTIVE SUMMARY

This Valuation of Muskoka's Natural Assets Background Research, Findings, and Recommendations Report has been prepared by Viridi Consulting in association with the District of Muskoka's Valuation of Natural Assets study. The purpose of this report is to provide the District of Muskoka with the following:

- External best practice research surrounding tourism and recreation literature, natural asset valuation literature, and case study analysis to determine what other communities have discovered in regards to natural asset valuation methodologies and implementation;
- Preliminary analysis of Muskoka's natural assets to determine their importance to the District and which assets should be prioritized; and
- Policy recommendations for the District to consider incorporating into their policy framework based on findings from this report.

During the identification of initial findings, it become apparent that understanding the importance of tourism and recreation to the District's economy is integral in assisting decision-makers in planning for tourism in a sustainable fashion. However, in valuing natural assets, it was evident that there are a number of challenges; namely in regards to accounting for both the use and non-use values of natural resources, data availability, time limitations, and level of expertise. Furthermore, with Muskoka's unique topography and challenges, valuation methods examined through the academic literature and case studies analysis required tailoring to ensure the District's natural assets were appropriately categorized, valued, and prioritized. Ultimately, in conducting an analysis of all identified natural asset valuation methods, the land cover classification method, followed by the benefit transfer method were chosen for Phase 2 to determine the value of each natural asset identified, and apply to the corresponding land cover type. Following this analysis, applicable policy documents for the District were examined to outline possible gaps and areas of opportunity for the District to strengthen their policy framework.

Based on the GIS analysis conducted in Phase 2, Muskoka's land covers were categorized, given appropriate values, and ultimately ranked overall in terms of total value as follows: Forest > Water > Protected Lands > Wetland > Cropland – with forest having the highest composition. A number of maps were created to depict and analyze the natural assets in Muskoka, namely maps illustrating minimum, maximum, and average dollars per hectare value. As a result of the analysis in Phase 2, a number of recommendations were formulated to further the valuation analysis of Muskoka; namely ensuring all natural asset data has the same geographic extent, creating a distinct and comprehensive Land Cover

Package for the District, and acquiring spatial data for tourist sites. Based on the value of natural assets, three potential future research topics were suggested, including threats to natural assets, selection of development sites, and protection of wildlife habitats.

Finally, based on the results and discussion in Phase 2, a number of broad policy recommendations were formulated and were organized into four primary areas for improvement. These four areas include: strengthening the connection between tourism and water resources by establishing a more explicit link between protection and conservation of water-based tourism, and enhancement and improvement of water-based recreation and tourism; disturbance and development restrictions; endangered species and wildlife habitat protection; and protection of forest resources to naturally filter water for drinking water purposes, and continue to provide an environment attractive to tourism and recreation. The incorporation of natural assets into the District's Asset Management Plan was also explored.

Overall, there is significant potential for the District of Muskoka to implement and further develop this natural asset valuation method and model, to then implement into its policy framework. This will assist in protecting the District's essential natural assets and unique mix of landscape cover to ensure each municipality has a resilient economy relying on outdoor recreation and tourism industries; as well as a sustainable ecosystem, community, and tourism balance.

Deep in the woods of Huntsville
(russ1duncan, 2015)

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INTRODUCTION

Natural asset valuation

Increasing threats to natural ecosystem services as a result of climate change, human development, and various human activities highlights the need for upper-tier and lower-tier municipalities alike to evaluate their natural assets. This is done to determine the most effective ways to sustainably protect and maintain these essential services. In areas where outdoor recreation and nature-based tourism are predominant, such as the District of Muskoka, these areas are tasked with the unique challenge of balancing economies based on the tourism industry, with protection of natural landscapes and features that provide both intrinsic and extrinsic beneficial values. This balance and evaluation of the natural landscape is essential for sustainable and resilient communities into the future.

By developing a successful system of valuing natural assets in qualitative terms, impacts of human actions on watersheds and other fundamental ecosystem services can be understood, protected, and implemented into the appropriate policy framework. In the context of Muskoka, the fluctuating population with seasonal tourism and cottage living, as well as its close proximity to large urban centres in Southern Ontario, further highlights the need to protect its pristine natural resources, outdoor recreation, and nature-based tourism for the economic well-being of the area. With the District's unique mix of landscape cover, as well as its six municipalities with varying challenges and needs, it is integral to evaluate and manage key natural assets in relation to the needs of each area.

What is natural capital/assets and ecosystem services?

For the purpose of this analysis, natural capital/assets includes water, land, atmosphere, and resources organized into natural ecosystems providing various ecosystem goods and services essential to the economic and social well-being of humans. In addition, ecosystem services are the benefits and values derived from ecosystems, and can be measured in terms of their non-market values through valuation of the natural capital (Wilson, 2012).

Muskoka Steamships (Tyler, 2014)

1.0 PHASE 1: EXTERNAL RESEARCH – FINDINGS SUMMARY

During Phase 1 of the study, Viridi Consulting compiled a comprehensive background research report surrounding natural asset valuation and application in the District of Muskoka context. For this research, two literature reviews were conducted regarding natural assets in the context of tourism and recreation, as well as natural asset research pertaining to water and forest resources and appropriate GIS application for the District of Muskoka specifically. Following this literature review, seven case studies were analyzed; being Thousand Islands Archipelago and National Park, Lake Simcoe Basin, Rouge Area and Park, British Columbia's Lower Mainland, Town of Gibsons, Rio Bravo Conservation Area, and Town of Aurora; to provide an overview of natural asset valuation and policy implementation in other jurisdictions to date. Finally, a thorough analysis of the gaps and weaknesses in Muskoka's policy framework was conducted, including analysis of the Draft District of Muskoka Official Plan, Area Municipality Official Plans and Economic Strategies, the Muskoka Growth Strategy, Muskoka Tourism Policy Review, and the Muskoka Watershed Report Card. A summary of the research findings will be outlined below, with complete background research for each section attached in the appropriate appendices.

1.1 ACADEMIC LITERATURE REVIEW - TOURISM AND RECREATION FINDINGS

The literature review on natural asset valuation in the context of tourism and recreation identifies methods in which natural assets can be valued in relation to these industries. In understanding the importance of tourism and recreation for the District of Muskoka's economy, it is imperative that methods be in place that allow policymakers to better plan for tourist attractions in an ecological manner, promoting sustainable amenities for residents and visitors. Topics examined that aim to value natural assets in tourism and recreation include: Total Economic Value (TEV), Analytic Hierarchy Process (AHP), and classification frameworks for resource fragility (Boxal et al., 1996; Carlsen, 1997; Deng et al., 2002; Gurira & Ngulube, 2016; Hughey et al., 2004; Krantzberg & Boer, 2006; Tapsuwan et al., 2012; Tisdell, 2003).

It is noted in each article the difficulties in valuing natural assets; however, common themes include identifying the importance of use and non-use values attributed to resources. While the methods reviewed should be considered in the recommendations for future research, their applicability to Muskoka is narrow. Common limitations of the articles presented relate to the scale of study, focusing more on national parks, as opposed to regional planning in the case of Muskoka. An analysis of the strengths, weaknesses, opportunities, and threats (SWOT) of the given tourism and recreation methodologies is provided below (Table 1). This analysis is presented in the context of Muskoka. Ultimately, the chosen method for valuing Muskoka's natural assets is identified in Section 1.4 Summary of SWOT Findings - Chosen Valuation Method.

Table 1: SWOT analysis for tourism and recreation literature review (Boxal et al., 1996; Carlsen, 1997; Deng et al., 2002; Gurira & Ngulube, 2016; Hughey et al., 2004; Krantzberg & Boer, 2006; Tapsuwan et al., 2012; Tisdell, 2003).

STRENGTHS	WEAKNESSES	OPPORTUNITIES	THREATS
Total Economic Value			
Use values (i.e. travel costs & hedonic values): - clear financial values on market - derived from consumer data Non-use values (i.e. contingent valuation & choice modeling): - tourists' knowledge of ecological preservation / willingness to protect resource	Scale of study. Mostly concerned with valuing national parks. Use values rely on secondary data. Time consuming if one were to collect primary data. Non-use values are hypothetical/ subjective. Bias present in non-use values. No mention of GIS application.	Integrate use and non-use valuation. Some measures may require both values such as travel costs. Non-use values allow Muskoka to engage residents through surveys/ consultation events.	Beyond scope of regional municipality. May be private sector driven.
Analytic Hierarchy Process			
Focus on benefitting the tourist experience. Follows a point/ranking system. Based on resource attractiveness and how it complements internal and external goods. Represents the economic effects of tourism (i.e. use values) such as visitation rates.	Scale of study. Mostly concerned with valuing national parks. All functions of the agency must be carefully evaluated (i.e. administration, human resources, land management, facilities, and programming). No mention of GIS application.	Identifying areas of conflict, coexistence, and symbiosis among uses. Allows one to determine goals, specify objectives, operationalize the program, and measure program effectiveness.	Incorporation of the opinions of various parties can improve or dilute process. Pressures from development industry impacting environmental protection.
***Classification Framework* (most reflective of chosen method)**			
Focuses on the fragility of natural assets in coping with tourism. Incorporates non-use values such as perceived importance of a resource. Balance of environmental significance and presence of infrastructure that supports resources.	Non-use values are hypothetical/ subjective. Bias present in non-use values. Lacks sufficient measures of economic effects of tourism. No mention of GIS application.	Opportunity to build off of existing municipal data and policy. If the information is not available, the framework walks through steps of evaluation. Non-use values allow Muskoka to engage residents through surveys/ consultation events.	

Please see Appendix A attached for a detailed literature review regarding tourism and recreation.

1.2 ACADEMIC LITERATURE REVIEW - NATURAL ASSET VALUATION FINDINGS

The literature on natural asset valuation provides insights on which valuation methods to be used in the context of Muskoka. To begin, natural assets and ecosystem services can be categorized into four groups, which are provisioning services, regulating services, supporting services, and cultural services. In consideration of these four categories, different valuation methods should apply to different types of ecosystem services. Secondly, since Muskoka is well-known for its vegetation and water resources, valuation methods focusing specifically on water resources and forest ecosystems are also examined. However, there are potential obstacles for applying these methods, such as data availability, the lack of expertise or knowledge, and time limitation. Furthermore, the application of GIS technology is also part of the focus of this literature review. In particular, an in-depth review of the Landscape Scale Analysis (LSA) and the Enhancement Opportunity Analysis (ESA) took place. Finally, the last part of the literature review pertains to the incorporation of natural asset valuation into Muskoka's policy framework (Kai, 2018; Nijnik & Miller, 2017; CVC, 2012). Several improvements can be made based on the findings of the literature to enhance Muskoka's policy decision-making in considering its abundant natural assets. Ultimately, the chosen method for valuing Muskoka's natural assets is identified in Section 1.4 Summary of SWOT Findings - Chosen Valuation Method. An analysis of the strengths, weaknesses, opportunities, and threats of the natural asset valuation methodologies reviewed are provided below (Table 2). They are provided in the context of Muskoka.

Table 2: SWOT analysis for natural asset valuation literature review (Kai, 2018; Nijnik & Miller, 2017; CVC, 2012).

STRENGTHS	WEAKNESSES	OPPORTUNITIES	THREATS
Landscape Scale Analysis			
Requires the application of GIS technology. This framework can be used to protect natural areas. Use of a multi-criteria analysis.	Requires the results to be overlaid with other maps and data from the municipality (some of this data may not be available). Cannot determine the level of ecological integrity of natural habitats. Analysis was conducted for an urban area (Mississauga).	A conservation strategy can be developed for the landscape based on the multi-criteria model. Used in conjunction with the Enhancement Opportunity Analysis.	Certain areas of potential natural cover and high biodiversity are not captured when the results are overlaid with similar data from the municipality.
Enhancement Opportunity Analysis			
Requires the application of GIS technology. Utilized to identify areas that can be enhanced to improve healthy ecosystem functioning. Can be used to derive a monetary value from the flow of goods and services production over time.	The scores do not necessarily mean the lands can be restored, enhanced, or managed. Analysis was conducted for an urban area (Mississauga), while Muskoka is predominantly natural land.	Can be used to create scientific assessments on a broader landscape scale. Used in conjunction with the Landscape Scale Analysis.	
Water Resources Valuation			
A systematic tool for collecting water-related data. The required data to conduct the valuation is not difficult to gather.	More information is required in order to conduct a full analysis.	Places both monetary and non-monetary values on water services.	The dynamic and interrelated nature of ecosystem services often leads to the risk of double-counting.
Forest Resources Valuation			
The historical cost method and the market price method are more feasible in the context of Muskoka due to the time constraint, limited data and resources, as well as lack of expertise.	It is difficult to identify all biological assets as many provide hidden ecosystem services. Difficult to value biological assets as there is no perfect methodology that currently exists.	Creates potential rewards such as increasing public awareness of protecting the forest ecosystem, maintaining biodiversity, and balancing economic growth and diversity.	The dynamic and interrelated nature of ecosystem services often leads to the risk of double-counting.

Please see Appendix B attached for a detailed literature review regarding natural asset valuation.

1.3 CASE STUDY ANALYSIS FINDINGS

In addition to the literature review findings, an analysis was conducted on various jurisdictions – in the form of case studies – that have previously conducted natural asset valuations. Through these case studies, one primary methodology was identified with various steps; and an analysis outlining the strengths, weaknesses, opportunities, and threats of the primary steps utilized by the case study methodologies was conducted to determine applicability of the steps within the context of the District of Muskoka. The chosen method for valuing Muskoka's natural assets is identified in Section 1.4 Summary of SWOT Findings - Chosen Valuation Method. Below is a summary of the methodology steps utilized by the case studies.

1.3.1 Natural asset valuation method utilized by all case studies (Wilson, 2008a; Wilson, 2012; Molnar, Kocian & Batker, 2012; Eade & Moran, 1996; Kyle, 2013; Malouin et al, 2013):

- Step 1 - Land and Water Cover Classification: involves classification and mapping of the distribution of land cover using tools such as ecological land classification systems; the Southern Ontario Land Resource Information System; aerial and/or satellite photography data; and more commonly, The Economics of Ecosystems and Biodiversity (TEEB) classification system.
    - Some case studies also classified by ecosystem services (i.e. provisioning, regulating, supporting/habitat, and cultural services)

- Step 2
    - Option 1 - Benefit Transfer: also referred to as benefits monetization, benefit transfer involves the use of values from other studies conducted in regions with similar features and characteristics. Values are often based on multiple variables such as avoided costs of disaster/degradation, replacement/damage costs, willingness to pay, market-based costs, and/travel costs.
    - Option 2 – Direct, In-house Value Calculations: benefit transfer can be substituted for in-house calculations when the appropriate data are available. This was the case in the Lake Simcoe Basin and British Columbia's Lower Mainland case studies (whereby a hybrid of in-house calculations and benefit transfer was utilized).

- Step 3 - Calculating Asset Values: based on the values of ecosystem services determined from the benefit transfer (see Step 2), the total values of non-market ecosystem services (often annually-based) can be calculated by applying values to the land classifications found in Step 1.

- Step 4 - Extrapolating Future Value: the British Columbia's Lower Mainland case study furthered their valuation by calculating the net present value for ecosystem benefit values to account for the future flow of ecosystem services similar to traditional capital assets.

1.3.2 Strengths, weaknesses, opportunities, and threats of the above method steps:
Overall, the below SWOT analysis is aimed at exploring and justifying the land cover identification and benefit transfer steps utilized by the case studies within the context of the District of Muskoka study. Land cover identification and benefit transfer were utilized by all case studies analyzed; therefore, all case study methodologies are applicable in the context of Muskoka. Please note that SWOT analysis

for step 3 was not conducted as this merely involves applying values determined from the benefit transfer to the identified land classifications.

Table 3: SWOT analysis for primary steps utilized for case studies methodologies (Wilson, 2008a; Wilson, 2012; Molnar, Kocian & Batker, 2012; Eade & Moran, 1996; Kyle, 2013; Malouin et al, 2013).

STRENGTHS	WEAKNESSES	OPPORTUNITIES	THREATS
Land and Water Cover Classification			
Classifies land based on the local context. Land cover classification information is easily available and applied to create a valuation model.	Method does not account for other variables or criteria that could be beneficial to overlay and evaluate (i.e. does not provide a multi-criteria analysis) in the process. Some land cover data may be outdated depending on the sources (needs to be overlayed with aerial, satellite, and/or other data layers to determine if current land cover has changed).	Provides a possible method for evaluating Muskoka's land cover. Could be incorporated with additional data layers to increase accuracy and applicability to Muskoka. By overlaying additional data (i.e. multi-criteria analysis), further ratios/prioritization of natural assets in Muskoka can be conducted to provide a more accurate analysis of disturbances on Muskoka's natural assets - once multi-criteria model is created, additional data can easily be input.	Based on the limited time and resources, multi-criteria is not plausible for this study.
Benefit Transfer			
Provides a framework for valuing natural assets at watershed and municipal levels. Less costly and time consuming than collecting primary data to formulate economic values of natural assets - does not require in-house calculations (which is not readily available). Method can incorporate a number of studies and sources to increase accuracy in values. Additional variables can easily be incorporated to adjust values.	Monetary values are underestimated by using conventional economic revenue calculations - some values may not be accurate as some benefits are unknown, and selection bias can occur. Should be further developed through detailed GIS and market analysis. Limited data availability can create challenges. Method does not always account for the unique ecosystems and features of the area.	Benefit Transfer method is an applicable, and commonly used, method of placing a monetary value on natural assets - would be applicable to Muskoka as it utilizes other studies to compile an array of values of various criteria identified through the valuation model for Muskoka. Opportunity to build off of existing studies that calculated values to apply to the context of Muskoka.	Multiple literature sources need to be utilized (and correctly applied to the context of Muskoka) to increase accuracy. Literature sources need to come from Regions that have a similar typology as Muskoka to ensure values are reflective of the assets and their importance.
Direct, In-house Value Calculations			

Provides accurate values applicable to specific natural assets within the context of the area.	Requires sufficient time and resources to calculate, being outside the scope of this study.	Could be explored in Muskoka in the future if time and resources allow.	Not applicable to the Muskoka study due to limited time and resources.
Extrapolating Future Value - Net Present Value			
Accounts for future flow of ecosystem services (over 50 years at a range of discount rates: zero - no discount; 3% - common in socio-economic studies; and 5% - more conventional) to account for depreciation in benefits similar to traditional capital assets.	Natural capital usually appreciates over time - does not operate similar to traditional assets.	Could be applied to the Muskoka valuation method if it is assumed that present benefits are more valuable than those benefits in the future.	Will not be used in the Muskoka valuation model as net present value is not commonly used in other jurisdictions (aside from British Columbia's Lower Mainland); and is therefore not heavily tested for validity.

1.3.3 Applicability of case study contexts:

Applicable case studies in the context of Muskoka:

- Thousand Islands Archipelago and National Park case study provides an applicable methodology (and natural asset values utilized in Phase 2 of this study) for the District of Muskoka due to its proximity to Muskoka, similar topography, and possible impacts of tourism activities on natural assets; however, being protected as a National Park, and subsequent implementation methods, would not be applicable to Muskoka.
- Lake Simcoe Basin case study also provides an applicable methodology (and natural asset values utilized in Phase 2) for the District of Muskoka due to its similar location, topography, and tourism industry; however, protection of this basin is primarily managed by the Conservation Authority and therefore, their implementation methods would differ from those explored for Muskoka.
- Town of Aurora case study provides an applicable methodology (and natural asset values utilized in Phase 2) as well due to its proximity to Muskoka; similar land cover types (i.e. the portion of the Town that falls within the Greenbelt); and its implementation of natural asset valuation from a municipal, land-use planning perspective.
- Rouge Area case study provides beneficial support and background information surrounding the land classification and benefit transfer analysis methods (and natural asset values utilized in Phase 2); however, it is protected as a National Park, which would not be applicable to Muskoka.

Less applicable case studies in the context of Muskoka:

- The case studies in British Columbia can support the land classification and benefit transfer analysis method; however, they are not as applicable to Muskoka as their location, topography, and challenges differ (i.e. these case studies evaluate their urban contexts, beaches, marine ecosystems, farmland, etc.).
- Similar to the above case study, the Rio Bravo Conservation Area provides support for the methodology for valuing natural assets; however, its location, challenges, and protection methods as a Conservation Area in Central America would not be heavily applicable to Muskoka.

1.3.4 Summary of methods for implementing valuation into planning policy frameworks to protect natural assets:

- Implementation of Asset Management Plans and/or eco-asset strategies to incorporate natural assets into infrastructure management using the Municipal Natural Asset Initiative (MNAI) developed by the Town of Gibsons (Town of Gibsons, 2012; Town of Gibsons, 2015; Town of Gibsons, 2018).
- Establishment of reserves, woodlots, arboretum, wildlife parks, and/or conservation areas (Kyle, 2013).
- Development of urban design guidelines to better address and protect natural areas and materials (Wilson, 2012).
- Implementation of a Watershed Protection Plan (Wilson, 2008a).
- Restoration and stewardship activities and initiatives (Wilson, 2008a).
- Acquisition, conservation, and/or remediation of essential lands by municipalities/landowners (Wilson, 2012; Eade & Moran, 1996; Kyle, 2013).
- Development of a Natural Heritage Strategy (Wilson, 2008a).
- Implementation of a secondary plan that seeks to capitalize on eco-services (Kyle, 2013).
- Development of a natural asset accounting framework/natural asset register through intergovernmental collaboration to identify, evaluate, and manage natural assets (Town of Gibsons, 2015; Town of Gibsons, 2018).
- Development Charges could help fund natural asset restoration initiatives (Town of Gibsons, 2015).

Please see Appendix C attached for a detailed analysis of the following case studies: the Thousand Islands Archipelago and National Park, Lake Simcoe Basin, Rouge Area and Park, British Columbia's Lower Mainland, Town of Gibsons, Rio Bravo Conservation Area, and Town of Aurora.

1.4 SUMMARY OF SWOT FINDINGS - CHOSEN VALUATION METHOD

Based on the above SWOT analyses, the benefit transfer method for placing monetary values on Muskoka's natural assets would be the most effective method as there is a sound literature base to utilize for valuing each identified asset. Furthermore, in-house monetary calculations would require additional time and resources to gather (being outside the scope of this study). In regards to the classification method, the land cover classification is a beneficial method for classifying natural assets. After classifying natural assets into different land cover types, the value of the natural assets will be determined based on an evaluation of the land cover types and their associated ecosystem services mentioned in the case studies. The actual monetary value of each land cover type is determined by analyzing the value stated in the case studies that have similar topology and environment. With this information, the value of each natural asset will be represented by the value of their corresponding land cover type. In consideration of the time constraint and available resources for this study, a multi-criteria analysis will not be accomplished to examine the impact of potential disturbances on natural assets and their values. Instead, multi-criteria analysis will be discussed in the Phase 2 Section 2.5 Opportunities for Future Studies. As a result, the final products of the study consist of maps of the distribution of valuable resources, a list of natural assets and their corresponding land cover type, a summary of each land cover type with their associated ecological services identified in the case studies, and finally a raster map showing the value per hectare. This will help guide and support the policy implementation recommendations for Phase 3.

1.5 MUSKOKA POLICY REVIEW

Potential gaps in Muskoka's policy framework were analyzed in order to understand where policy improvements could occur to ensure support for the valuation of natural assets for the Muskoka initiative. To provide an overview of gaps in Muskoka's policy framework, a number of land-use planning policy documents were reviewed. To begin, the Draft District of Muskoka Official Plan was analyzed, highlighting the beneficial nature of the currently proposed policies for natural features in protecting natural assets. The following policies were identified as requiring potential updates:

- D1.3 "Creating and Maintaining a Strong Tourism Sector" - explicit links to water resources and subsequent natural assets should be incorporated and/or created
- F1.1 b) "Objectives" - does not provide general direction for implementation of more detailed monitoring systems and techniques for evaluation and protection of natural heritage features
- F1.2.2 "Habitat of Endangered Species and Threatened Species" - could incorporate findings from Phase 2 to better protect identified endangered species and wildlife habitats
- F1.3 "Development and Site Alteration" - does not address natural asset protection explicitly
- Section F1.5.2 "Natural Asset Planning" - does not currently incorporate valuation, natural asset prioritization, comprehensive mapping of protection areas, or protection requirements of key natural assets to implement a natural asset planning strategy (based on Phase 2 products and findings); focuses on natural assets from an infrastructure perspective
- F1.5.3 "Consideration of Cumulative Impacts" - does not provide alternative initiatives to further protect natural features (i.e. "bonusing/incentive" or "land swap" programs between government and landowners/developers to better protect key natural features)
- F2.5 b) "Watershed and Subwatershed Planning" - does not provide additional reference to natural asset valuation initiative
- Various subsections under F1.2 "Natural Heritage Features in the District" - could speak more specifically to their monetary values and prioritization to protect key natural assets identified in Phase 2 of the study
- Policies surrounding identified disturbances and/or development restrictions (through Phase 2 findings) could also be incorporated

Based on the above findings, and subsequent recommendations formulated in Phase 3 of this study, natural asset mapping, policies, and analysis would then be implemented into the area's municipal official plans and subsequent zoning by-laws in the applicable sections (refer to Appendix D for a more detailed overview of the applicable sections). More specifically, natural asset and disturbance findings from Phase 2 have highlighted a number of policy recommendations that would be beneficial to implement into Muskoka's planning documents to better protect key natural features.

In examining the District of Muskoka's *Asset Management Plan for Roads, Bridges, Water and Wastewater Assets,* the plan does not mention or incorporate natural assets into the District's long-term financial planning (Watson & Associates Economists Ltd., 2014). As a result of the case study analysis of the Town of Gibsons, which explained the policy implementation method utilized by the

Town for incorporating natural asset valuation into their asset management framework and eco-asset strategy, incorporation of the Muskoka natural asset valuation into the District's Asset Management Plan (and subsequent Area Municipality Asset Management Plans) could help in further protecting Muskoka's natural assets. Utilization of the Municipal Natural Asset Initiative (MNAI) could be applied in the context of Muskoka if such natural asset policy incorporation is feasible. In this regard, the District could increase protection of key natural assets by incorporating such assets into the District's asset management framework, financial planning/statements, and possible eco-asset strategy.

Furthermore, the District's Economic Strategy, as well as the lower-tier municipalities' equivalent, were examined and all found to have a heavy emphasis on the importance of tourism. A clear gap is that there is no mention of natural assets and how natural environment protection would provide economic benefits. There is also a need to have one coherent economic message that spans across the District boundaries. Thirdly, the Muskoka Growth Strategy was examined, which promotes development in already built-up areas within Muskoka to protect the environment. However, new policies could be implemented to require new developments to be environmentally-friendly, and incorporate protection and enhancement of the environment with new development. Fourthly, the Muskoka Tourism Policy Review analyzes the tourist commercial development policies within the Muskoka Official Plan and recommends improvements that could be made; however, additional analysis could be conducted to ensure there are no negative implications to the aesthetics and health of the landscape as a result of new development. Finally, the Muskoka Watershed Council documents, namely the Report Card, summarize the environmental health of the watershed and subwatersheds, as well as the current conditions of the land and its resources. The District could take a more action oriented approach by implementing policies that would increase the environmental health of these watersheds.

Please see Appendix D attached for a detailed analysis of the policy gaps within Muskoka's policy framework.

1.6 SUPPLEMENTARY FINDINGS: BEYOND THE SCOPE OF THE STUDY

Although it was outside the scope of this study, the findings have alluded to the benefits of implementing a Conservation Authority. For an overview of these supplementary findings beyond the scope of this study, in addition to some other administration and governance elements, please see Appendix E attached.

2.0 PHASE 2: VALUATION OF NATURAL ASSETS

The area of interest for this valuation of natural assets study covers the Muskoka River Watershed and northern portions of the Black River and Severn River Watersheds, which includes the District of Muskoka. In total, the area of interest is approximately 7,765.45km^2 or 776,545 hectares. A map of the area of interest from ArcGIS Online is shown in Figure 1 below. The purple boundary indicates the study area and the black dashed line outlines the District of Muskoka.

Figure 1: A map of the area of interest for this study.

2.1 METHODOLOGY

Based on the review of various case studies surrounding natural asset valuation conducted by other municipalities analyzed in Phase 1, the valuation method selected for Muskoka was a combination of land cover classification and the benefit transfer approach. For this study, the GIS software and tools used to produce the value maps were ArcGIS 10.5.1 and two pieces of python scripts. The following flowchart shows the major phases required to complete the valuation of natural assets in Muskoka:

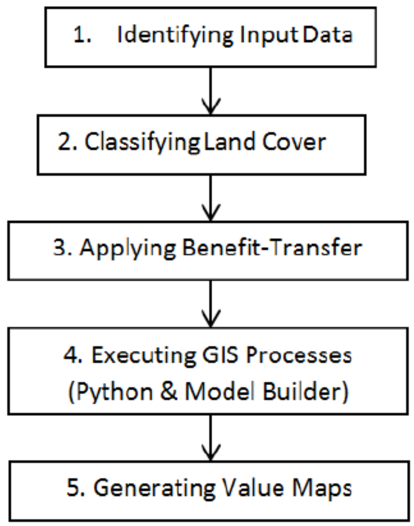


Figure 2: A flow chart showing the general process of conducting natural asset valuation for Muskoka.

2.1.1 Identifying Input Data

The natural asset data used for this study was primarily provided by the District of Muskoka in geodatabases through a FTP link. This includes waterbody, watercourse, natural heritage areas, conservation reserves, provincial parks, municipal and District boundaries, building footprints, the hotspots of species at risk, and more.

The District provided two wetland data layers, namely *WSHD_MNR_WETLAND* and *wetlands*. The *wetlands* layer is an enhanced version created in 2009 based on the 2008 air photo dataset, but has an extent limit only up to the District boundary. In contrast, the *WSHD_MNR_WETLAND* layer covers the entire area of interest, but the data quality is not as high as the *wetland* layer. For this study, Viridi Consulting prioritized data quality over data coverage; thus, *wetlands* was used as the source of wetland data for Muskoka.

Among the data layers provided by the District, many were acquired from the Ontario Land Cover layer, which was originally obtained from the Land Information Ontario (LIO) open data source. Compared to the District's primary land cover data, the Ontario Land Cover layer is more comprehensive, since it contains a wider variety of land cover data, particularly vegetation data. As a result, Viridi Consulting decided to use the Ontario Land Cover layer as the primary land cover data source along with the District's subsidiary land cover data. Next, multiple data cleanup processes were conducted as follows:

1) Bedrock, cloud and shadow, disturbance, and minerals were not valued in this study and were therefore removed from the Ontario Land Cover layer, since there was a lack of academic literature or trustworthy sources on mineral-related valuation found within the study timeframe.

This was acceptable as these land covers only occupy 1.77% of the total area of interest, which is not identified as significant land cover in the context of Muskoka.

2) Similarly, community and infrastructure features were also excluded from the Ontario Land Cover layer since it was irrelevant to the purpose of this study of valuing natural assets.

3) The Ontario Land Cover layer also contains wetland features, namely swamp and marsh. The *wetlands* layer provided by the District has an extent limit with more detailed categories, being Alder Brush, Open Water Marsh, Marsh, and Swamp. Directly replacing the swamp and marsh data in the Ontario Land Cover with the *wetlands* layer would cause overlaps and slivers with other land cover data of the same layer. Instead, this problem was solved in the latter GIS processing phase by manually assigning the correct land cover code after merging the two layers (i.e. *wetlands* and wetland features in the Ontario Land Cover) to eliminate any overlaps. This created one single layer of wetland data from both sources, and was used for the analysis.

4) The Ontario Land Cover layer also contains the data of clear open water. Although the waterbody data provided by the District has much higher resolution (Figure 3), the clear open water feature from the Ontario Land Cover layer was chosen to be the source of waterbody data for maintaining consistency with other data features in the Ontario Land Cover layer, and to prevent unnecessary gaps.

Figure 3: Screen capture showing the District's waterbody data in blue and clear open water feature of the Ontario Land Cover layer in purple.

Overall, a summary of the land cover data gathered from the Ontario Land Cover layer is indicated in Table 4 below.

Table 4: A summary of the land cover features used in the Ontario Land Cover layer.

ONTARIO_LAND_COVER_COMPILATION_V2		
Land Cover	**Area (Ha)**	**Land Area Composition**
Agriculture and Undifferentiated Rural Land Use	22897.68	2.95%
Bedrock	11388.07	1.47%
Bog	10888.92	1.40%
Clear Open Water	136931.75	17.63%
Cloud/Shadow	1931.24	0.25%
Community/Infrastructure	11856.1	1.53%
Coniferous Treed	37705.85	4.86%
Deciduous Treed	234440.51	30.19%
Disturbance	139.05	0.02%
Hedge Rows	38.89	0.00%
Marsh	2918.65	0.38%
Mixed Treed	221596.07	28.54%
Plantation – Treed Cultivated	204.5	0.03%
Sand/Gravel/Mine/Tailings/Extraction	246.27	0.03%
Sparse Treed	77421.63	9.97%
Swamp	5828.21	0.75%
Treed Upland	112.48	0.01%
Total Area	**776545.37**	**100.00%**

2.1.2 Classifying Land Cover

Next, the natural asset data were classified into different categories based on their land cover type. In total, five land cover categories were identified with a unique code, being: Forest (1), Water (2), Wetland (3), Protected Lands (4), and Cropland (5). Table 5 below lists data included in each land cover category, name of the data layer, and the data source:

Table 5: A summary of the data layers and sources of each land cover category.

Category (Code)	Land Cover	Data Layer	Data Source
Forest (1)	Coniferous Treed	Ontario_Land_Cover_Compilation_V2	Land Information Ontario
	Deciduous Treed		
	Mixed Treed		
	Plantation – Treed Cultivated		
	Treed Upland		
Water (2)	Clear Open Water		
	Stream	Watercourse	District of Muskoka
	Virtual Connector		
	Virtual Flow		
Wetland (3)	Bog	Ontario_Land_Cover_Compilation_V2	Land Information Ontario
	Marsh		
	Swamp		
	Brush Alder	Wetlands	District of Muskoka
	Marsh		
	Open Water Marsh		
	Swamp		
Protected Lands (4)	Provincial Park	Provincial Park	District of Muskoka
	Conservation Reserve	Conservation Reserve	
Cropland (5)	Agriculture and Undifferentiated Rural Land	Ontario_Land_Cover_Compilation_V2	Land Information Ontario

These land cover categories were created based on their significant value to the District of Muskoka identified by their associated ecological services as follows:

Forest (1):
As the dominant land cover component of the area of interest, the forest land cover takes up approximately 63.6% of the total area. The main components of this land cover category include coniferous forests, deciduous forests, upland forests, and plantation. The forest land cover offers a variety of ecosystem services. It is an essential contributor to the carbon cycle and aids in reducing greenhouse gases while producing oxygen (Kyle, 2013). Additionally, it is the habitat for various species, including the species at risks in the area of interest. Flood and wind mitigation are also provided which will not only help the wildlife, but also identify areas of development. Moreover, forest features also provide an improvement to air quality; however, the most important ecological service it provides is soil retention, water filtration, and erosion prevention. It is the only land cover type discussed

in this report that has the ability to prevent erosion; and thus is essential to protect, particularly near areas of development.

Water (2):
In the area of interest, water features occupy 17.6% of the total land cover, which is the third largest land cover category. For this study, the water land cover category consists of waterbodies, streams, virtual flows and connectors. Water features are the homes to various aquatic species and major sources of freshwater supply (Malouin et al., 2013; Wilson, 2008a; Wilson, 2012; Molnar et al., 2012; Eade & Moran, 1996; Kyle, 2008). Besides other ecological services, water features are also the main contributor of Muskoka's recreational services and activities, such as fishing, boating, kayaking, and more.

Wetland (3):
The Muskoka Watersheds only contain 7.8% wetlands. Wetland features found in the area of interest are bog, marsh, swamp and brush alder. Similar to forest and water land covers, wetland features offer multiple ecological services. Wetland features are significant due to their ability to provide recreation, waste treatment, and habitat, but most importantly regulate and filter water at high volumes (Kyle, 2013). Wetlands act as a natural water filter system, removing pollutants such as phosphorus, heavy metals and toxins ("The value of wetlands", 2017). Wetlands are capable of growing food in places such as Asia, West Africa, and the United States ("The value of wetlands", 2017). While wetlands are used for specialty agriculture in Muskoka, namely in regards to cranberry production in Bala; it is not found to be of significance to Muskoka's natural asset valuation.

Protected Lands (4):
In this study, provincial parks and conservation reserves were classified as Protected Lands. This land cover category dominates 18.9% of the total land cover of the Muskoka Watersheds, resulting in the second highest land composition. The value of protected lands are primarily recreational-based, being the main component of Muskoka's tourist destinations (Malouin et al., 2013; Molnar et al., 2012; Kyle, 2008). However, the natural characteristics of the protected-land features make them the key contributor to carbon services, air quality regulation and enhancement, as well as soil formation and nutrient sequestration. Since the protected lands areas include other assets within its boundary, a bonus value was given for those areas in addition to the assets' values as it has more significance due to the policies protecting these areas.

Cropland (5):
Unlike other land covers that are more significant in size, the area of interest only contains 2.9% of cropland features, such as agricultural and rural lands. The main contributions of cropland are carbon services, food production, nutrient cycling, generating soil formation, and enhancing air quality (Kyle, 2013). The economic value generated from agricultural activities can fluctuate depending on the weather and seasons. Since this report analyzes the benefits the land has to the environment and not the values of the food produced in the area, the non-market value is much lower for this land cover category compared to others.

Overall, based on the academic literature and case studies analyzed in Phase 1, the types of ecological services offered by each land cover category were examined and summarized below, being the basis of the benefit transfer approach (Table 6).

Table 6: A summary of the ecological services provided by each land cover category identified in the case studies (Eade & Moran, 1996; Kyle, 2013; Molnar et al., 2012; Wilson, 2018a; Wilson, 2012; Malouin et al, 2013).

ECOLOGICAL SERVICES		SOURCE	LAND COVER TYPES					
Type	Description	-	Forest	Water	Wetland	Protected Land	Cropland	Species at Risk Hotspots
Provisional	Wildlife habitat & biodiversity	a, b, c, d, e, f	√	√	√	√	√	√
	raw material production	c, d	√	√				
	food production	c, d	√	√			√	
	freshwater supply	a, b, c, d	√	√	√			
Regulating	Climate regulation	c, d, f	√	√	√	√	√	√
	Water quality & filtration services	a, b, c, d, f	√	√	√			
	nutrient & waste regulation	a, b, d, f	√	√	√		√	√
	water regulation & flood control	a, b, c, d, e, f	√	√	√			
	Air quality	a, f	√	√	√	√	√	√
	Atmospheric regulation	a, b, d, f	√	√	√	√	√	
	Soil formation	b, c, e, f	√	√	√	√	√	√
	Soil retention & erosion prevention	a, b, c, d, e, f	√					√
	Pollination and dispersal services	a, b, f	√		√	√	√	√
	Carbon services	b, e, f	√	√	√	√	√	√
	Nutrient sequestration	a	√	√	√	√	√	
Supporting	disturbance avoidance	a, d	√	√	√			
	Nutrient cycling	c, d, f	√	√	√	√	√	
	Photosynthesis	a	√		√	√	√	√
Cultural	Tourism/Recreation	a, b, c, d, e, f	√	√		√		
	aesthetic and amenity	a, d, f	√	√	√	√		
	other cultural services	a, c	√	√	√	√		

LEGEND	
a	Thousand Islands Archipelago and National Park (Malouin et al., 2013)
b	Lake Simcoe Basin, Ontario (Wilson, 2008a)
c	Rouge Area and Park, Ontario (Wilson, 2012)
d	British Columbia's Lower Mainland (Molnar et al., 2012)
e	Rio Bravo Conservation Area, Belize (Eade & Moran, 1996)
f	Town of Aurora, Ontario (Kyle, 2018)

A map of each land cover category is included in Appendix F.

2.1.3 Applying Benefit Transfer

Based on the summary of the valuation methods identified in Phase 1, the valuation method selected for this study was the benefit transfer approach. Four case studies of areas with similar geographic characteristics as the District of Muskoka were analyzed in Phase 1, including Lake Simcoe Basin, British Columbia's Lower Mainland, Town of Aurora, and the Thousand Islands Archipelago National Park. Each case study provided insight on the value of natural assets based on their associated land cover category. More specifically, scientific assessments were adopted to justify the value of each land cover category by examining the types of ecological services. Overall, the value of different land covers in dollars per hectare per year indicated in each case study are displayed in Table 7 below.

Table 7: Values for each land cover type from various case studies (Kyle, 2013; Molnar et al., 2012; Wilson, 2018a; Wilson, 2012; Malouin et al, 2013)

Land Cover Type	Thousand Islands Archipelago ($/ha)	Lake Simcoe Basin ($/ha)	Town of Aurora (Rouge National Park portion) ($/ha)	Town of Aurora (the Greenbelt portion) ($/ha)	British Columbia's Lower Mainland ($/ha)
Forest	4776	4798	5149	5414	6143-10946
Wetland	15908	11172	9651	14153	3108-378529
Cropland & Field	151	529	378	477	-
Water/Snow/Ice/ Shoreline	19081	1428	514	-	2362-66327
Hedgerows/Cultural Woodlands	-	1453	3110	1678	-
Plantations	-	-	3802	-	-
River	-	-	1421	335	-

In order to minimize the disparity of natural asset value caused by the difference in provincial economic development, case studies of study areas located on the Canadian Shield within proximity to the District of Muskoka were prioritized when determining Muskoka's land cover value. In other words, British Columbia's Lower Mainland case was not considered a valid source for the benefit transfer approach for Muskoka. Based on the value presented in Table 7, the values of each land cover category identified in this study could then be calculated (illustrated in Table 8 below).

Table 8: Values calculated for this study based on the findings in Table 7

Land Cover Category	Minimum Value ($/ha)	Maximum Value ($/ha)	Average Value ($/ha)
Forest	4776	5414	5095
Wetland	9651	15908	12779.5
Cropland	151	529	340
Water	1428	19081	10254.4
Protected Lands	1453	3110	2281.5

These values were used in the following GIS process, whereby the minimum, maximum and average values were assigned to the corresponding data cell based on their land cover category. The dollar values calculated have been accounted for inflation and are in Canadian dollars.

2.1.4 GIS Process

Since the data provided by the District was all in vector format, the first step of the GIS process was to rasterize the data. The [Feature to Raster] geoprocessing tool was applied with a main field identified for each data layer. The selection of the main field was done manually to choose the most representative data field for each data layer. In addition, the cell size of each raster layer was 50m by 50m, which is the same as the cell size indicated in the case study of Rio Bravo Conservation Area. This means that each cell has an area of 0.25 hectare. In order to minimize the process time, a python script was used for the rasterization process (Figure 4).

```
import arcpy

arcpy.env.workspace = r'C:\Users\hachau\Desktop\PLAN 405\Data\Waterloo_GIS_Package_2.gdb'
arcpy.env.overwriteOutput = True
featureClasses = arcpy.ListFeatureClasses()

field = 'Description'
cellSize = 50

renameDic = {}
renameDic['Area_Of_Inte'] = 'AOI_Ras'
renameDic['Conservation'] = 'Conservation_Ras'
renameDic['First_Nation'] = 'First_Nation_Ras'
renameDic['Muskoka_Heri'] = 'Heritage_Ras'
renameDic['Ontario_Land'] = 'Land_Cover_Ras'
renameDic['Provincial_P'] = 'Prov_Park_Ras'
renameDic['Waterbody'] = 'Waterbody_Ras'
renameDic['Watercourse'] = 'Watercourse_Ras'
renameDic['Wetland_Merg'] = 'Wetland_Ras'
renameDic['Building_Poi'] = 'Buidling_Point_Ras'
renameDic['Community_Bo'] = 'Comm_Boundary_Ras'
renameDic['FloodRisk_Re'] = 'FloodRisk_Ras'
renameDic['Railway'] = 'Railway_Ras'
renameDic['Road_Segment'] = 'Road_Ras'
renameDic['Trail_Merged'] = 'Trail_Ras'
renameDic['Utility_Line'] = 'Utility_Ras'

for fc in featureClasses:
    print fc
    try:
        outRaster = "C:\\Users\\hachau\\Desktop\\PLAN 405\\Data\\Ras\\Species.gdb\\" + renameDic[str(fc)[0:12]]
    except KeyError:
        outRaster = "C:\\Users\\hachau\\Desktop\\PLAN 405\\Data\\Ras\\Species.gdb\\" + str(fc)[0:12]
    arcpy.FeatureToRaster_conversion(fc, field, outRaster, cellSize)
```

Figure 4: The python script used to mass convert the vector data into rasters.

After rasterizing the data layers, the [Reclassify] and [Raster Calculator] tools were applied depending on the land cover category. Some categories were comprised of multiple layers (i.e. wetland, water, and protected land), while forest and croplands were solely derived from the Ontario Land Cover layer. By using the [Reclassify] tool, all layers were assigned by their Distinct land cover code determined in the previous steps. For example, for areas that are covered by coniferous-treed cells of the Ontario Land Cover layer, a value of “1” was assigned because coniferous-treed cells were classified under the Forest land cover. For the categories with multiple data layers (i.e. wetland, water and protected land), the many layers that compose that category were added together using the Raster Calculator tool and then reclassified to eliminate any overlaps of data. The overlaps could cause the value of the land to be double-counted; therefore, it was necessary to remove the duplicates. The output of this step created five individual raster layers for each land cover category, namely forest, water, wetland, protected land, and cropland.

Next, a new field was added to each land cover layer for calculating the value of each land cover category. Originally, the value of each land cover category was in dollars per hectare per year. Since the area of one cell was 0.25 hectare, the values were divided by four using [Calculate Field] to calculate the value per year. Just like the previous step, the output of this step would create five raster layers with value per year stored in each cell. Finally, the [Raster Calculator] tool was applied to sum the values of each cell from all land cover categories. In total, there were four different maps generated, being the average value map, minimum value map, maximum value map, and the value difference map.

Overall, the entire GIS process was created by using Esri's Modelbuilder, which can be replicated and changed depending on the type of map being created (Figure 5). Since there were four different maps generated, the model was iterated multiple times with different values. It is easy to add additional layers or geoprocessing tools to a model, as long as the raster layer before the application of the final [Raster Calculator] has the same domain, range, and value per cell.

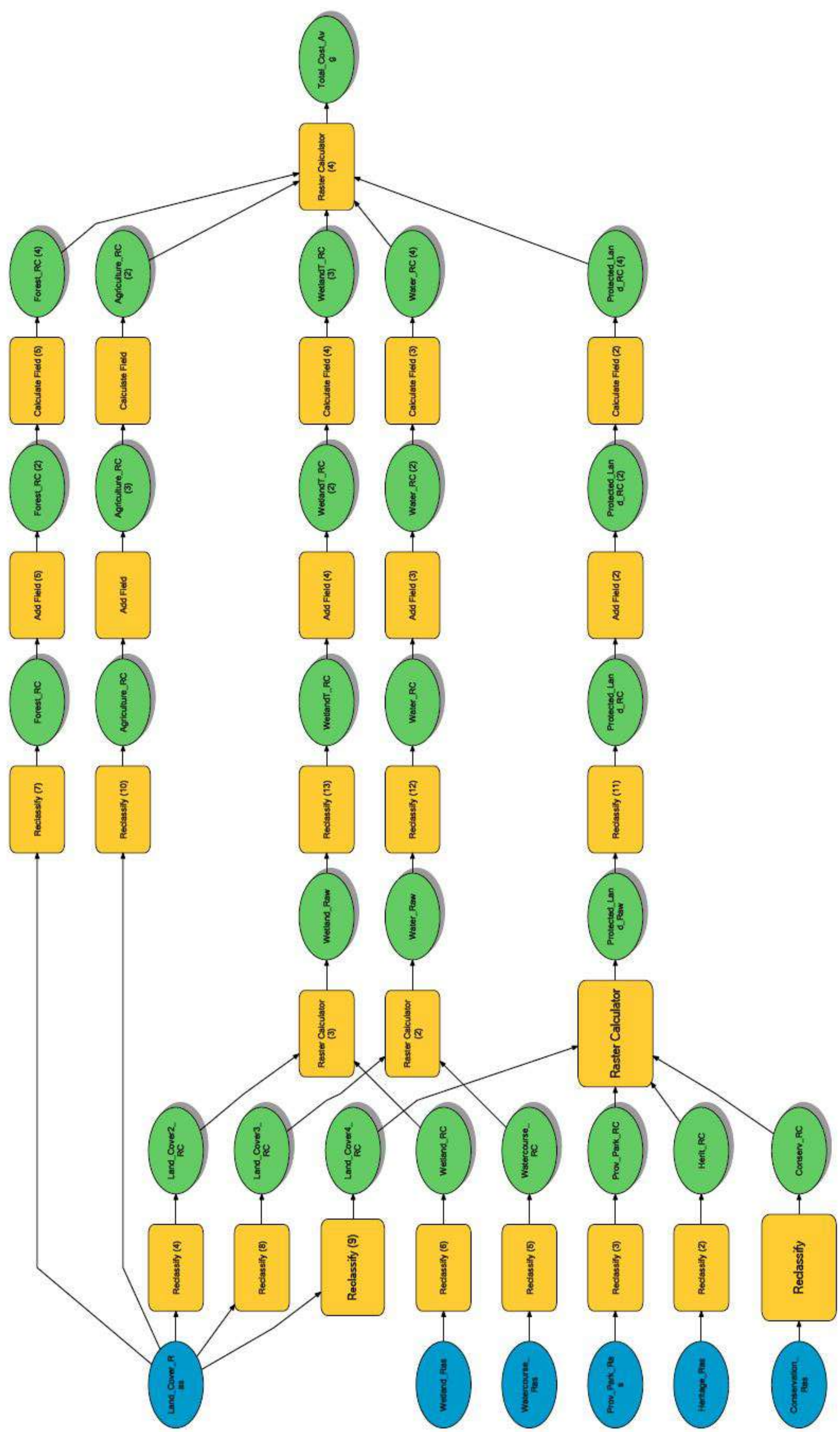


Figure 5: The geoprocessing model created for calculating the average value.

2.2 VALUATION OF NATURAL ASSETS RESULTS

Based on the methodology and the values collected in Table 9 above, a map showing the averaged total value for the Muskoka's natural assets by land cover categories is generated as displayed below (Figures 6). The result of the map indicates that although forest is the land cover category that has the highest average total value, it is very scattered across the Muskoka watershed. In contrast, water resources, which are the land cover that has the second highest average total, are more geographically concentrated in the western central portion of the Muskoka watersheds, as well as near Georgian Bay. This visual display can be used to identify the key areas of interest when implementing policies to protect the District's natural assets. However, it is noted that these evaluations were generated from borrowed values from the case studies, thus the values may differ when more site specific analysis is performed.

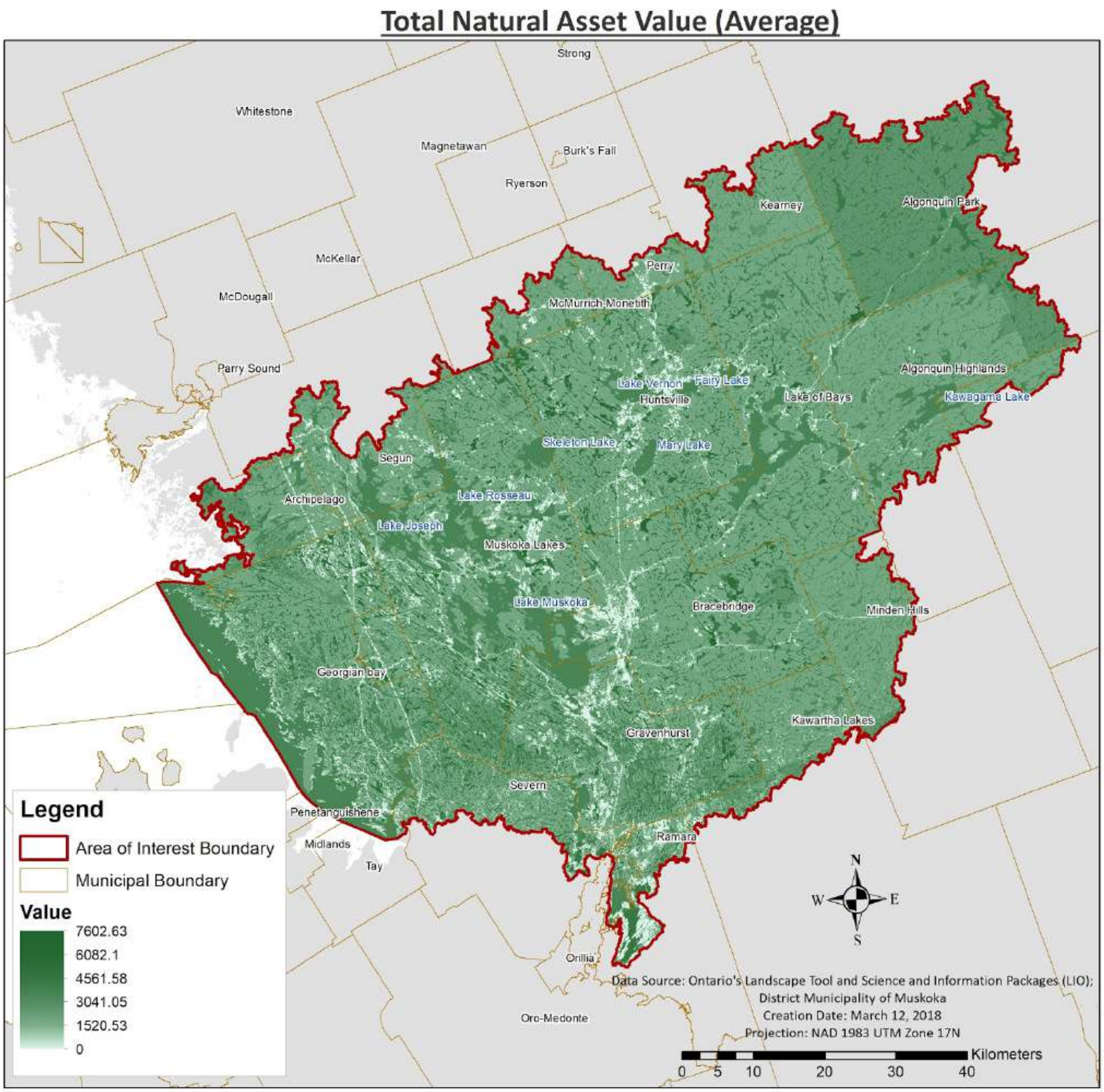


Figure 6: A map showing the distribution of average total value of the natural assets in Muskoka watersheds.

Furthermore, the minimum and maximum total value maps are also generated by using the same approach (Appendix G). In addition, a value-difference map comparing the minimum and maximum maps is also included in Appendix G.

Table 9: The total average, minimum and maximum value for each land cover category in the study area.

Land Cover Category	Minimum Value	Maximum Value	Average Value
Forest	$2,728,957,446.00	$3,093,504,106.50	$2,911,230,776.25
Wetland	$617,533,711.50	$1,017,897,242.00	$817,715,476.75
Cropland	$3,450,954.00	$12,089,766.00	$7,770,360.00
Water	$290,968,566.00	$3,887,935,019.50	$2,089,451,792.75
Protected Lands	$1,128,314,073.00	$2,415,042,510.00	$1,771,678,291.50
Total	$4,769,224,750.50	$10,426,468,644.00	$7,597,846,697.25

Based on the output of GIS analysis, the total average value for the study area is $7,597,846,697.25, while the minimum is $4,769,224,750.50 and the maximum is $10,426,468,644.00. The large difference between the minimum and maximum value is created by the large difference in water values, being a difference of $3,596,966,453.50. The second biggest value difference occurs on protected lands. Although the values do not indicate a large contrast, the area of coverage is the largest out of the five land cover categories.

2.3 DISCUSSION

Overall, based on our findings, the ranking of Muskoka's land cover can be valued as follows:

1. Forest
2. Water
3. Protected Lands
4. Wetland
5. Cropland

This ranking can be used for enhancing Muskoka's future policy development framework by prioritizing or targeting the natural assets classified within the land cover categories indicated above. This ranking is based on the average total value of the land cover category in the area of study. Several implications are also evident by examining the results. Firstly, since protected lands overlap with forest and other land covers, it is reasonable that protected lands have the second highest composition. The most significant land cover is forest, as it is the highest composition after protected lands. However, the value of forest is much lower than water, although forest covers approximately 2.5 times more than the water land cover in the study area. According to the table indicating the provision of ecological services of each land cover category (Table 6 previously discussed), forest land cover contributes a wider variety of ecological services in comparison to other land covers. Since forests provide the widest range of ecological services and has the highest land coverage, it was ranked as the most valuable asset in the study area.

For the minimum value map, wetland features are highlighted as they have the highest value. The lowest value found on the minimum map is the water land cover, which is represented in light green. Interestingly, the water land cover indicates a much higher value in the maximum value map, creating a value difference of $3,596,966,453.50. This value difference is created by the varying water land cover values indicated in different case studies, with the minimum value of water land cover drawn from the Rouge National Park in the Aurora case study and the maximum value from the Thousand Island Archipelago National Park case study. The potential cause of this significant value contrast might be due to the possibility that sites with more significant water features (e.g. Thousand Islands) would have more water recreational services; thus, water land cover would be valued higher. In contrast, sites without many water features would value water land cover lower, since water features would have very limited economic significance.

In addition, forest, cropland and protected lands did not receive a significant increase in value; therefore, their visibility on the map remained the same across all three maps. Furthermore, wetlands are harder to differentiate from forests and protected land while rivers, lakes, and ponds can be identified with ease.

Among the three value maps, the average map is more consistent since no one area stands out exponentially from the others. This is because the value for water is averaged and not at the extreme ends of the spectrum. As seen on the difference in value map, the most extreme differences between the minimum and the maximum value is water at the difference of $17,653 per hectare per year, and second being wetlands at $6,257 per hectare per year. As a result, the average map is more suitable for identifying areas of concern for all natural assets, as there are less high-value lands not skewed by water or wetland. In general, forest features are the most valuable natural assets in the context of Muskoka as they cover the largest percentage of the area of interest. The second and third most valuable is water and wetland respectively; however, although they have a higher dollar value, their percentage cover is far lower than forest. The remaining natural assets of croplands and protected lands are found to have the least value in comparison to other natural assets.

2.4 RECOMMENDATIONS

Data availability and quality is the foundation of a valuation study such as this; therefore, based on the GIS analysis of this study, it is recommended that the District improve their data availability and data quality.

In order to achieve more accurate valuation results, it is important to ensure all natural asset data have the exact same extent to cover the entire area of interest. For this study, the wetland data provided by the District has high resolution, but it has a limited extent that only covers the District of Muskoka, resulting in less accurate results outside of the District boundary. Compared to the waterbody data contained in the Ontario Land Cover layer, it was discovered that the District's waterbody data has a much higher data resolution. In addition, there are some differences in data near the shoreline. Since the Ontario Land Cover layer is created based on satellite imagery, data validation should be necessary to identify the most up-to-date natural asset coverages. In this regard, the District should consult with the Ministry of Natural Resources and Forestry to create a land cover layer.

Building on the previous suggestion, it is also highly recommended that the District create its own Land Cover layer for the area of interest. Although the District has some high-resolution natural asset datasets, the data is not as comprehensive as the Ontario Land Cover layer. To begin, the District could use the Ontario Land Cover layer as a guide to prepare a list of required land cover data, and avoid missing any important data inputs. For example, the most significant natural asset, forest and vegetation, is missing from the District's data package. Although other natural assets, such as bedrocks and agricultural lands, are not as significant as water and vegetation, it is still recommended that comprehensive data be collected for enhancing the accuracy of the valuation results, as well as for potential future studies. By creating a high resolution land cover package covering the entire area of interest, the result of the study would be more accurate. This could also be a potential project for the District to partner with nearby municipalities and regions to collect this data.

Furthermore, Viridi Consulting recommends that the District acquire spatial data on tourist sites. Tourist sites in this definition are areas which offer recreational activities occuring on a frequent basis, or are known as destinations where people would want to visit. Based on a report of 2015 tourism profile prepared by the Ontario Ministry of Tourism, Culture and Sport (MTCS, 2017), Muskoka's large tourist population and well-known outdoor activities dominates a major part of the District's economy (Table 10).

In 2015, the total amount spent by visitors of the region was approximately $700,000,000 (MTCS, 2017). The large amount of profit generated by the outdoor activities also implies that the District's natural assets should have higher cultural values. If the tourist site data is available, its economic profit can be further assessed and considered in the valuation process. In discussions with the client, it is understood that the data of tourist sites are currently managed by the lower-tier governments. As an alternative, Viridi Consulting encourages the District of Muskoka to develop an Open Data Portal to share geospatial information with the lower-tier governments. A good example is the Region of Waterloo's Open Data Portal, whereby the Region organized geospatial data into different categories, and shared among lower-tier governments (Figure 7).

Table 10: Muskoka Regional Tourism Profile from 2015 (MTCS, 2017)

Muskoka Regional Tourism Profile (2015)	
Activities Participated (Person Visits)	Total Number of Visitors
National/Provincial Nature Parks	373,100
Historic Sites	132,100
Sightseeing	192,700
Indigenous	6,500
Any Outdoor/Sports Activity	2,676,800
Boating	1,380,300
Canoeing	933,900
Golfing	128,600
Fishing	610,600
Hunting	34,400
Skiing/Snowboarding	18,000
Cross-country Skiing	82,800
Snowmobiling	87,600
Cycling	139,500
Hiking	872,200
Camping	773,000
Visit a beach	736,200
Wildlife/Bird Watching	509,300

Figure 7: Region of Waterloo's Open Data Portal (Region of Waterloo, n.d.).

Moreover, sharing data with lower-tier municipalities not only creates additional inputs on the District's geospatial data resources, but it also minimizes the amount of budget and effort required for primary data collection. Since lower-tier municipalities might have stronger local knowledge or a better understanding of their natural environment, their inputs can be very valuable for the creation of the District's own Land Cover package.

2.5 OPPORTUNITIES FOR FUTURE STUDIES

Following insight into the value of Muskoka's natural assets, the findings of this study could be applied to other areas of interest to further preserve the District's assets and environment. By using the value of natural assets as an input, three potential future research topics for the District to consider are discussed below:

2.5.1 Threats to the natural assets

The District could analyze the potential threats to its natural assets, such as the impacts of acid rain, pollution, flooding and development on the natural assets (Yan, 2011). This analysis also requires additional data and input from various experts (i.e. hydrologist, meteorologists and chemist) to conduct the study. For example, acid rain analysis would require climate data, such as annual precipitation, main components of acid rain (e.g. SO_2, $CaCO_3$), and population data. Based on discussion with the District, this data is currently unavailable; however, it would be useful to gather such data to conduct similar future studies. A useful source of similar acid rain analysis can be found through the following link: http://gis.lanecc.edu/geostac/tyser_f/acid-precipitation. In addition, watershed analysis and the direction of flooding can be modelled and analyzed through GIS software to identify the flow of point-source pollution, as well as the impacted area of natural assets. Particular attention should be placed on areas of high-value natural assets for identifying any serious sources of threats in close proximity to those natural assets. Protection strategies and policy enhancement should be placed in areas of high risk to prevent damage, and preserve the quality of the natural assets.

Table 11: Species at risk found in the District of Muskoka.

Species at Risk in Muskoka		
Status	**Common Name**	**Type**
Endangered	American Ginseng	Plant
	Forked Three-awned grass	Plant
	Spotted Turtle	Reptiles
Threatened	Massasauga	Reptiles
	Eastern Hog-nosed Snake	Reptiles
	Eastern Foxsnake	Reptiles
	Branched Bartonia	Plant
	Least Bittern	Bird
	Peregrine Falcon	Bird
	Stinkpot	Reptiles
Threatened with Extinction	Kirtland's Warbler	Bird
Special Concern	Broad Beech Fern	Plant
	West Virginia White	Moths and Butterflies
	Bald Eagle	Bird
	Cerulean Warbler	Bird
	Golden-winged Warbler	Bird
	Yellow Rail	Bird
	Blanding's Turtle	Reptiles
	Northern Map Turtle	Reptiles
	Five-lined Skink	Reptiles
	Milksnake	Reptiles
	Eastern Ribbonsnake	Reptiles

2.5.2 Selection of development sites

The District of Muskoka is known for its natural environment; and therefore, a significant amount of effort is placed on protecting those natural assets. Viridi Consulting used development-related data provided by the client and conducted a simple analysis on the location of existing development in relation to the value of natural assets. This includes a hotspot analysis of the District's existing population allocation represented by the existing household building points as a substitution for population density data; as well as existing community infrastructure including railways, roads, trails, and utility lines (Appendix H). In addition, maps indicating the location of floodlines, utility lines, trails, railways, and road networks in relation to natural assets can be found in the following section regarding additional future opportunities for development impact study. Based on the results identified on the maps, the current existing community infrastructure is located in close proximity to high-valued natural resources, being primarily water bodies. It is recognized that developments are necessary near water bodies to support the existing recreation uses; however, by incorporating spatial analysis, the location where the development will have the least impact on the protected water resources can be identified. In addition, in order to maintain the value of Muskoka's natural assets, future development is encouraged to occur in the built-up areas. However, more accurate and comprehensive analysis can be carried out through multi-criteria analysis to determine the most suitable future development sites with the consideration of natural asset values and the location of existing built environments. By doing so, sprawling community infrastructure can be eliminated. The results can also be considered and discussed with the local residents and community groups as part of the policy development process to determine which areas should be better preserved, and development restricted.

2.5.3 Protection of wildlife habitats

The District of Muskoka provided a list of species at risk and their hotspots during the initial phase of the study. In total, there are 22 species at risk, including plants, insects, and animals, with four different levels of risk status in the area of interest (Table 11 above).

Based on the potential habitat data provided by the District, the hotspot of endangered species occupies 7.3% of the area of interest's total land cover; the hotspot of threatened species occupies 66.7% of the total land cover; and the hotspot of species with special concern dominates 74.9% of the total land cover. However, the data provided by the District of Muskoka on the species at risk only show the potential habitats of these species, thus the statistics mentioned above may not be accurate. A map of the potential wildlife habitat distribution for each risk status is created and attached in Appendix I. Given this significant output, Viridi Consulting believes wildlife habitat plays a significant role in Muskoka's natural resources. Funding and protection programs initiated by multiple levels of government, private organizations, and community groups should therefore be focused on these wildlife hotspots (Government of Ontario, 2018). These programs provide funds for researchers to conduct studies on the endangered species, which will further provide insight on how to protect these species and their habitats. As each species require different habitats, more focused research will allow for more specific policies to be implemented for each species at risk. This protection would not only create additional economic value to the wildlife hotspots, but also better preserve the surrounding natural environment to protect the wildlife at risk. Potential analysis could be conducted to examine the relationship between human population and built-environment, and the identified wildlife hotspots, as well as their future potential migratory trends. The impacts of climate change on the wildlife hotspots can also be studied for the development and implementation of protection and mitigation strategies. Inputs from biologists and meteorologists would play an important role in this study. As a result, policy enhancement could occur in areas of high wildlife population to prevent negative impacts caused by human activities and development.

2.6 ADDITIONAL FUTURE OPPORTUNITIES - DEVELOPMENT IMPACT STUDY

In addition to the above recommendations, it is also recommended that the District conduct a further study regarding the impact of development on Muskoka's natural assets. Due to the time constraints of this study, the impacts of the existing development and infrastructure on natural assets are demonstrated through simple mapping (as illustrated in the maps below). A more comprehensive study, including the analysis of proximity, pollution sources, and stream flow direction, are encouraged as future research topics. Furthermore, the output of the spatial analysis can also be incorporated into the policy decision-making process by identifying the key areas of interest for executing a particular policy plan.

The impacts from development will affect the quality of the natural asset, which in most cases will have a negative effect and lower the value of the natural assets. By having a more in depth analysis of the District's development and infrastructure, the true values of the natural assets can be discovered. As shown on the maps below, there are developments that are located close to high value assets such as

Lake Muskoka. The high value of the lake is a result of the water recreation it provides; however, nearby development could have a negative impact on the quality of the lake. By examining the impacts of water recreation and nearby development on the lake, the true value of the lake can be determined. Also, since this project is mainly focusing on the environmental values, the recreational values can also be incorporated in future studies to find the total economic value of each asset.

Policies will have to consider the high value areas and the development nearby, to aid in preserving and protecting the natural asset. For high value areas like Lake Muskoka, policies should protect the natural habitat from development and recreation activities. Overall, disturbances such as development, infrastructure and human activities should be considered in future studies as they have an effect on the quality of the natural assets.

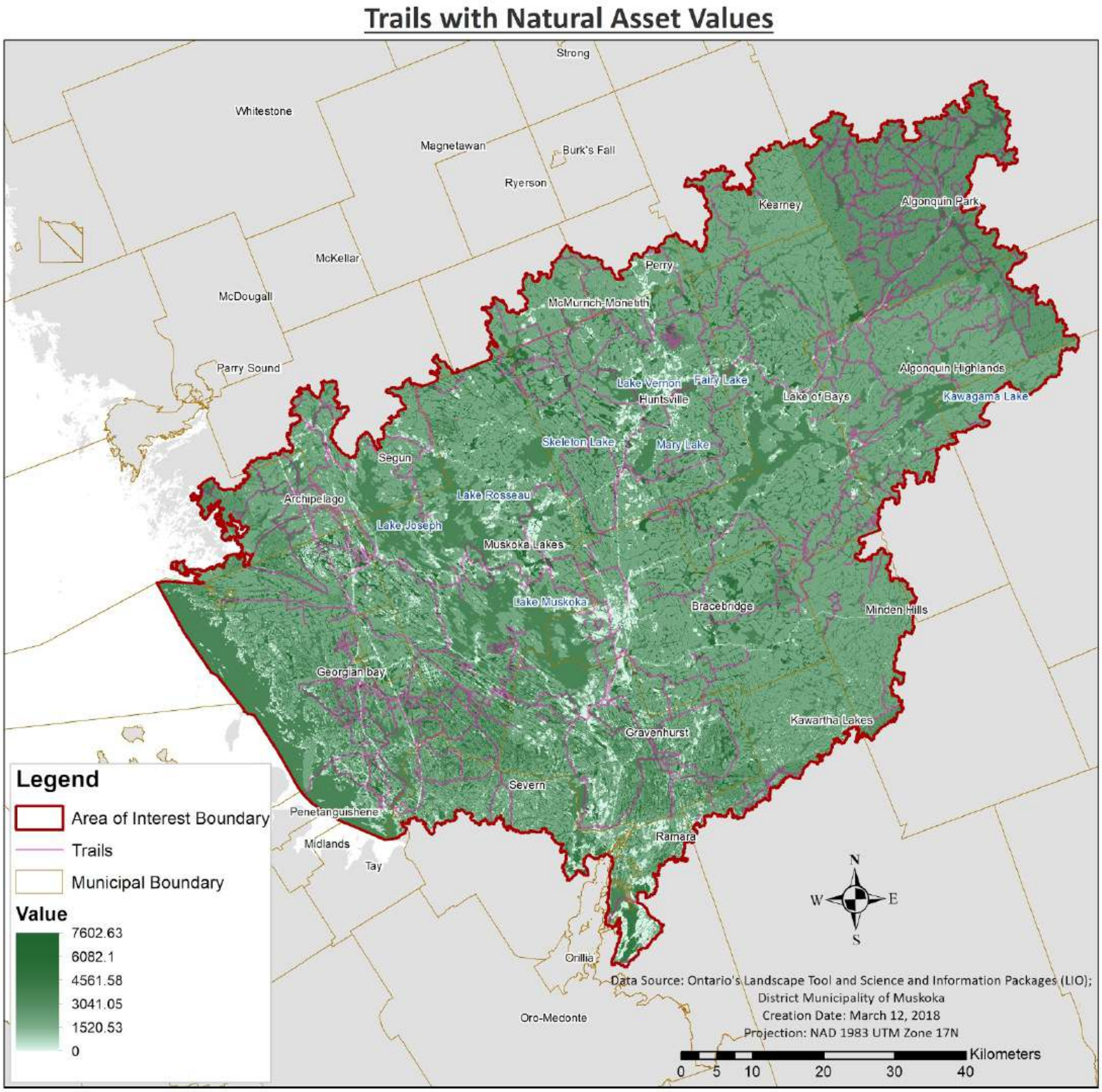


Figure 8: A map showing trail locations in relation to the value of natural assets.

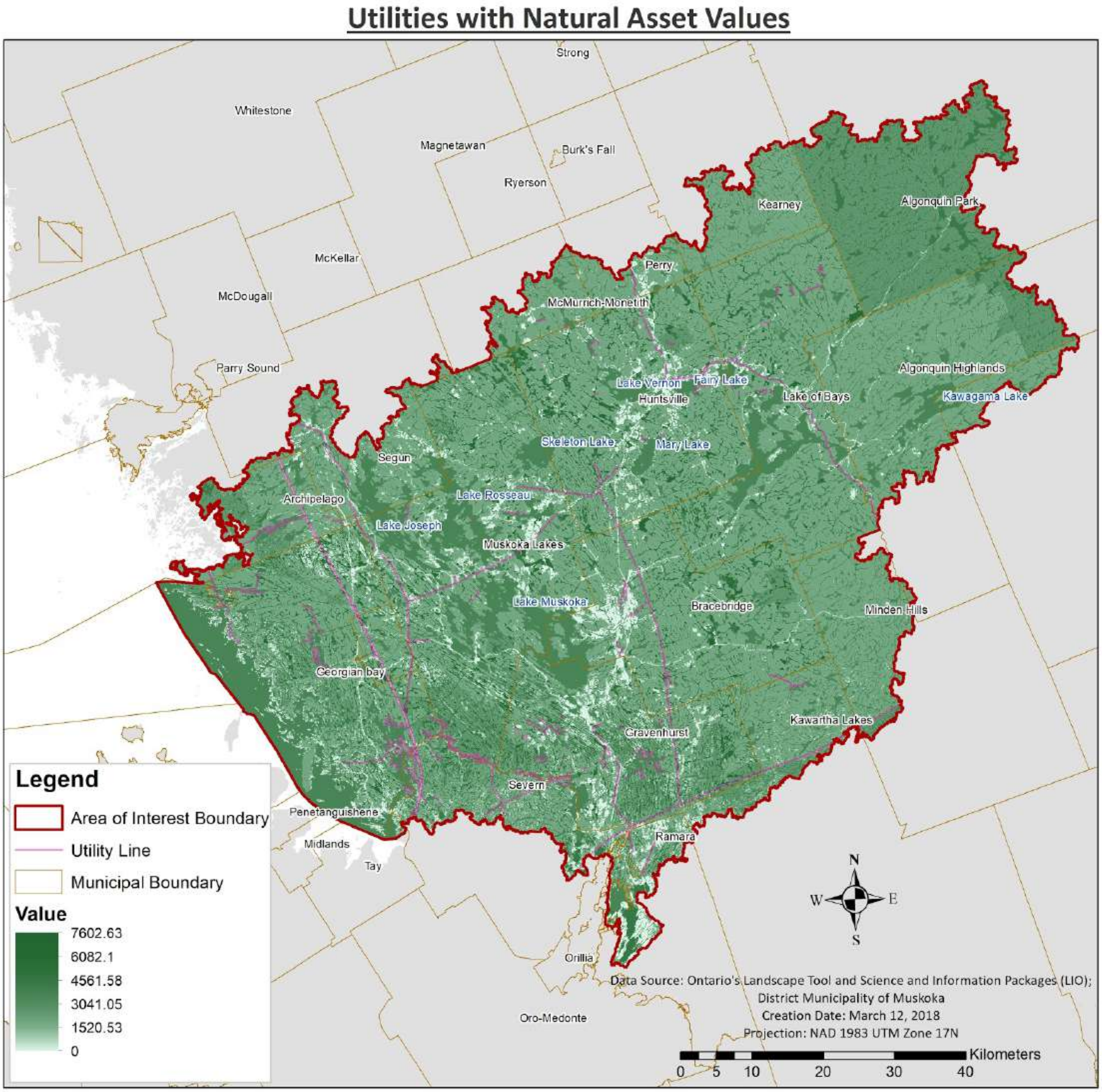


Figure 9: A map showing the location of utility lines in relation to the value of natural assets.

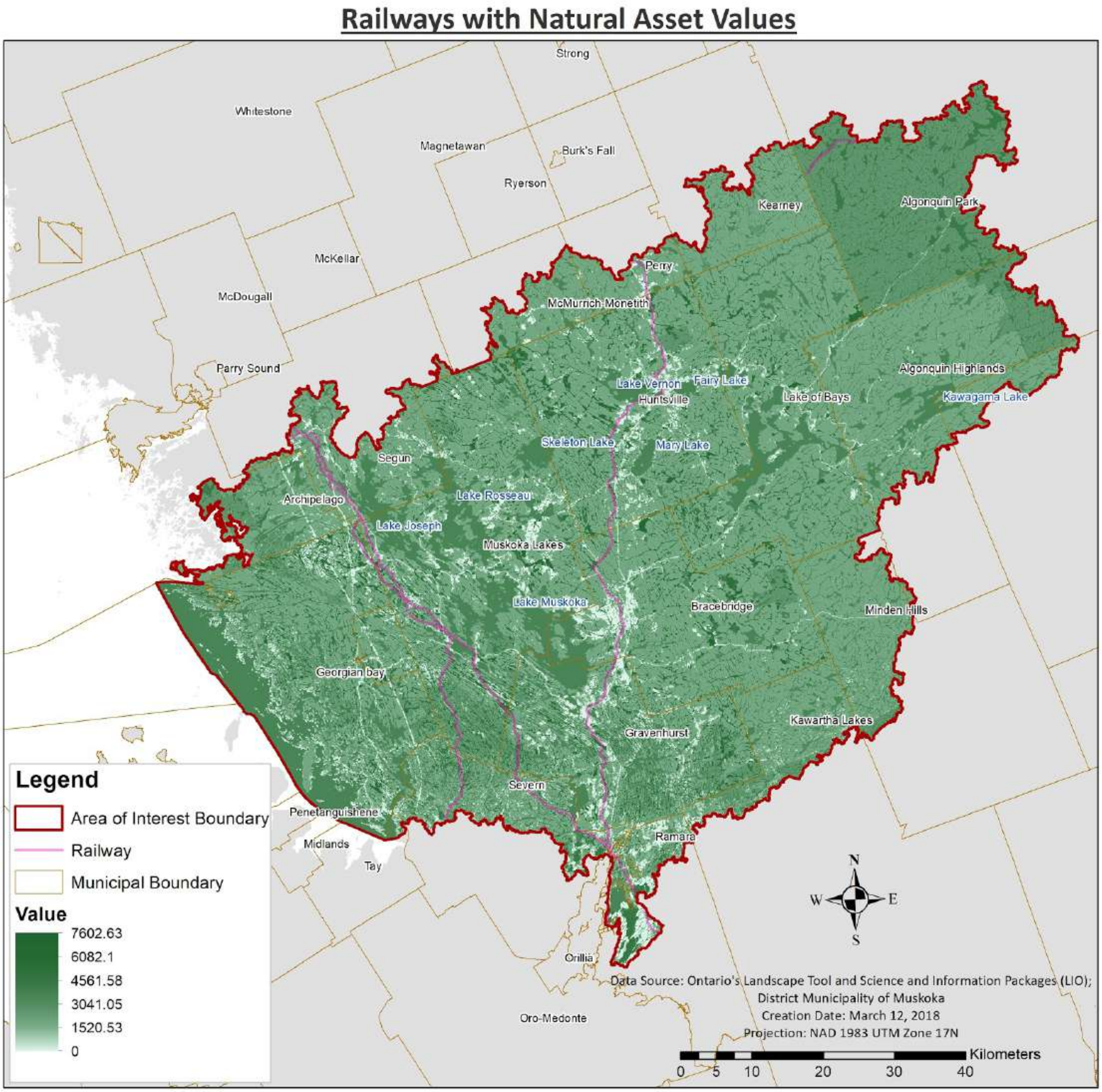


Figure 10: A map showing the location of railways in relation to the value of natural assets.

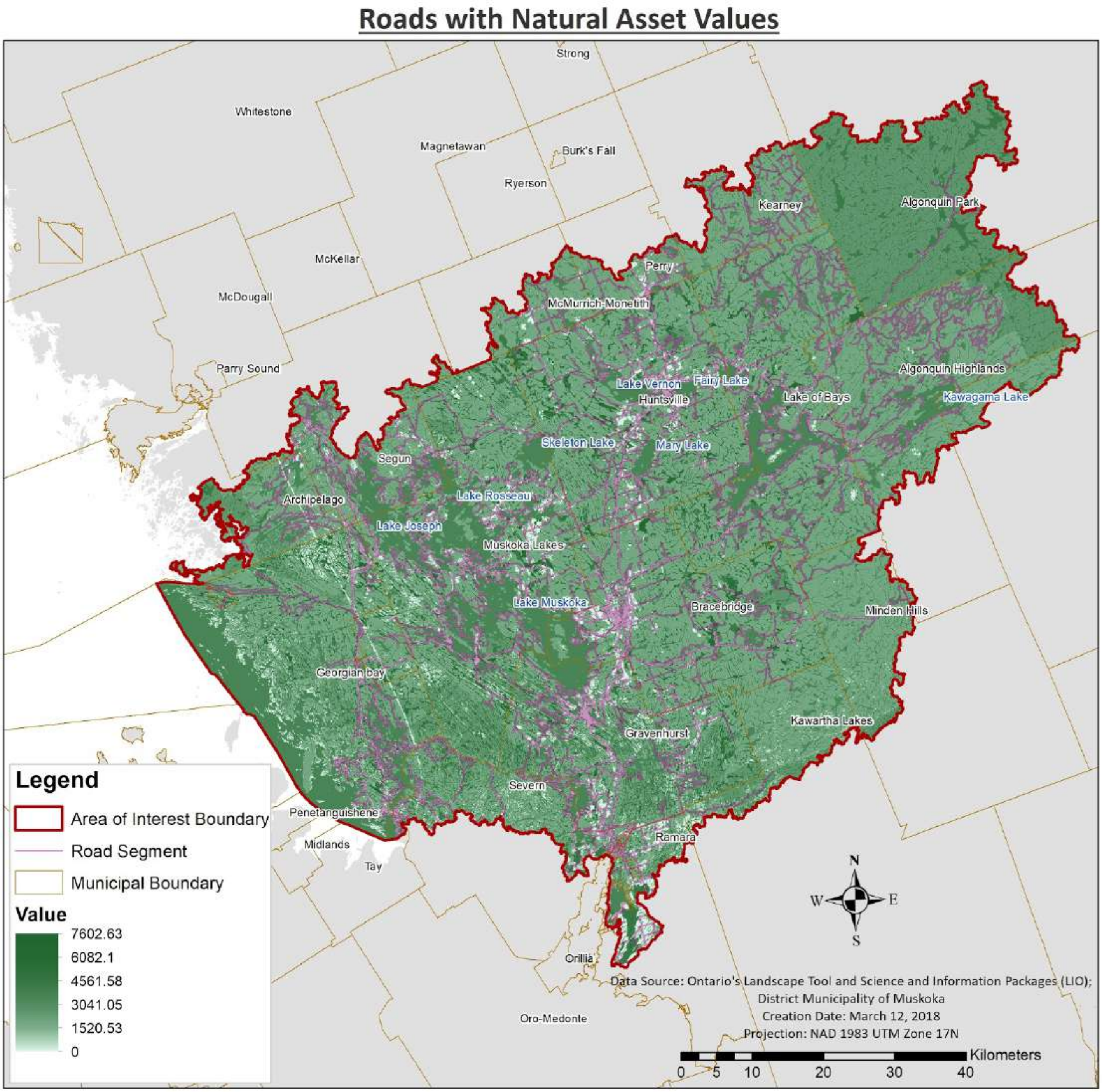


Figure 11: A map showing the road network in relation to the value of natural assets.

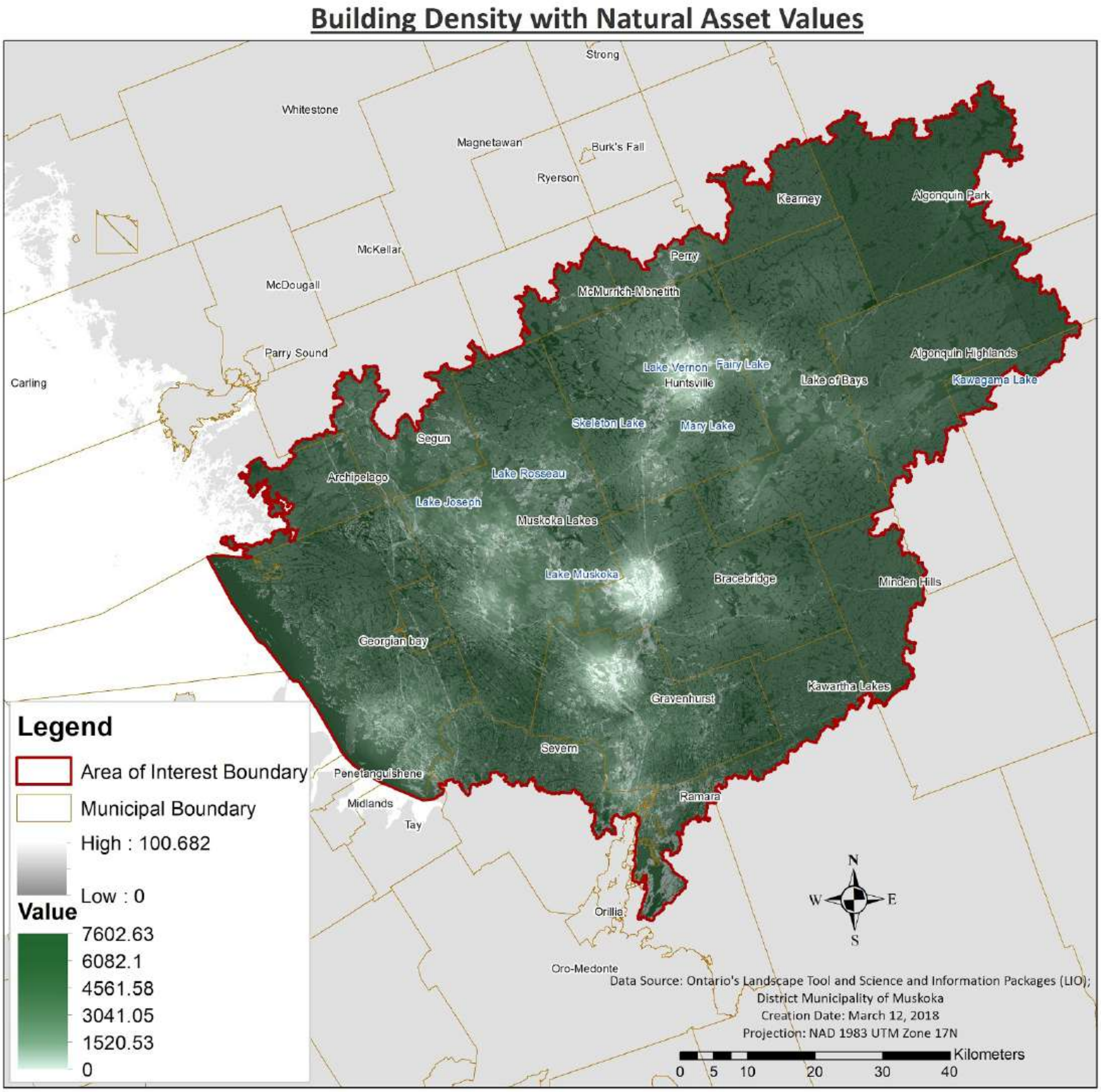


Figure 12: A map showing population hotspots represented by building density in relation to the value of natural assets.

Communites and Infrastructure with Natural Asset Values

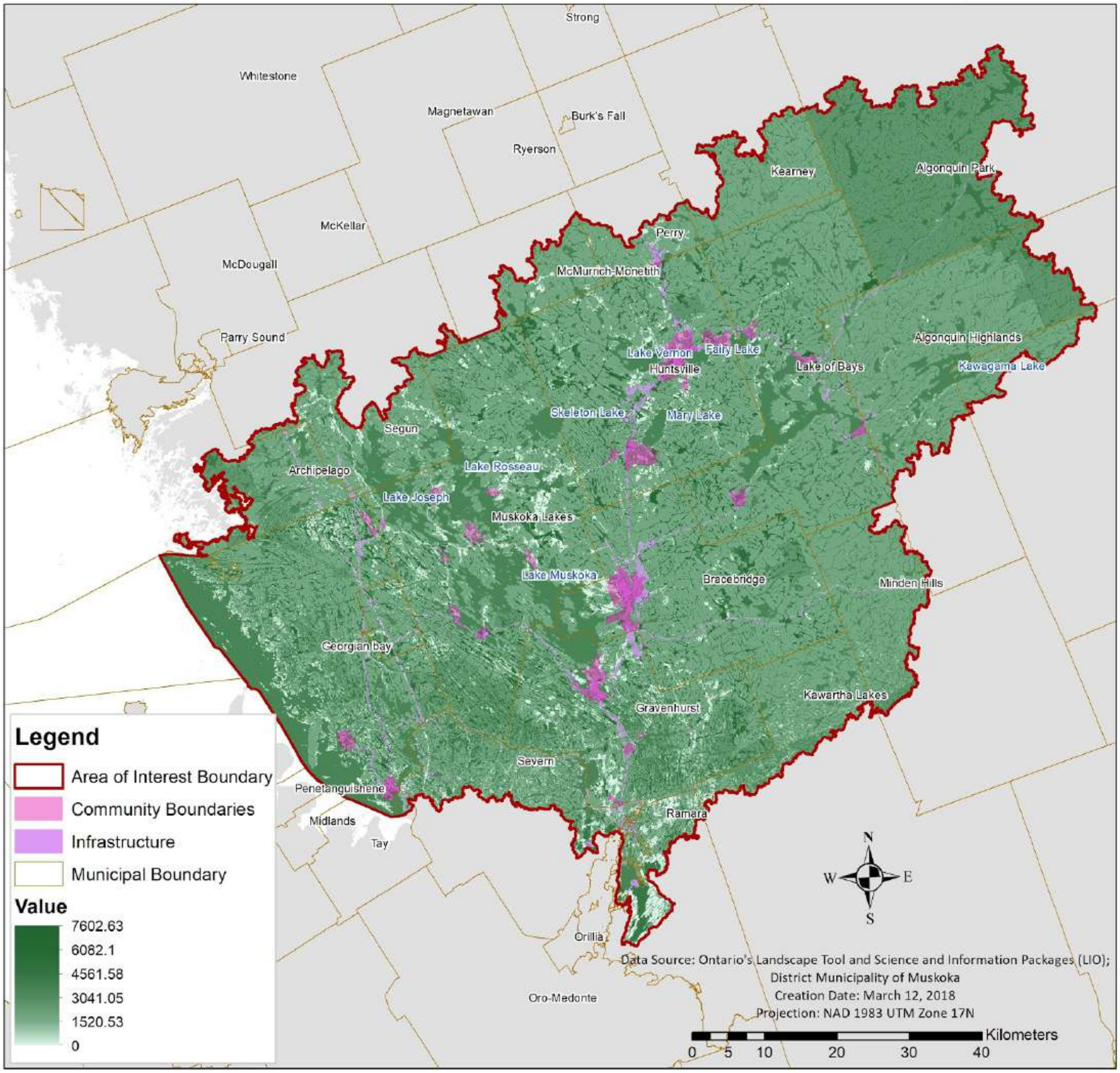


Figure 13: A map showing the location of communities and infrastructure in relation to the value of natural assets.

3.0 PHASE 3: POLICY RECOMMENDATIONS

Based on the findings and analysis from Phase 2, there were a number of key areas for improvement identified in the District of Muskoka's policy framework. These key areas for improvement were examined to formulate broad policy recommendations and include: the connection between tourism and water; development and disturbance restrictions; protection of endangered species and wildlife habitats; and protection of forest resources for source water protection. Finally, recommendations surrounding the District's Asset Management Plan were also examined. Policy recommendations surrounding these areas will be presented below.

3.1 TOURISM & RECREATION AND WATER RESOURCES

As part of the District of Muskoka's Draft Official Plan, Section D1.3 identifies the District's intention of creating and maintaining a strong tourism sector. The policies of this Plan are intended to recognize the importance of tourism to the economy by supporting the long-term viability and growth of existing and future tourism resources and destinations (District of Muskoka, 2017). Various objectives are identified that include promoting the maintenance, expansion and upgrade of existing tourist destinations. In addition, the District encourages the continued recognition of the link between the natural environment and tourism economy (District of Muskoka, 2017). Building off of this link with the natural environment, based on the findings in Phase 1 and 2, Viridi Consulting recommends there be more explicit links to water resources as they relate to tourism. The water resources that should be emphasized are: the protection and conservation of water-based tourism, and the enhancement and improvement of water-based recreation and leisure.

Throughout several case studies of other jurisdictions that have conducted natural asset valuation, the value of water (dollars per hectare) varies widely based on location; for example, the Town of Aurora valued water resources as relatively low ($514/ha). In contrast, jurisdictions such as Thousand Islands Archipelago & National Park and Lake Simcoe Basin valued water resources higher and of greater importance (i.e. $19,081/ha). Jurisdictions such as Thousand Islands and Lake Simcoe have landscapes and economic sectors that are reflective of the District of Muskoka; therefore, water resources should be valued at a higher scale when considering policy recommendations for the District. This valuation can be emphasized in the District's Official Plan policy s.F2.5 b) "Watershed and Subwatershed Planning", as mentioned in more detail in Appendix D. This policy does not provide additional reference to natural asset valuation, and coordinating watershed planning initiatives with other local municipalities.

The Ontario Ministry of Tourism, Culture and Sport (2017) issued a report detailing tourism profiles in the Province. The report recognized Muskoka's large tourist population and well-known outdoor activities as a dominant part of the District's economy; however, this information is not available in a spatial format (MTCS, 2017). There is considerable data regarding locations of waterbodies, watercourses, and wetlands provided by the District and Province, thus associating this information with the tourism data would lead to better policies and regulatory measures. These policies can be implemented to safeguard and enhance these two complementary resources: tourism and water. Areas such as the Township of Muskoka Lakes and Georgian Bay have land cover largely dominated by water, and therefore have a high value based on our assessment. As a result, Viridi Consulting feels the District would benefit from enhanced tourism and water policies.

The following section assesses other municipalities and townships in Ontario that reflect similar landscapes and community needs to the District of Muskoka. This assessment investigated other Official Plans and strategies with relation to the importance of tourism and water as complementary resources in promoting sustainable tourist environments.

Town of Lakeshore: Tourism Development Strategy
The Town of Lakeshore developed an inventory of tourism resources including: Business Name, Location/Address, and Business Category & Description (e.g. "Water Based Recreation Opportunities – fishing, swimming/beach; boating"). The Town of Lakeshore also designated "Water-Based Recreational Opportunities" as a "Core Attraction" (Town of Lakeshore, 2008).

City of Kawartha Lakes Official Plan
5. Urban Settlement Designation Policy Changes
5.11 Economic Development
The tourism industry will be expanded and promoted within the settlement and rural areas for recreation, eco-tourism, agritourism and other attractions. To ensure this, the City will:

e) Maintain, protect and enhance the tourism assets in the settlement areas, including the recreational areas along the lakes, rivers and the Trent-Severn Waterway, and downtown and main street areas. Develop an inventory of tourist attractions within the settlement areas and determine the areas of improvement (City of Kawartha Lakes, 2017).

Implementing an inventory and designation for core water-based attractions can aid in further developing a strategy that focuses on tourism-related activities in the District of Muskoka. Through the inventory, the District will be able to identify deficiencies, establish standards, and develop guidelines. The District should pursue opportunities to improve waterfronts by providing more amenities such as "docks, public washrooms and/or comfort stations as a way to keep boaters in town to take advantage of local business and entertainment" (City of Kawartha Lakes, 2017).

Prince Edward County Official Plan

- *1.4 Water and Related Resources Planning*
- *1.4.1 The inland lakes of Prince Edward County have impaired water quality, which affects their recreational and aesthetic attributes. These lakes will continue to be subject to further pressures for residential, recreational and commercial developments. Shoreland Management Plans may be undertaken for the inland lakes in the County to provide for more specific land use policies and designations related to future shoreland development; protection of environmentally sensitive areas and consideration of other tourism, recreational, agricultural; and other land uses within each lake shoreland.*
- *1.4.4 The Shoreland Management Plan will provide an inventory of fishery and wildlife habitat, vegetation, and shoreline uses, erosion and flooding areas, surface water quality and factors contributing to environmental degradation in the watershed. The Shoreland Management Plan shall provide policies and designations for each of these lakes to ensure environmental protection, public access, and appropriate land use types and density* (Prince Edward County, 2006).

Due to the demand for waterfront properties and the popularity of water-based recreation in the District of Muskoka, creating a Shoreland Management Plan or related Plan will ensure there are specific regulations for developing and implementing tourist activities on water bodies of high importance.

County of Hastings Official Plan

3.2.5 Significant Wetlands 'W'

- *[…] Evaluated wetlands that have been classified as provincially significant are designated "Environmental Protection" and identified by the symbol 'W' on the Land Use Schedules. The County shall promote the continued protection of all significant wetlands to maintain and improve water quality, assist in flood control, provide important fish and wildlife habitat and contribute to substantial social and economic benefits which include selected outdoor recreational and tourism related activities* (County of Hastings, 2002).

The District of Muskoka identifies Provincially significant wetlands as part of their Draft Official Plan, and designates them as Natural Heritage Features (District of Muskoka, 2017). Development and site alteration are not permitted in Provincially significant wetlands and significant coastal wetlands; however, there is little mention of its implications to recreation. Policies should outline whether or not social and economic functions are permitted on specific wetlands, with regards to outdoor recreation and tourism related activities such as fishing.

The District shall require local municipalities to identify and zone all Provincially significant wetlands as areas for environmental protection or natural features, encouraging the recognition of recreational benefits.

Township of Rideau Lakes Official Plan

Vision

6. *The most significant natural feature of the Township is its water bodies. These are a resource of paramount value for recreational and tourism purposes and must be protected from environmental degradation through means such as the establishment of policies related to sewage disposal, surface and groundwater protection, water-oriented recreation and tourism and residential development. As a mature recreational and tourist area, considerable effort must be placed on policies to ensure that changes to existing developments are undertaken in an environmentally-sensitive and sustainable manner* (Township of Rideau Lakes, 2010).

2.23 Surface Water Quality and Quantity

2.23.1 Development Adjacent to Water Bodies

2. *[…] Various sections of this Plan incorporate policies implementing recommendations of this research in recognition of the importance of providing sustainable recreation, tourism and other water-oriented opportunities. Policies to address lake capacity, water setback and water frontage issues are detailed in the Waterfront Development Policies section of this Plan* (Township of Rideau Lakes, 2010).

Town of The Blue Mountains Official Plan

It is the Town's policy to assign high priority to the enhancement of recreational and tourism related activities. The Town will: (a) Encourage the maintenance and expansion of existing recreation and tourism related facilities. (b) Encourage new land uses that will promote existing or require the establishment of new recreation and tourism facilities which diversify opportunities for all possible forms of recreation such as skiing, snowmobiling, fishing, hunting, golfing, walking, hiking, biking, equestrian and nature trail uses, water access activities, all in a manner consistent with the preservation of the natural environment (Town of the Blue Mountains, 2007).

The District of Muskoka outlines key objectives, permitted uses, and policies within lands designated Waterfront Area (District of Muskoka, 2017). A main component the District should consider when updating Official Plan policies is further emphasizing the importance of water-oriented recreation and tourism in these areas, recognizing that they are of paramount value and must be protected from environmental degradation. Policy improvements can include addressing lake capacity, water setbacks, and water frontage issues. In doing so, the District of Muskoka should assign high priority to the enhancement of tourism-related activities, promoting new and existing uses that are consistent with the preservation of the natural environment.

In addition, a component that is not quite touched upon in the literature and policy research, but should still be considered for future policy direction in the District, is the distinction and contrast between tourism and water resources. Both water and tourism are valuable assets to the District in their own respect and as complementary goods. Through the interventions mentioned in Phase 2 and 3, tourism and water-based recreation are of high importance; however, the protection of water resources such as drinking water is also of high value and concern. Future policy recommendations for the District should address the trade-offs between prioritizing one resource over the other, as benefitting one could present negative impacts on the other. For example, promoting recreational use along a shoreline could introduce disturbances to natural processes in the area.

3.2 DEVELOPMENT AND DISTURBANCE RESTRICTIONS

Based on the findings from the Phase 1 case study review, and the results from the Phase 2 GIS analysis, recommendations can be made regarding disturbance and development restrictions within the District of Muskoka in order to protect valuable natural assets. While the District already manages the environmental impacts of development through its application review process, special consideration should be given to development and site alteration applications that are located on important natural assets. This way, new development will prioritize the protection and enhancement of the landscape's natural assets which provide important ecological services. Furthermore, the re-creation of natural features (i.e. building a stormwater management pond instead of keeping the natural wetland) should only take place in areas that have already been developed on. This way, the protection of natural capital is always the priority instead of developing on an important natural feature (such as a wetland), and then re-creating the service it originally provided (such as a stormwater management pond).

Another disturbance/development restriction recommendation is that land-use planning decisions should be based on a cost-benefit analysis. This can be achieved through utilizing the findings from Phase 2 to determine what the value of the natural assets are in the location where the proposed development will occur. Therefore, there will be an understanding of the cost of having the natural asset removed, as well as the price to replicate the ecological services that would be lost. For example, the Phase 2 analysis estimated the value of a forest to be $5,095 per hectare. If a development application proposed a 1 hectare development within a forest ecosystem, the District would lose out on $5,095 worth of ecological services annually plus the additional money it would take to replicate those lost services. Therefore, that particular development application may be rejected since the cost would be greater than the benefit.

> ***Town of Aurora Official Plan***
> *5.0 Building a Greener Community*
> *This Section establishes policies that promote green building technologies, renewable and alternative energy options, waste management efforts and other sustainable design options for*

development with the aim of supporting the Town's objectives for a healthy, vibrant and sustainable community (Town of Aurora, 2010).

In 2009, the Town of Aurora implemented green development and low impact development (LID) policies to their Official Plan, approved in 2012. These policies, which are applied to all new developments, promote the use of more naturalized and energy-efficient developments which mimic the natural environment in reducing the impact of stormwater runoff, improve energy efficiency, and improve water infiltration. These policies are contained in Aurora's Official Plan under Section 5.0 *Building a Greener Community* and 5.2 *Green Building and Design Policies*. Specific policies pertaining to green development and design standards are specified in Section 5.2 F, and list requirements such as design standards for permeable driveways and parking surfaces, landscape design standards to promote water efficiency, and the implementation of green roof surfaces. The District of Muskoka could implement similar policies for development applications in order to reduce stormwater management facility costs; since forests, water bodies, and wetlands provide water quality and filtration services. It is recommended that these policies are applied to all development applications and site alteration plans in order to restrict developments that could negatively impact the environment.

Based on the results from Phase 2, the District and lower-tier municipalities should also consider integrating the value of natural assets into their economic strategies. This would communicate the economic importance of development, which is the protection of natural assets. As shown in the Phase 2 Building Density with Natural Asset Values map (Figure 12), the areas with the highest building density remain close to areas that have a high natural asset value. Therefore, it is important that development within, or close to, the existing built-up areas does not impact the economic services the natural assets provide.

3.3 ENDANGERED SPECIES AND WILDLIFE PROTECTION

Sections F1.2.2, F1.2.3, and F1.2.4 of the District of Muskoka's Draft Official Plan focus on the preservation of endangered species and natural habitats within the District (District of Muskoka, 2017). In most cases, when development is proposed, proponents must first consult Provincial guidelines to identify areas of significant wildlife habitat. Furthermore, the Muskoka Watershed Council undertakes public outreach and educational projects surrounding endangered species and wildlife habitats, particularly in relation to the decline in bat species (Muskoka Watershed Council, 2017).

Pollinators

Approximately one-third of all plant species rely on cross pollination, making it a critical component in the sustainability of the natural environment and global economy (Schwarzmann, 2013). The District of Muskoka should incorporate policies to better protect pollinators and encourage programs that educate the public of their importance and best management practices, to mitigate long-term degradation.

The City of Guelph has undergone an initiative that seeks to establish its *Pollination Park*, the first of its kind in Canada, which seeks to provide habitat protection for pollination species such as bees and hummingbirds. The City also makes reference to the protection of pollinators in its Official Plan:

City of Guelph Official Plan
6A.2.10 - Restoration Areas

a) To identify opportunities for restoration throughout the City, including opportunities to increase and/or sustain open meadow landscapes from pollinators, birds and other wildlife to ensure diversity within the Natural Heritage System.

6A.6.4 - Pollinator Habitat
1) the City recognizes the role that pollinator habitat plays in supporting ecosystem functions
2) Opportunities to protect, maintain and enhance pollinator habitat within City parks, Restoration Areas and Ecological Linkages, lands adjacent to stormwater management facilities and open space areas will be encouraged.

Pollinator Habitat means natural areas within the landscape that contain indigenous plants, shrubs, and trees that provide pollen, nectar, and other floral resources for pollinator insects and other animal pollinators. In addition, these areas may provide appropriate nesting sites, such as exposed soil, rotting logs, cavity trees, hollow-stemmed plants, and host plants specific to local pollinators (City of Guelph, 2014).

However, the District's policies would differ due to the difference in species and habitats. For instance, Muskoka has a relatively prominent bat population. Bats are extremely beneficial when it comes to controlling insect populations (i.e. mosquitoes), pollinating plant species, and distributing seeds (Hind, 2017). It is common for bats to roost in human inhabited areas such as barns, sheds, garages, attics, etc. Often perceived as pests, property owners may resort to illegal means of evicting them, such as fumigation or poison control (Hind, 2017). Policies or programs may be established that help educate the public of the importance of bat populations, and appropriate methods of evicting them safely if necessary.

Furthermore, a major factor affecting bat habitat loss is encroachment from human development. Bats tend to roost in areas where insect populations are abundant such as marshes, wetlands, and streams (Hind, 2017). To help raise awareness of the declining bat species resulting in half of Muskoka's bat species to be added to the Endangered Species list, the Muskoka Watershed Council has undertaken public outreach and educational projects through the establishment of the Muskoka Bat Collective in 2015. This collective involves educational programming of local students in cooperation with citizens, businesses, and the Ontario Ministry of Natural Resources and Forestry (MNRF) to help raise necessary awareness (Muskoka Watershed Council, 2017). However, stronger consideration and control measures may be necessary for development in areas containing bat habitats.

Another important pollinator in the District of Muskoka are bee populations. Across Ontario, managed honey bees and bumblebees were responsible for approximately $897 million of the $6.7 billion in sales of agricultural crops in 2017 (OMAFRA, 2017). Today, a major threat to bee populations are pesticides used on crops and flora, and although the District has small amounts of agricultural cropland, pesticides used on private properties may endanger them. According to a report published early in 2014, more than half of the apparently "bee-friendly" plants sold by major retailers such as Home Depot, Lowe's, and Walmart contained high traces of pesticides (Cilliers, 2014).

3.4 SOURCE WATER AND FOREST RESOURCES

As per Section F2.3 of the District's Draft Official Plan regarding Source Protection Plans, land uses and activities permitted by the underlying land use designations in designated vulnerable areas in the South Georgian Bay Lake Simcoe and Trent Source Protection Plans is prohibited, with further protection under Section F2.3.3 within Wellhead Protection Areas and Surface Water Intake Protection Zones. Overall, water quality and quantity is heavily protected in those areas that fall under the authority of the existing Source Protection Plans (District of Muskoka, 2017). To ensure protection of source water within the Muskoka River Watershed, a Source Protection Authority could be created and implemented. However, it is recognized that this is a long-term initiative that requires additional authority and processes to implement; and the majority of the District is not subject to the *Source Water Protection Act*, and therefore not bound by the requirement to complete Source Water Protection Plan (please refer to Appendix E for supplementary findings for more information on this). Therefore, to enhance protection of water resources for drinking water purposes, additional protection of the District's forest cover could be implemented.

In this regard, Section G1.2.1 in the District's Draft Official Plan describes forest cover as contributing to water retention and stormwater management, erosion control, climate change mitigation and resiliency, fibre production, wood products, wildlife habitats, and recreation; however, the plan primarily focuses on encouraging sustainable forestry practices and protecting large areas of forest cover from rural development/lot creation for the forestry industry (District of Muskoka, 2017). Through the plan's policies, reforestation, proper forest management practices by private landowners, and appropriate maintenance of tree and shrub cover to continuously provide the above benefits is encouraged; and municipalities are encouraged to implement tree preservation and/or site alteration by-laws to protect forested areas (District of Muskoka, 2017). In relation to Phase 2 findings, high priority areas containing large areas of significant forest cover are located in the north-eastern portion of the District of Muskoka, namely Huntsville, Lake of Bays, and Bracebridge, as illustrated in the Forest map attached in Appendix F.

Other jurisdictions

In the case studies of natural asset valuation in Thousand Islands, Town of Aurora, and Lake Simcoe, forests were one of the largest contributors to natural asset economic value (with forests and wetlands most often providing the highest values). The significance and economic contribution of forest cover is further illustrated in the District of Muskoka with forests being the most dominant land cover component (and ranked highest overall in the natural asset valuation) within the area of interest. As identified in the above case studies, forest cover provides essential ecosystem services in the form of water regulation, air quality regulation, carbon storage, water filtration, erosion prevention, soil fertility, pollination, biological control, cultural services, habitat services, food provisions, water supply, climate regulation, flood control, pest control, biological and genetic diversity, amenity/tourism/recreation, cultural/heritage conservation, and habitat provision (Wilson, 2008a). Of particular interest to Muskoka, forested watersheds provide higher quality water for clean and safe drinking water supply through natural filtration and pollutant removal, and essential erosion/flood control; as well as provide an environment attractive and conducive to tourism and recreation. The following outlines potential forest preservation policies from other jurisdictions.

Town of Aurora Official Plan

12.6.3 Forest Management Policies

Recognizes Forest Areas as providing essential ecosystem services highlighting the need to maintain, protect, and/or restore significant forest areas. In addition, Council shall develop and implement a woodland strategy in cooperation with the Ministry of Natural Resources to identify goals and objectives for managing forest areas, as well as inventory these resources; followed by methods of protection and an implementation strategy (Town of Aurora, 2010).

Developing and implementing a woodland strategy, as well as a subsequent implementation strategy, would be beneficial in the context of Muskoka as it would further protect essential forest resources where applicable. Through the development of this strategy, key areas of interest would be refined so that development and/or forestry practices could be limited in significant areas (i.e. near water bodies, wellhead areas, groundwater recharge areas, etc.). As an alternative, it is recommended that existing policies within the Draft Official Plan pertaining to maintenance and protection of forest areas be enhanced to increase forest protection through incorporation of similar forest management policies as provided above.

Additionally, the Town of Aurora encourages and educates private landowners about federal/provincial tax incentive programs (i.e. Managed Forest Tax Incentive Program in Ontario) in exchange for protection and sustainable management activities on lands containing a minimum of four hectares of forest (Kyle, 2013). This program addition could also be encouraged in the District to increase sustainable forest management practices and enhance forest management policies.

Township of Leeds and the Thousand Islands Official Plan
4.26 Tree Protection
Property owners are encouraged to enter into agreements under the Woodlands Improvement Act to establish managed forests. In evaluating development applications that may impact forest resources, Council will consider the maintenance of natural vegetation between development and waterbodies by removing minimal vegetation. In this regard, Council will consider passing a Forest Conservation By-law and Tree-cutting By-law under the Municipal Act in waterfront areas. Protection of significant woodlands is also a priority in the Township through identification, protection, and partnerships between landowners and municipalities to ensure adequate protection of large quantities of forested lands (Township of Leeds and the Thousand Islands, 2006).

The District could further emphasize the priority of forest protection through its Draft Official Plan policies. Utilizing the findings from Phase 2 of this study, key forested areas, namely those areas adjacent to water bodies, could be further protected through incorporation of tree protection policies similar to the one provided above to increase partnerships with landowners. Furthermore, the implementation of a Forest Conservation By-law, or similar counterpart, in all municipalities of Muskoka should be kept up-to-date to reflect the key areas for forest protection.

Lake Simcoe Official Plan
Section 3.11.7, 312.18, 3.12.20, 3.13.6
Vegetation protection zones are established around wetlands, seepage areas and springs, fish habitat, permanent and intermittent streams, and lakes whereby development and site alteration is prohibited, with the exception of forest, fish and wildlife management; conservation and flood erosion; recreation, shoreline, and existing uses if determined to not have a negative impact on the natural resources (County of Simcoe, 2013).

The District of Muskoka outlines shoreline buffers for development to limit negative impacts on its water bodies. To further these existing policies, the District could provide more specific direction towards protecting key forested areas by establishing applicable setbacks in the District Official Plan around large tracts of essential forested areas for further protection (where applicable). Through this policy improvement, a higher priority could be given to maintenance and enhancement of forested areas for water filtration, erosion and flood control; as well as tourism and recreation activities related to forested areas.

> ***County of Haliburton Official Plan***
> *3.3.11 and 6.3.4*
> Any clearing of forested areas must be in conformity with the County Forest Management By-law and County Shoreline Tree Preservation By-law. In addition, forestry operators will develop an inventory of forest resources with County and local governments to ensure sustainable management of forests; whereby County Council may establish sustainable forestry advisory bodies where necessary (County of Haliburton, 2017).

The Draft District Official Plan already outlines the importance of sustainable forestry practices; however, these policies could be further enhanced by developing an inventory of forest resources and areas. This could improve the findings of Phase 2 of this study with more accurate representation of forest areas to support forest protection in the District Official Plan policies.

It is recognized that forestry is an important resource for the District, and therefore policies surrounding forest protection will need to balance the forestry industry with protection; however, it would be beneficial for the District to establish a stronger focus on preservation of forest cover for the purpose of water filtration, erosion/flood control, and tourism/recreation in areas that are determined to be essential for these purposes through the above policy recommendations. This will help ensure the protection of clean drinking water sources in the future.

3.5 NATURAL ASSETS AND THE DISTRICT'S MANAGEMENT PLAN

As highlighted in the policy framework gaps in Phase 1 of this study, as well as the evidence of the need to protect Muskoka's key natural assets identified in Phase 2, the District's *Asset Management Plan for Roads, Bridges, Water and Wastewater Assets* could incorporate key natural assets to better recognize their importance, and protect the ecosystem services they provide long-term. In this regard, the District could utilize the case study of the Town of Gibsons in British Columbia in applying the Municipal Natural Asset Initiative (MNAI) steps and recommendations to incorporate natural assets into the District's asset management plan, financial plan, and possible eco-asset strategy in the future. Municipal Natural Assets are defined in the MNAI as: "the stocks of natural resources or ecosystems that contribute to the provision of one or more services required for the health, well-being, and long-term sustainability of a community and its residents" (Making Nature Count, 2017). Therefore, natural assets managed or owned by a municipality that provide similar municipal services as engineered infrastructure can be considered in the asset management framework and subsequent plans. However, it is important to keep in mind that shared natural asset management is more effective in protecting key natural assets that cross jurisdictional boundaries. Furthermore, the MNAI highlights the Municipal Natural Asset Management (MNAM) framework that involves systematically managing infrastructure assets to both account for, and protect, the numerous benefits natural assets provide primarily in the form of economic cost savings in naturally operating similarly to capital assets (Town of Gibsons, 2015; Town of Gibsons, 2018; Making Natural Count, 2017).

In relation to the incorporation of natural assets into the District's asset management frameworks, Muskoka could pass a municipal asset management policy to define and recognize natural assets as its own asset class, as well as outline specific obligations to maintain, operate, and replace a defined asset class similar to traditional capital assets with natural asset management strategies and financial planning strategies and statements. The District could also create and endorse an eco-asset strategy similar to the Town of Gibsons to outline municipal natural assets at the core of the municipal infrastructure system; and ultimately implement key natural assets into the Districts *Asset Management Plan for Roads, Bridges, Water and Wastewater Assets* and related financial plans (i.e. based on annual cost for asset replacement). Following the completion of some or all of these steps, the District's Draft Official Plan policy B16 - Asset Management could be revised to provide direction and incentive for the District to incorporate natural assets into the asset management plan, framework, and strategies. Overall, the Town of Gibson provides a solid framework of documents to help support implementation of the above recommendations.

Dee Bank River (Millson, 2013)

APPENDIX A: ACADEMIC LITERATURE REVIEW – TOURISM & RECREATION

INTRODUCTION

In 2011, National Geographic recognized Muskoka Cottage Country as the number one destination for summer travel as part of their "10 Best Summer Trips of 2011" (National Geographic, 2011). It is no surprise that the District of Muskoka is receiving international praise due to its unique natural features reflective of Northern Ontario, as well as its close proximity to urban Southern Ontario. Outdoor recreation and tourism is the prime economic driver for Muskoka's success, accounting for 57% of its workforce (Malon Given Parsons Ltd., 2008), so it is imperative that measures be in place that support these resources.

This literature review will discuss the methods in which natural assets can be valued in the context of tourism and recreation. Topics examined include total economic value, analytic hierarchy process, and classification frameworks for resource fragility. This literature review is intended to give a broad overview of the methods currently studied in the field, identifying strengths, limitations, and opportunities for further research.

METHODS FOR VALUING NATURAL ASSETS

Total Economic Value

There are several components that contribute to the valuation of natural resources. The difficulties in valuing natural resources for tourism and recreation, specifically, are even broader due to the tangible and intangible aspects associated with these resources. While admission into a national park, for example, can be valued based on its popularity and monetary gain, the overall value of environmental conservation associated with this form of recreation is more difficult to assess. Tisdell (2003) introduces the concept of Total Economic Value (TEV) to address this discrepancy in valuing natural assets, taking into consideration both the use and non-use values of natural resources in tourism and recreation. This concept is reflective in other research, including Carlsen's (1997) analysis of economic valuations of natural areas to influence land-use planning and tourism decisions.

Carlsen's article identifies the multiple economic benefits of natural areas with regards to both market and non-market valuation through environmental auditing. Carlsen identifies the broad implications of tourism on public lands, accounting for the commercial products associated with the natural area, as well as analyzing the state of the regional economy. Carlsen suggests identifying the areas that incur direct financial gain, compared to those that incur non-monetized gain such as tourists' knowledge of ecological preservation (Carlsen, 1997).

Tisdell (2003), on the other hand, takes a more refined approach to TEV, considering its implications on tourism, with regards to how it can support the management and protection of tourism natural resources. Tisdell examines the traditional techniques of travel costs, hedonic pricing, and contingent valuation; and a more recent technique: choice modeling. The approach of travel costs and hedonic pricing are more objective in nature as they relate to revealed preference models, whereas contingent valuation and choice modeling involve more subjective analyses in a stated preference model (Tisdell, 2003). Given that each method can be perceived as objective or subjective, it is wrong to assume that any method is more appropriate than the other; rather that they each excel in measuring different elements. Each method comes with its strengths and weaknesses; however, the article presented by Krantzberg & de Boer (2006) discusses these differences in a more simplified approach.

Krantzberg & de Boer (2006) discuss the valuation of ecological services in the context of the Great Lakes Basin ecosystem, with the ultimate goal of sustaining healthy communities and creating a dynamic economy. According to Krantzberg and de Boer, the Great Lakes are an essential aspect of the North American environment, both for the livelihood and recreation of millions of Canadian and U.S. residents, but also for the diverse and unique ecosystems contained within it. Their article suggests four methods for valuing natural resources to identify the TEV of the Great Lakes. These include direct observation, direct hypothetical (contingent valuation), indirect observable, and indirect hypothetical. The valuation of tourism natural resources can be defined under one or all of the methods presented (Krantzberg & de Boer, 2006).

Direct observation methods, similar to Tisdell's (2003) revealed preference models, provides a clear financial value to the resources of tourism; resources that have a direct impact on the market. Examples of this financial gain can relate to the profitability of fish collected in the Great Lakes (Krantzberg & de Boer, 2006). Direct hypothetical methods, on the other hand, are more reflective of the concepts presented that pertain to non-use values, such as contingent valuation models (Tisdell, 2003). This concept considers an individual's willingness to protect a particular environmental service given responses to surveys (Krantzberg & de Boer, 2006). As in the case of Gurira & Ngulube (2016), this approach was utilized in their evaluation of sustainable culture heritage tourism in the Great Zimbabwe World Heritage Site, Zimbabwe. It was found to be inadequate and unresponsive due to the biases associated with the method. These biases may include strategic bias in the questions asked towards tourists, as well as the answers that respondents provide if they know it has an effect on policy decisions (Tisdell, 2003). Other forms of bias identified with contingent valuation include information bias, starting point bias, and hypothetical bias (Krantzberg & de Boer, 2006). As a result, this method should be used with caution.

As opposed to direct observation methods that pertain to resources that have a correlated market value, indirect observable methods are the opposite; while there is no direct financial figure associated with the resources, there are external costs acquired. Examples of indirect observable methods include travel costs and hedonic values, as mentioned in Tisdell's (2003) article (Krantzberg & de Boer, 2006). A travel cost suggests that an individual is forging some amount of time and money to use an environmental service, such as a free fishing area. This measures their willingness to pay for a service, say for instance the individual travelled a large distance to participate in the recreational activity (Krantzberg & de Boer, 2006). Tisdell (2003) suggests that this is difficult to measure; however, it is possible that the time taken to get to the destination is enjoyable and there is not a perceived financial burden. Travel cost methods require elaborate behavioral data, as opposed to verbal responses, so the scope of collecting this data can pose constraints (Krantzberg & de Boer, 2006).

Tapsuwan, MacDonald, King & Poudyal (2012) investigate the hedonic aspect of indirect observable methods. Their study examines the property value of rural land with natural resources and recreation as a factor. Natural amenities are forest areas, bodies of water, and fields of soil. Amenity rich lands can offer scenic views, wildlife, and recreational activities, and are usually priced higher than agricultural land. The article discusses the hedonic model by determining the value of residential properties in Murray-Darling Basin, Australia. It is an equation which considers a multitude of factors including the neighbourhood and residential characteristics. This method was modified for this study to also include environmental attributes, such as recreational facilities and natural land, to better reflect the benefits of being in a rural area. The conclusion of this study is that property value is associated with the quality of natural amenities nearby, where national parks have more influence over the value than forests. The authors found that people are more willing to pay for homes near recreational activities than to be closer to the nearest metropolitan area. Furthermore, man-made features inside of natural areas are a factor; however, the biggest contributor to property value is river recreation areas, where people are willing to pay more for areas near bodies of water (Tapsuwan et al., 2012). This is especially characteristic of the high demand for waterfront properties in the District of Muskoka.

Lastly, Krantzberg & de Boer (2006) examine indirect hypothetical methods, very similar to Tisdell's (2003) choice modeling method. Boxall, Admowicz, Swait, Williams & Louviere (1996) examine this concept in more depth, comparing it to the contingent valuation method regarding natural resources in tourism. Both of the concepts are based on the individual's willingness to protect an environmental service; however, choice modeling allows respondents to make repetitive choices on a preferred recreation resource in comparison with another resource. Boxall et al. (1996) use the example of recreational moose hunting to decipher between the two models. The resources that are selected more often, for example moose hunting versus fresh water fishing, would have a higher perceived value.

While the above literature pertains mostly to national parks, it is applicable to the District of Muskoka because of the comparisons between use and non-use values. Muskoka is an environment that is unique with its natural areas in close proximity to development. As in the case of Tapsuwan et al. (2012), hedonic models are used to determine the economic value of a property that is adjacent to water, a natural amenity. Similarly, Krantzberg & de Boer (2006) discuss the TEV model with regards to the Great Lakes. The measures used can be replicated to relate to Muskoka's many lakes and waterbodies.

On the other hand, other approaches identified in academic literature for valuing natural assets in tourism and recreation include the Analytic Hierarchy Process (AHP), as well as classification frameworks involving the sensitivity of such resources, as outlined below.

Analytic Hierarchy Process

Deng, King, & Bauer (2002) outline the methods for evaluating and rating natural destinations to benefit the tourist experience in Australia's national and provincial parks. When an evaluation system is in place, tourists can more easily decide which destinations to visit, and do so in a responsible way, because they understand the economic and environmental value of these areas. The authors note the importance of identifying areas of "conflict, coexistence, and symbiosis" with regards to how tourism interacts with the natural environment (Deng et at., 2002). Similarly, they discuss the discrepancies in defining what ecotourism or nature-based tourism entails when considering the tourist's direct or indirect involvement with the resource (Deng et at., 2002).

The main method utilized by Deng et al. (2002) for evaluating natural attractions for tourism is an Analytic Hierarchy Process (AHP). AHP gives a weighting and subsequent point to a park based on its overall "attractiveness". This attractiveness is contingent on five key elements: resources, accessibility, facilities, local community, and peripheral attractions. Similar to Tisdell (2003), Carlsen (1997), and others, the concept of AHP considers the monetary value of tourism, such as relating price levels, as well as evaluating visitation rates based on site popularity. However, the process is also heavily weighted on the natural and cultural resources available, in addition to how well the surrounding community complements the attractions. The article gives examples of how to use the hierarchy system through pairwise comparisons, and provides case studies of how parks in the State of Victoria are valued (Deng et al., 2002).

The AHP methodology is applicable to the District of Muskoka because it focuses on benefitting the tourist experience by testing measures of attractiveness. Muskoka is an area that sees a major seasonal increase in population because of the natural attractions it provides. Identifying a point system for how to prioritize natural assets can be used in Muskoka to direct growth away, or towards, certain resources.

Classification Framework

Hughey et al. (2004) address similar issues to Deng et al. (2002) across the Tasmanian Sea in New Zealand. The authors note the complexity in evaluating and rating nature-based tourist destinations, and identifying criteria for sustainability. Due to an overwhelming increase in recreational and natural tourism in New Zealand, a need for identifying ways to protect, support, and promote sustainability in these areas was required. The article suggests a simple classification system that focuses on the importance and fragility of natural assets. Three main components are presented that influence the value of a natural area. These components include the presence of biophysical types such as flora and fauna species, the perceived importance of the natural assets ranging from low to high values, and how resilient the asset is to tourists (i.e. fragility). Figures and tables are presented for each component, comparing the overall value and sensitivity of the natural assets for tourism (Hughey et al., 2004).

The main component presented in Hughey et al. (2004) addresses the fragility of natural assets and their resilience in coping with tourism. This is applicable in the context of Muskoka because the District sees a large influx of population on a seasonal basis. As a result, the tourism and recreation resources that these residents and visitors use fluctuate on a seasonal basis as well; therefore, it is important to ensure these natural assets can handle periods of limited to high usage.

CONCLUSION

Strengths

Based on the literature presented, each article takes a holistic approach to identifying methods in which assets can be valued in the context of tourism and recreation. The articles recognize the complexities in valuing natural resources, given the numerous factors that contribute to a sustainable ecosystem, and how such resources support tourism and recreation. Much of the literature in the past has focused solely on the direct monetary value of natural resources (Tisdell, 2003); but as presented by authors like Krantzberg & de Boer (2006) and Deng et at. (2002), the non-use economic values are also addressed for those areas where no direct monetary value is available. This allows areas with environmental significance to also be considered when comparing development interests. Conversely, the aspect of use values in the methods presented, such as hedonic valuation, are strong because of their use of actual market transactions (Krantzberg & de Boer, 2006). Values like this are not hypothetical and are derived from consumer data.

Limitations and Future Research

Much of the literature presented, especially pertaining to TEV, present challenges regarding the reliance on secondary data and subjectivity or bias associated with particular methods. For example, the findings presented utilizing the contingent valuation method found that respondents could alter their answers if they knew it had a direct impact on the development of that site (Krantzberg & de Boer, 2006). While these biases should be acknowledged in any study considering user opinions, a survey of visitors or local residents would take a great deal of time and person hours to review the findings at a regional scale. Much of the literature presented considers protected lands such as national parks, as opposed to regional areas, containing both natural tourism resources and increasing pressure from growth and development. In this regard, Muskoka is a unique scale compared to current literature. This draws the question of whether the level of evaluation presented in the literature is feasible from a regional municipality, public sector perspective as components may be primarily private sector driven. As an example, the travel cost method presented by Tisdell (2003) requires elaborate behavioral data, as opposed to verbal responses; therefore, the scope of collecting this data may pose constraints (Krantzberg & de Boer, 2006).

Furthermore, it is difficult to place a financial figure on the non-use (non-market) resources presented in the literature. The articles presented suggest non-use methods as having perceived value associated with them based on answers to questionnaires or surveys. One might perceive a recreational hunting area as having more value over another recreational resource, but this is difficult to weigh against methods that relate to actual market values. Therefore, each tourism and recreation natural resource in question should be tested using each model, either utilizing one or several options to determine its valuation.

The authors suggest that the non-use, stated preference models should be more common when identifying natural resources for tourism and recreation; as opposed to use values that rely on secondary data (Boxall et al., 1996). In order for these intangible values to have more weight, finer detail needs to be given towards the questions asked and the population surveyed (Tisdell, 2003). This too must consider the sample size so that it relates to the appropriate net benefits of the area, so that the use and non-use values of tourism resources can be complementary.

APPENDIX B: ACADEMIC LITERATURE REVIEW – NATURAL ASSET VALUATION

In addition to the literature review outlined above, which identified methods in which natural assets can be valued in the context of tourism and recreation, further examination into valuation methods applicable to the District of Muskoka is analyzed in the following literature review. This research provides insights regarding the most appropriate valuation methods for the District of Muskoka, as well as examines the application of GIS technology in valuing natural assets through Landscape Scale Analysis (LSA) and Enhancement Opportunity Analysis (ESA). Furthermore, this research particularly focuses on the valuation methods for water and vegetation resources, as well as how to incorporate the valuation practice into the District's policy framework.

INTRODUCTION

Existing research surrounding natural asset valuation tends to focus on the application of different valuation methods and potential obstacles for implementing those methods. In recent decades, multiple natural capital accounting strategies and methods were developed to identify, quantify, and place a value on different ecosystem services both in monetary and non-monetary terms (Kai, 2018). Before selecting a feasible method of natural asset valuation for an area of interest, a comprehensive understanding of the District of Muskoka's natural capital and ecosystem services is required. This requires categorization of natural assets into visible and invisible services. According to Kai's study (2018), natural assets can be categorized into visible resources, and invisible services or ecosystem services. For example, minerals, timber, water, and energy are visible services; whereas water filtration, flood protection, pollination, and wildlife habitats are invisible services (Kai, 2018). In the context of Muskoka, the majority of natural assets are comprised of water and vegetation resources, since the District is made up of nineteen quaternary watersheds and 94% vegetation cover. Further ecosystem service categorization will be outlined below.

According to the United Nations System of Environmental-Economic Accounting (SEEA), ecosystem services can be categorized into four groups (Kai, 2018):

- Provisioning services (i.e. food, fresh water, raw materials);
- Regulating services (i.e. local climate, carbon sequestration, waste-water treatment, pollination, erosion control);
- Supporting services (i.e. habitat for wildlife, maintenance of genetic diversity); and
- Cultural services (i.e. recreation, mental and physical health, tourism, aesthetics)

In considering the above four categories, Nijnik & Miller (2017) argue that valuation methods should be selected depending on the type of ecosystem services, spatial scale, and location (Nijnik & Miller, 2017). For provisioning goods like timber and fibre, the market valuation method is more appropriate, which is the analysis of market prices. In contrast, regulating services, such as flood regulation and air quality, can be evaluated by adopting the avoided cost method to estimate avoided losses. In recent years, the benefit transfer approach has become a prevalent valuation method for non-market goods, because it is simple to understand and to conduct (Nijnik & Miller, 2017). Overall, Nijnik & Miller's (2017) idea provides a general method for the District of Muskoka's natural asset valuation, whereby valuation methods can vary by the type of natural assets. However, the major concern for valuing natural assets in Muskoka are the time constraints and resources required to conduct a combination of multiple valuation approaches.

METHODS AND TOOLS FOR VALUING NATURAL RESOURCES

Water Resources

In regard to valuation of water resources, Kai (2018) presents a potential tool for categorizing water resources specifically. For this study, a systematic tool of SEEA was developed for collecting water-related data, as well as placing monetary and non-monetary values for water services. The tool is made up of the following five categories (Kai, 2018):

1. Physical Supply, Use Tables, and Emission Accounts (*hydrological data regarding the volume of water used and discharged into the environment by the economy, as well as the quantity of pollutants added to the water*)
2. Hybrid and Economic Accounts (*links water volume with monetary information)*
3. Asset Accounts *(measures water resources in physical terms*)
4. Quality Accounts (*describes water quality at the beginning and end of an accounting period*)
5. Valuation of Water Resources

This tool can be applied to the method of valuing Muskoka's water resources, since the required data to conduct the valuation is not difficult to gather. Findings from the first category can also be incorporated into the study, which is the identification of potential threats to the District's natural assets using GIS technology.

Forest Resources

Patil (2017) examines the potential economic valuation approaches for forest ecosystems by comparing the relationship between forest valuation and ecosystem sustainability. As an example of Kai's (2018) viewpoint, forests provide both visible ecosystem services, such as trees being used for lumber and pulp; and invisible ecosystem services, such as climate regulation, pollution control, biodiversity, water regulation, and soil erosion control (Patil, 2017). In general, there are five major methods for identifying the value of forest ecosystems. The first is the historical cost method, which determines the value by calculating the sum of all investment, management, and operating costs that the forest provides. The second is the market price method, where the value is based on the sum of all investment, management, and operating costs the forest provides that the current market conditions applied. Third is the discounted cash flow method, where cash flow projections are used in order to estimate how attractive the area is as a future investment opportunity. Next is the real option pricing method, or the deferring, abandoning, expanding, staging, or conducting of a capital investment project within the forest ecosystem. Finally, there is the sensitivity analysis method which takes into consideration how an independent variable can impact a dependent variable under a few assumptions within the forest ecosystem (Patil, 2017). Among the forest valuation methods indicated above, the historical cost method and market price method are more feasible in the context of Muskoka due to the time constraint, limited data and resources, as well as a lack of expertise.

Landscape Scale Analysis and Enhancement Opportunity Analysis

Since this study requires the application of GIS technology, a report written by the Credit Valley Conservation was analyzed, which focuses on the valuation of Mississauga's natural capital through Landscape Scale Analysis (LSA) and Enhancement Opportunity Analysis (ESA). The City's valuation process begins with identifying the importance of natural assets in contributing to the City's ecosystem services and functions, followed by identification of potential opportunities to implement this framework to protect natural areas (CVC, 2012). LSA involves characterization of ecosystem functions of natural and semi-natural areas at the landscape level by using GIS mapping, and an evaluation of its importance relative to the broader landscape. In this regard, spatial configuration has been shown to be important for biodiversity and ecosystem function. In general, LSA is comprised of the following steps: background information review with a summary of available data and characterization of natural spatial configuration; criteria and threshold development into nine criteria; LSA execution using GIS mapping and creation of habitat patches scored using the 9 criteria in regards to their importance to ecosystem function in the City in relation to its size and adjacent land uses; and post-analysis data summarization by clustering habitat patches into groups by their score relative to other significant natural heritage features. With this, habitat patches were then designated either 'Core ecofunction habitats' (scores of 6-9), 'Highly Supporting ecofunction habitats' (scores of 2-5), 'Supporting ecofunction habitats' (scores of 1), or 'Contributing ecofunction habitats' (scores of 0) (CVC, 2012).

Once the LSA is complete, the results are then overlaid with a map of the City, Life Science Areas of Natural and Scientific Interest, Environmentally Significant Areas, Provincially Significant Wetlands, the City's Natural Areas System (NAS), the Region of Peel Greenlands System, and hazard lands. The NAS has previously conducted field surveys and ranked natural areas into linkages, residential woodlands, and special management areas to provide site level analysis in addition to the broader LSA analysis. By overlaying with various data, and creating a multi-criteria model as a result, a conservation strategy can be developed for the landscape (in relation to land ownership/willingness) (CVC, 2012).

Following the LSA, the ESA is conducted to identify areas that can be enhanced to improve healthy ecosystem functioning. ESA is comprised of the following steps: land-use type identification for enhancement; criteria and threshold development similar to those in the LSA; ESA execution determining patches (score of 0 or 1 for each criterion) based on proximity to features that contribute to ecosystem function with scores summed across criteria and ranging from 0 (low stewardship or restoration priority) to 8 (high stewardship or restoration priority); and post-analysis data summarization by clustering into functional groups through visual examination of how the patches increase natural areas/enhancement of essential City corridors. This results in designation into 'High priority' (scores of 5-8), 'Medium priority' (scores of 2-4), and 'Low priority' (scores of 0-1). ESA, overlaid with LSA results and Conservation Authority owned properties, can create scientific assessments on a broader landscape scale. ESAs assess the contribution of certain areas to the existing ecosystem function. Also, applying the Credit Valley Conservation economic valuation of natural assets to this model can derive a monetary value from the flow of goods and services production over time (CVC, 2012).

CHALLENGES

All of the above valuation methods consist of various obstacles. Besides the common obstacle of data limitation, the dynamic and interrelated nature of ecosystem services often leads to the risk of double-counting (Nijnik & Miller, 2017). On the other hand, the valuation of forest ecosystems would create potential rewards, such as increasing public awareness of protecting the forest ecosystem, maintaining biodiversity, and balancing economic growth and diversity (Patil, 2017). However, several criticisms are also prevalent when conducting forest ecosystem valuation. First, it is difficult to identify all biological assets in an ecosystem as there are many assets that provide hidden ecosystem services, such as the services that microorganisms provide (Patil, 2017). Furthermore, it can also be difficult to value biological assets as there is no perfect method that currently exists.

Similarly, Credit Valley Conservation's LSA and ESA method also encountered several challenges. Firstly, when LSA results were overlaid with NAS data, it was evident that the NAS data highlights some areas of high biodiversity or integrity that was not categorized as high functioning by LSA. Furthermore, LSA highlights areas of potential natural cover not captured by NAS (CVC, 2012). Therefore, both methods should be used in conjunction with one another. In addition, a Natural Heritage System and Strategy needs to be implemented to integrate various natural features to ensure long-term sustainability of the area's ecosystem functioning. Secondly, LSA cannot determine the level of ecological integrity of natural habitats, and since GIS data from aerial photography does not always exactly correspond to field measurements, updating is required on a regular basis to ensure accuracy of the model. LSA is most effective as part of a hierarchy of studies at the site, local, and landscape level – namely in conjunction with the Credit Valley Conservation valuation analysis conducted at the overall watershed scale, and Provincial studies and plans at a broader scale. In addition, merging different data (i.e. LSA and NAS) can require edge refining, or further interpretation. Thirdly, the ESA scores do not necessarily mean the lands can be restored, enhanced, or managed, but merely identify areas that would benefit ecosystem function most significantly if it were enhanced (CVC, 2012).

TRANSLATION INTO POLICY FRAMEWORK

In recent years, there is a growing awareness of the importance of incorporating natural asset valuation into policy frameworks. The Economics of Ecosystems and Biodiversity (TEEB) classification system helps decision-makers recognize the importance of ecosystems and biodiversity, and how to incorporate ecosystem values into decision-making. It also helps decision-makers recognize the economic contributions ecosystem services provide (Kai, 2018). In addition, the World Bank's Wealth Accounting and Valuation of Ecosystem Services (WAVES) brings together a wide variety of parties including governments, organizations, academics, and United Nations agencies to implement natural capital accounting (Kai, 2018). Both incentives also enable informed decision-making regarding green growth in cities.

Additionally, the International Center for Integrated Mountain Development (ICIMOD) created a framework where ecosystem services were a main focus in order to enhance food, water, and energy security, which are all interrelated (Kai, 2018). For example, wetlands provide many services such as clean drinking water, irrigation water for agriculture, and help regulate water quantity for flood protection. Watersheds are also a valuable natural resource since they provide a variety of ecosystem services. In a local context, the Credit River Watershed in the Greater Toronto Area (GTA) is estimated to provide a minimum of $371 million per year worth of ecosystem services; namely by providing waste treatment worth $137 million per year, water supply worth $100 million per year, climate regulation worth $41 million per year, and riparian services worth $35 million per year (CVC, 2012).

According to a survey sent to a hundred experts worldwide regarding the application of natural capital accounting, evidence shows that the incentive of incorporating natural capital accounts into the public policy decisions has experienced multiple challenges (Recuero Virto, Weber, & Jeantil, 2018). The survey results summarize the current major obstacles into six categories, which are political, structural, institutional, design, data availability, and cooperation. First, structural obstacles are often a result of data availability and resource limitations, which involves a country's development status and ability to conduct natural capital studies. Second, political obstacles occur due to government opposition (Virto et al., 2018). Third, institutional obstacles are caused by insufficient collaboration between sectors to ensure data compatibility for the implementation of natural capital accounts. Fourth, design obstacles are defined as failure in establishing an accounting framework. Fifth, data acquisition relates to the access to financial resources, which is often a burden for less developed countries (Recuero Virto et al., 2018). Finally, cooperation obstacles are the lack of international standardization of the best practice. Except for political obstacles, structural obstacles, institutional challenges, design limitations, lack of data availability and cooperation constraints are all potential challenges for implementing natural capital accounting in Muskoka.

APPENDIX C: CASE STUDY REVIEW

In conducting background research surrounding natural asset valuation, there are a number of jurisdictions that have previously conducted an evaluation of their natural assets. The areas that will be examined in this section include: Thousand Islands Archipelago and National Park, Lake Simcoe Basin, Rouge Area and Park, British Columbia's Lower Mainland, Town of Gibsons in British Columbia, Rio Bravo Conservation Area, and Town of Aurora. It is important to note that these jurisdictions (namely municipalities, Parks Canada, and Conservation Authorities) are each at different phases of their valuation, analysis, and implementation; and such valuation is relatively new. Therefore, these case studies are meant to highlight the potential options for conducting such an analysis, with the intention of providing supporting background research for Phase 2 and 3 of this study.

THOUSAND ISLANDS ARCHIPELAGO AND NATIONAL PARK, ONTARIO

Location Background

Thousand Islands National Park is one of Canada's smallest national parks, measuring approximately 22.9 square kilometres (2,290 hectares) of fragmented land. The park is situated within the Frontenac Arch Biosphere Reserve, one of Canada's highest areas of biodiversity. However, due to population growth in surrounding areas, the Park faces major threats from park visitors, habitat fragmentation and loss, introduction of exotic species, and pollution (Malouin et al., 2013). A map of the Thousand Islands National Park and Ecosystem can be found in Figure 14 below.

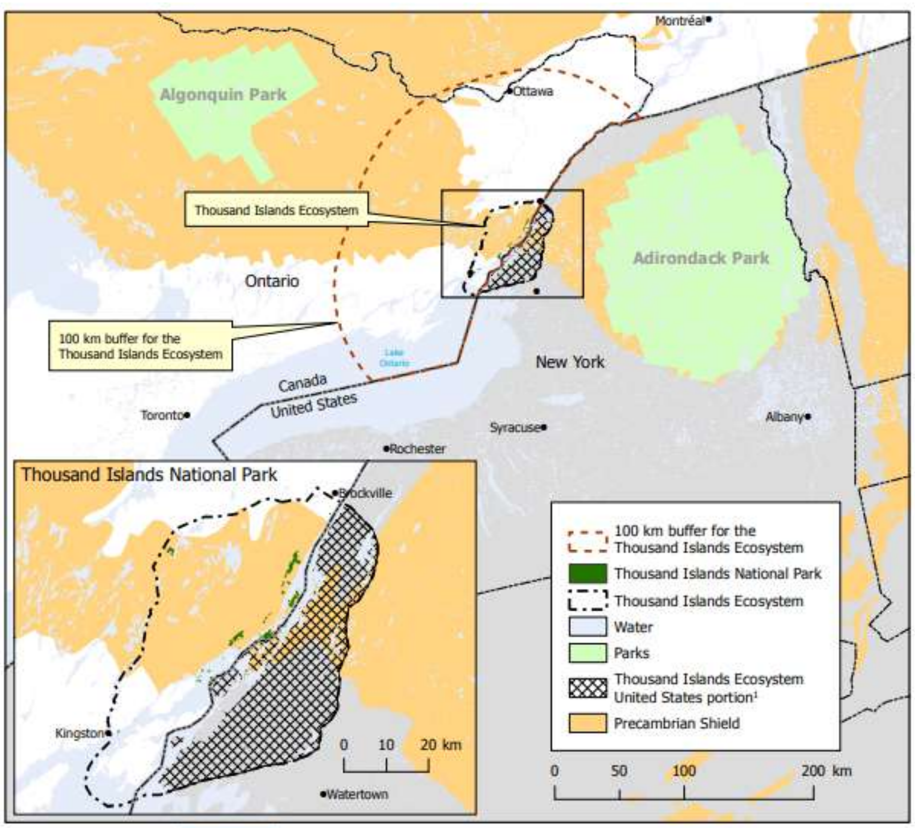


Figure 14: Map of Thousand Islands National Park and Ecosystem (Malouin et al., 2013).

Methodology for Valuing Natural Assets

In 2011, Statistics Canada received funding to conduct its Measuring Goods and Services (MEGS) project which sought to develop experimental ecosystem accounts (i.e. a collection of data that provides information about the quantity of ecosystem assets from which society benefits) in order to provide better policies to support ecosystem goods and services throughout Canada. Part of this study included a non-market monetary valuation of the Thousand Islands Ecosystem and surrounding area to estimate the annual value of its ecosystem services. Two approaches were taken for the valuation of the Park's assets: one was using existing monetary values determined from a study that valued environmental goods and services in Southern Ontario (Estimating Services in Southern Ontario); the other approach used past valuation studies from similar ecosystems to estimate asset values, otherwise known as benefit transfer/value transfer. During the study, the following environmental goods and services were evaluated: atmospheric regulation; water quality, nutrient and waste regulation; water supply regulation; soil retention and erosion control; habitat and biodiversity; pollination and dispersal services; disturbance avoidance; recreation; aesthetic and amenity; and other cultural services. It was determined that the Park's composition is as follows: forest (82%), wetland (10%), cropland and field (2%), and built-up areas (2%). Then using the benefit transfer method, annual values of environmental goods and services within the Park were estimated to be between $12.5 million and $14.7 million in 2012 (Malouin et al., 2013). For a breakdown of values for different land cover types and their associated geodatabases, please see the Table 12 below.

Table 12: Annual ecosystem service flows, by land cover type and selected land cover compilation in Thousand Islands National Park (Malouin et al., 2013).

	Area-weighted average value per hectare [2]	Land cover compilation											
		Troy and Bagstad GIS, 15 m, 2008		AAFC land cover, 30 m, 2011		CCRS land cover, 250 m, 2011		SOLRIS, 15 m, 2008		MEGS geospatial database, 250 m [1], 2011		Parks Canada LANDSAT-TM, 30 m, 2007	
		land cover	valuation [3]	land cover	valuation	land cover	valuation	land cover	valuation	land cover	valuation	land cover	valuation
	dollars	percent	dollars	percent	dollars	percent	dollars	percent	dollars	percent	dollars	percent	dollars
Total		**100.0**	**14,669,989**	**100.0**	**13,793,498**	**100.0**	**14,192,366**	**100.0**	**13,611,446**	**100.0**	**14,030,681**	**100.0**	**12,492,976**
Forest	4,776	68.9	7,334,476	82.0	8,733,404	76.8	8,170,562	71.7	7,629,237	71.9	7,655,654	82.4	8,775,725
Shrubland [4]	0	0.0	0	1.2	0	1.4	0	0.0	0	1.4	0	3.3	0
Grassland	377	0.8	7,049	0.0	0	5.9	49,210	0.0	0	8.3	69,541	0.0	0
Barrenland [5]	0	0.0	0	0.3	0	0.0	0	10.1	0	0.0	0	0.0	0
Wetland	15,908	18.5	6,557,799	11.3	3,994,971	5.1	1,794,411	16.2	5,757,333	11.0	3,890,792	10.0	3,551,735
Cropland and field	151	8.7	29,176	1.8	6,004	1.1	3,799	0.7	2,197	0.6	2,111	1.7	5,593
Built-up [6]	0	1.3	0	0.9	0	0.0	0	0.8	0	1.1	0	2.2	0
Water snow ice	19,081	1.7	741,489	2.5	1,059,119	9.8	4,174,384	0.5	222,679	5.7	2,412,584	0.4	159,923

1. Base layer of the geodatabase is 250 m; additional datasets improve overall resolution.
2. The Troy and Bagstad (2009) report estimated EGS monetary values by land cover; however, their categories differ from the land cover classes used in the MEGS project. For this reason, area-weighted averages of the Troy and Bagstad monetary values were applied to the various MEGS land cover types, from each land cover compilation.
3. These valuation estimates are based on the land cover categories and values per hectare compiled by Troy and Bagstad (2009) and are not as sensitive to land cover concordance and roll-up limitations as the other land cover compilation sources used in this analysis.
4. Shrubland does not exist as a distinct land cover class in the Troy and Bagstad (2009) report and monetary values are not provided for this land class. As a result, the total monetary valuation may be underestimated for the AAFC, CCRS, MEGS geospatial database and the Parks Canada LANDSAT-TM land cover compilations, which did attribute a proportion of the land cover to shrubland.
5. Barrenland does not exist as a distinct land cover class in the Troy and Bagstad (2009) report and monetary values are not provided for this land class. As a result, the total monetary valuation may be underestimated for the AAFC and the SOLRIS land cover compilations, which did attribute a proportion of the land cover to barrenland.
6. Built-up areas (including greenspace) were not valued; this land class was considered inappropriate for a study in a National Park.

Note(s): Monetary values, in 2012 Canadian dollars, represent annual flows of EGS per year and exclude real-estate values. Monetary estimates are associated only with the Thousand Islands National Park area. The value of these EGS is an underestimate since some EGS were not assessed for each land cover type in the Troy and Bagstad (2009) study, due to the lack of relevant studies for benefit transfer.

Weaknesses or Gaps in Methodology

The reason why methods like benefit transfer are used is due to the associated costs (both time and money) of conducting a study from scratch; therefore, similar studies can be leveraged. There are typically two main approaches to conducting benefit transfer. The first and easier approach involves using a "unit value transfer" which simply takes the monetary value of a good or service from one study and transfers it to another (i.e. taking the $/ha value from one location and applying it to another with similar attributes). Whereas the other approach involves using a "function value transfer", which uses regression methods to compare biophysical and socio-economic attributes to other site locations (i.e. determining the economic impacts from one study and reflecting them on another). Unfortunately, both methods can be subject to uncertainty (i.e. reports show the unit value transfer method can have errors in the range of 40%+/- uncertainty); however, this can be avoided by ensuring studies share similar enough attributes (Malouin et al., 2013).

Steps Taken to Improve Thousand Islands' Policy

Local conservation authorities have reported numerous ways in which they hope to better protect the Park's natural environment. One such method is the use of park management plans. These plans are responsible for outlining goals and objectives necessary for preserving natural features and services for people, and providing direction for years ahead. Management plans are to be updated every 5 years, taking local, regional and national environmental changes into consideration, as well as potential social and economic impacts (Parks Canada, 2010).

Another method the Park has introduced has been the designation of islands (park space) as 100% natural settings. This designation implements the following regulations: all toilets must dispose of waste via compost; camping sites must be primitive; no gas/electric generators permitted; and a pack-in, pack-out ethic (i.e. visitors must take all garbage with them). Three islands (Grenadier, McDonald, and Beaurivage) provide additional services such as garbage collection sites, potable water, and generator use (Parks Canada, 2010).

In some cases, the Park has encountered hyper abundant species such as deer. They are currently analyzing options to restore ecological balance via herd reduction (Parks Canada, 2010).

Lastly, the Park believes the most important action in conservation is reaching out to the regional residents and sharing with them the importance of conservation and sustainable use. Human development is the biggest threat to these natural ecosystems; therefore, the public needs to know the necessary steps to mitigate any impacts (Parks Canada, 2010).

LAKE SIMCOE BASIN, ONTARIO

Location Background

The Lake Simcoe Watershed is located within central Ontario, spanning 3,307 square kilometres (330,700 hectares), and is part of the Trent-Severn Watershed that connects Lake Ontario and Georgian Bay. Some portions of the watershed are part of the Province's Greenbelt. The basin is home to approximately 350,000 permanent residents and 50,000 seasonal residents; providing tourism and recreation (totaling $200/million per year in revenue), as well as agricultural lands as part of the Holland Marsh. It is also comprised of 32 species at risk, 35 tributary rivers, 5 major tributaries draining

Figure 15: Map illustrating the Lake Simcoe Watershed boundaries (Wilson, 2008a).

from the Oak Ridges Moraine, drinking water for 8 communities, and 14 water treatment facilities (Wilson, 2008a). A map of the Lake Simcoe Watershed is illustrated in Figure 15.

Methodology for Valuing Natural Assets

Valuing natural assets and ecosystem services involves the valuation of various material and non-material benefits derived from the various ecosystem processes and functions. Placing a non-market value on these services can be calculated based on economic damages, willingness of individuals to pay for services and goods, and willingness to accept compensation for losses. This study utilized avoided and replacement costs, in addition to willingness to pay whereby some of the values were determined based on direct analysis, while others were taken from other studies (often referred to as benefit transfer) (Wilson, 2008a).

Firstly, land and water cover types were identified, and classified across the study area. The land cover of the study area was classified into: water, agriculture, wetlands, forests, urban/built-up impervious areas, built-up pervious areas, transportation, grasslands, and pits and quarries. Such land cover has been mapped by the Lake Simcoe Region Conservation Authority, and vegetation types were mapped using the Ecological Land Classification, and combined with the land cover (Wilson, 2008a).

Secondly, estimation of ecosystem service worth was conducted using avoided and replacement costs under the following categories (Wilson, 2008a).

Water quality, supply and regulation

- Water filtration services – filtering of pollutants out of water, and reduced cost of treatment for surface water calculated based on statistical correlation/potential water treatment costs if forest and wetland cover declined from 30% to 10%, in combination with estimated daily residential water use
- Water sources – based on cost of providing residential drinking water (excluding treatment) by way of collecting, storing, and distributing
- Water regulation and flood control – estimated based on replacement cost using CITYgreen software/the construction costs for water runoff control if forest cover was converted into urban development
    - CITYgreen is a GIS application that conducts complex statistical analysis of ecosystem services, and calculates benefits (in dollar value) based on specific site conditions
- Waste treatment – estimated nutrient absorption by wetlands being 80-770 kg/ha/year for phosphorus removal, and 350-32,000 kg/ha/yea for nitrogen to then be estimated with total wetland area; costs for removing nitrogen and phosphorus by waste treatment plants estimated to be $22-61/kg of phosphorus and $3-8.50/kg of nitrogen

Clean air

- One tree estimated to produce 260 lbs of oxygen/year, and remove 8-12 g of air pollutants per square metre of canopy – using CITYgreen software, the amount of air pollutants removed by the tree canopy cover in the watershed was estimated

Carbon services

- Forests – based on the eco-climate zone (being Cool Temperature), carbon storing on average 200 tonnes/ha occurs, with the economic value of carbon stored in forests calculated based on avoidance cost, replacement cost, or market price of carbon trading; and the CITYgreen software calculated carbon sequestration amounts in relation to the value of $52/tonne of carbon dioxide

- Wetlands – using Canada's Soil Organic Carbon Database, stores of carbon in soils and peat was calculated (estimated 0.2-0.3 tonnes of carbon per hectare) with damage cost of carbon emissions being $52/tonne
- Agricultural Land and Grasslands – organic carbon stored in soils extracted from Canadian Soil Organic Carbon database, and based on average cost of carbon emissions

Biodiversity

- Habitat – based on average annualized wetland habitat restoration costs for a group of Great Lakes Sustainability Fund projects on avoided cost of habitat damages and degradation/loss of wetland habitat
- Pollination – calculated based on multiplying the total value of farm crops in the watershed by 30% (global average of crop production that is dependent on pollination), and average annual value per hectare applied to natural cover land types

Tourism/Recreation

- Being the most important industries of Lake Simcoe; with fishing, provincial parks, cottages, etc.; the economic worth of tourism was calculated based on the annual value of tourism in relation to the total natural cover and water cover
- Value of recreation based on pervious urban recreational areas estimated at 50% of the value of natural cover

Other ecosystem services

- i.e. air quality, water regulation, erosion control, soil formation, seed dispersal, and nutrient cycling

Finally, based on the values of ecosystem services as outlined above, the total annual values of non-market ecosystem services was estimated by land cover type, as illustrated in Table 13 below.

Table 13: Non-market ecosystem service values by land cover type (Wilson, 2008a).

Land Cover Type	Area (hectares)	Value per hectare ($/hectare/yr)	Total Value (Million$/yr)
Forest	66,379	$4,798	$319
Grasslands	8,353	$2,727	$23
Wetlands	38,974	$11,172	$435
Water	72,141	$1,428	$103
Cropland	96,202	$529	$51
Hedgerows/Cultural Woodland	3,855	$1,453	$5.60
Pasture	24,447	$1,479	$36
Urban Parks	3,363	$824	$2.77
Total	**330,741**	**$2,948**	**$975**

Weaknesses or Gaps in the Methodology

In many cases, the monetary value of natural assets is underestimated due to the use of conventional economic revenue calculations. In addition, this valuation merely provides a basis for natural asset valuation that should be further developed through detailed GIS and market analysis. However, this study is designed to provide a framework for valuing natural assets both at a watershed and municipal level (Wilson, 2008a).

How Valuation Can Translate into Policy

The valuation of natural capital provided by the Lake Simcoe Watershed is estimated to be worth $975 million/year, with the ecosystem services provided to each of the 350,000 permanent residents being worth $2,780/person annually (Wilson, 2008a). In this regard, forests and wetlands provide the highest value of natural assets through water filtration, water regulation, waste treatment, flood control, wildlife habitat, and recreation by the wetlands; and carbon storage, water filtration, recreation, and pollinator habitats by the forests (Wilson, 2008a). It is essential for restoration and stewardship activities to be implemented by municipal and provincial governments. Using the service values, land use planning at the watershed level can assess the loss of services, and cost due to land use changes. Furthermore, this valuation should be implemented into the *Lake Simcoe Protection Act* and Plan by the Province; as well as be integrated and developed into growth strategies and natural heritage systems by municipal governments (Wilson, 2008a). However, this valuation has not been integrated into the *Lake Simcoe Protection Act* and Plan, or other planning policy documents to date.

To advance the valuation of natural assets, the valuation process addressed could be further developed by implementing a natural capital account whereby values are incorporated with physical natural assets and qualitative states of such assets. This requires continual monitoring and measuring of natural asset use, as well as sound intergovernmental collaboration. However, these accounts can be useful as they provide an assessment of the subject area, the benefits of preserving these areas, and well as areas to restore in regards to identifying impacts of changing land uses. This can aid in making policy and planning decisions to reduce human impacts on the area’s ecosystems through aerial imagery and municipal zoning records to continually adjust in the future (Wilson, 2008a).

ROUGE AREA AND PARK, ONTARIO

Location Background

The Rouge area is comprised of Carolinian forest (the most species rich zone in Canada), two National Historic Sites, over 1,000 known wildlife species, a connective natural corridor between Lake Ontario and the Oak Ridges Moraine, and exemplary farmland in the GTA, namely on the eastern portion of the City of Toronto and Town of Markham. The area also contains farms, water bodies, and rural areas. The entire study area consists of three major watersheds (Rouge River, Petticoat Creek and Duffins Creek), as well as croplands, grazing lands, urban areas, forests, water, tree plantations, forests, wetlands, and hedgerows spanning 646 square kilometres (64,623 hectares) (Wilson, 2012). A map of Rouge Park is illustrated in Figure 16.

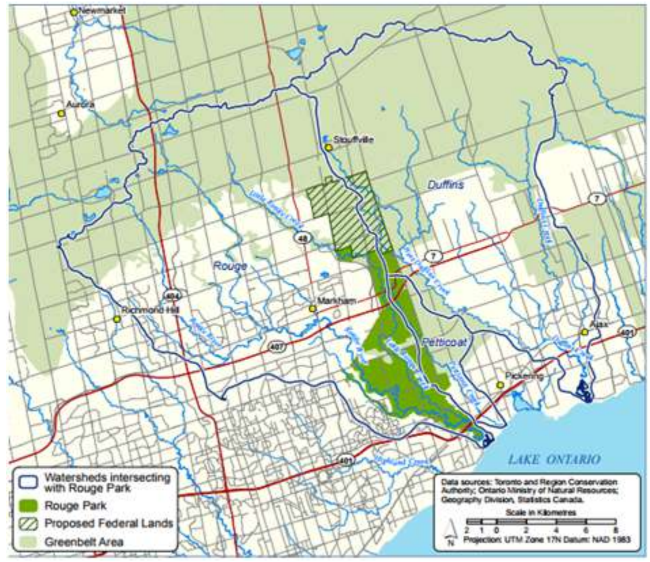


Figure 16: Map illustrating study area, including Rouge Park and relevant watersheds (Wilson, 2012).

Methodology for Valuing Natural Assets

In terms of the study methodology, the basis of data must first be determined and outlined through physical natural capital inventory development based on the extraction of land cover data using Southern Ontario Land Resource Information System to estimate land cover type. Second, the typology and identification of ecosystem services and benefits was conducted based on the classification system developed by The Economics of Ecosystems and Biodiversity (TEEB) Foundations report which compiled a review of literature surrounding natural asset valuation methods. Third, ecosystem services and values were categorized by ecosystem services type (i.e. received from ecosystems, processes, and non-material benefits) and landscape type (i.e. wetlands, lakes and rivers, forests, grassland and shrubland, well-managed cultivated areas, urban green space), whereby the benefits provided were identified. This involved typology creation for ecosystem services under four categories (as similarly discussed in the literature review), while also establishing the difference between ecological functions, services, and benefits generated: provisioning services – which provides basic materials (i.e. woods, food, fresh water); regulating services – which controls ecosystem processes (i.e. flood and climate regulations, water purification); supporting/habitat services – provides habitats and essential supportive services for ecosystem processes (i.e. nutrient cycling and soil formation); and cultural services – which provides humans with an interaction with nature (i.e. educations and recreational services). Fourth, non-market ecosystem service and market values were generated, which involved assessment of economic value of the benefits provided by services for each land cover type through benefits monetization (most often referred to as benefit transfer, whereby estimated market values are transferred from other studies). Finally, mapping of land cover and ecosystem goods and services involved mapping distribution of land cover, as well as average ecosystem service value per hectare (Wilson, 2012).

The valuation approach for natural asset monetization was determined as follows. There were three techniques identified to determine the economic value of non-market services in the Rouge Area and Park, being: direct market valuation approach (i.e. market-based and cost-based); revealed preference approach (i.e. hedonic pricing methods and travel cost); and stated preference approach (i.e. choice modeling and group valuation). Direct market valuation was used to reflect costs to individuals and when not available, was derived from market information associated with the service. Cost-based valuation was also used when applicable in terms of replacement/damage cost estimates. Once the valuation approach was determined, land cover, ecosystems, and land use mapping and analysis followed using geospatial data from the Southern Ontario Land Resource Information System. This categorized land cover into forests (coniferous, deciduous, and mixed), wetland (shallow water, bog, fen, marsh, and swamp), water-shoreline (open water and open shoreline), agricultural (grazing, hedgerows, idle land, and tree plantations), and other lands uses (built-up impervious, urban green space, extraction, and roads) (Wilson, 2012).

Ecosystem services of the area were evaluated to determine the non-market economic value for such services. These services included: climate change (economic value of carbon sequestration of forests, carbon stored by wetlands, carbon stored by croplands, clean air), flood prevention and water regulation (value of flood control by wetlands, waste treatment, clean water through filtration services provided by forests and wetlands), nature-based recreation, wildlife habitat (wetlands), pollination, biological control (birds as pest control), soil formation and erosion control, and cultural value of farmlands (local food production, and market value of croplands) (Wilson, 2012). These values were derived from various average market analysis sources in a similar fashion to the Lake Simcoe Basin's economic value gathering. Finally, the ecosystem service value was then applied by land cover type to determine the non-market economic value of such services in the total study area per year. Maps can be created based on this data to identify significant area hotspots in need of protection, rehabilitation, and policy limitations (Wilson, 2012).

Weaknesses or Gaps in the Methodology

Challenges in using benefits monetization involves limited data availability, namely in placing a monetary value on all ecosystem services. Moreover, such values generally only address a portion of the total benefits. In addition, estimated values tend to be lower than their actual value, and applying constant benefit values may not always be accurate. The knowledge on all of the benefits of a service is also unknown, and the estimated values and benefits to residents outside the study area were not considered. It can also be difficult to establish an accurate price for such services and assets (Wilson, 2012). In relation to the explanatory nature of this study, the land cover, typology, and ecosystem identification process is lacking in explanation and could possibly benefit from a more in depth/technical approach to evaluating natural asset importance.

How Valuation Can Translate into Policy

Overall, the Rouge and surrounding watersheds were valued at approximately $115.6 million, or $2,247/ha in economic benefits to residents; which can be divided into forests valued at $41.2 million/year, wetlands at $34.9 million, and agricultural land at $18.2 million/year with wetlands providing the greatest value per hectare. Studies of natural capital and ecosystem services can inform decision-making at all jurisdictional levels in policy and land-use planning initiatives. Most importantly, wetlands are threatened, yet provide the most vital natural assets and ecological services to contribute to various economic benefits. Some ways to better protect ecosystem services through planning policies include: policies to better promote sustainable communities through sustainable design interventions (i.e. stormwater retrofit plans), as well as surface water quality practices that are based on ecological corridors in all developments (Wilson, 2012).

Furthermore, in areas that span various watersheds, coordination policies and initiatives should be implemented to ensure they are protected on a watershed-basis. More areas should also conduct valuation studies with increased investment, as there is a shortage of such studies in Canada, accompanied by additional research regarding ecosystem service linkages, values, etc. In this regard, a natural asset valuation framework should be created, and tested, to address the benefits of ecosystem services, the linkages with other services, as well as the market value of such assets. This would be further supported by increased education and awareness to gain support for conducting further research and developing this framework (Wilson, 2012). Conservation of natural areas should also be established and expanded to help protect essential ecosystem services; reforestation and naturalization of damaged areas should be required by landowners and organizations; essential lands or lands that are abandoned should be acquired by the municipalities/conservation bodies to remediate and protect; and urban design guidelines and frameworks should be revised and implemented to require higher quantities of natural features and pervious materials.

BRITISH COLUMBIA'S LOWER MAINLAND

Location Background

The lower mainland of British Columbia is located in the southwest corner of the mainland, spanning 4,349 square kilometres (434,937 hectares) and containing Metro Vancouver, Fraser Valley, and Squamish-Lillooet, as well as two mountain ranges. The study area contains the Georgia Strait as well as the major watersheds that flow into the Strait. The study area has a growing population, and operates a seafood industry, ocean shipping, ship and boat building, ocean recreation; and also contains a wide diversity of terrestrial, freshwater, marine, and coastal species (Molnar, Kocian, & Batker, 2012).

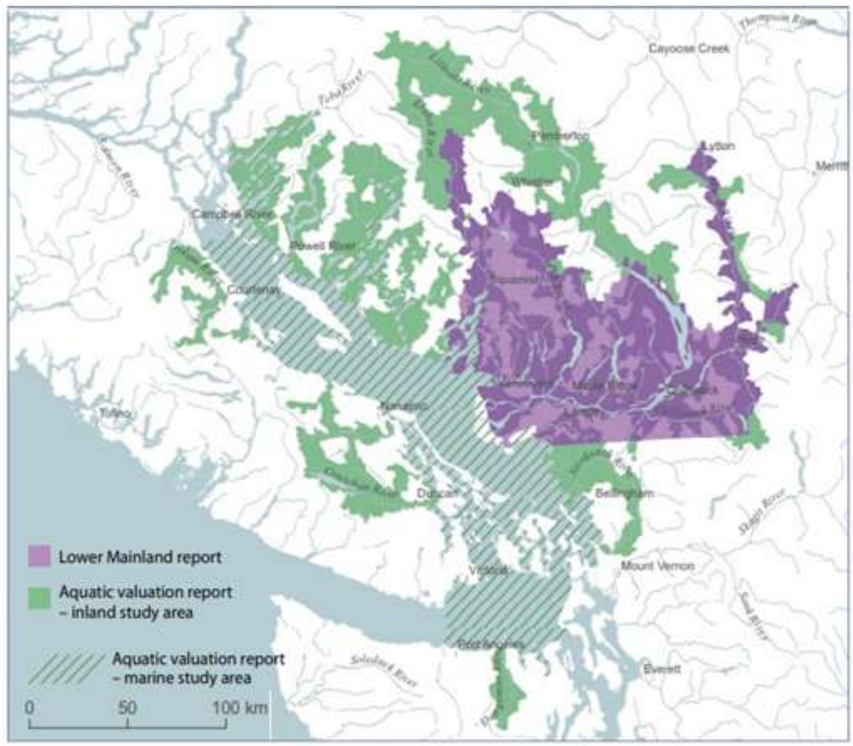


Figure 17: British Columbia's lower mainland valuation report boundaries (Molnar et al, 2012).

The scope of this study extends beyond the typical boundaries of British Columbia's lower mainland to better encompass the ecosystem services of the various watersheds in the area. The boundaries of the study are illustrated in Figure 17.

Methodology for Valuing Natural Assets

Firstly, the quantification of land cover classes was conducted utilizing aerial and/or satellite photography data to assess the area (in hectares) of various land covers, in conjunction with peer-reviewed valuation study data from Earth Economics, and compilation of five datasets (Biophysical Shore-Zone Mapping System, Land Cover Circa 2000, Vegetation Resources Inventory, National Ecological Framework for Canada, and National Hydro Network). The data was classified into nine categories: estuary, beach, lakes and rivers, riparian buffer, salt marsh, forest, marine, eelgrass beds, and wetland (Molnar et al., 2012).

Secondly, an ecosystem service framework was developed to identify ecosystem services and value of land cover classes. This involved establishing economic values by using the typology developed by The Economics of Ecosystems and Biodiversity (TEEB) classification system (classification of ecosystem services in the aquatic valuation into provisioning, regulating, habitat, and cultural as outlined in previous case studies). In valuing the ecosystem goods and services, the non-market valuation system was utilized based on in-house calculations and other studies that have been conducted. In this regard, the study utilized the benefit transfer analysis to create economic value estimates based on prior studies of various ecosystem types. This provided an appraisal, rather than a precise measure, as various studies were combined. This was then applied to the land cover by multiplying the hectares of land cover classes by the average annual values of ecosystem services for the study area (Molnar et al., 2012).

This study evaluated the economic value of the following provisioning services: fresh water, food, and raw material; the following regulating services: gas and climate regulation; the following disturbance regulations: soil erosion control, water regulation, water processing, and nutrient cycling; the following habitat services: biodiversity and habitat; and the following cultural services: aesthetic, and recreation and tourism. Each type of service included a suite of literature and studies to help value their importance. In relation to recreation and tourism specifically, the existing studies utilized travel cost (associated costs of recreation), hedonic pricing (willingness to pay for increased recreation services), and contingent valuation (price of housing in areas close to recreation areas vs. areas farther away) methods, and found to apply to eight of the nine land cover types, as outlined in Table 14 below (Molnar et al., 2012).

Table 14: Summary of value of ecosystem services by land cover in British Columbia's lower mainland (Molnar et al., 2012).

Land Cover Type	Total value/year (millions $/yr)		Value per hectare per year ($/ha/yr)	
	Low	High	Low	High
Beach	$0.35	$121	$612	$208,957
Estuary	$21	$71	$605	$2,073
Forest	$7,325	$13,053	$6,614	$10,946
Lakes/Rivers	$202	$7,395	$1,757	$64,254
Marine	$22,595	$22,604	$18,263	$18,270
Riparian Buffer	$316	$12,834	$847	$34,399
Salt Marsh	$0.23	$31	$426	$57,647
Wetland	$38	$4,645	$3,108	$378,529
Eelgrass Beds	$155	$577	$21,790	$80,929
Total	**$30,653**	**$61,331**	**$54,022**	**$856,004**

Thirdly, the net present value for ecosystem benefit values (over 50 years at a range of discount rates: zero – no discount; 3% - common in socio-economic studies; and 5% - more conventional) was calculated, which accounted for the future flow of ecosystem services, similar to traditional capital assets. It is important to note that natural capital usually appreciates over time, but the discount rates assume that present benefits are more valuable than those benefits in the future (Molnar et al., 2012).

Weaknesses or Gaps in the Methodology
The methodology used in this study focuses on the value of natural assets to people, rather than the intrinsic value of such assets to the environment itself. Therefore, the values of these assets are relatively low. In addition, approximately 30% of known services were evaluated in this study, creating underestimation of true service values of the area (Molnar et al., 2012).

There are also a number of limitations of this study, namely the static analysis, price distortions, increases in ecosystem services scarcity, unaccountability for existence value of ecosystems and non-economic values, and limits in behavioral change. In regards to the benefit transfer analysis, this analysis does not accurately account for the unique ecosystems of the area, size of ecosystem, selection bias, consumer surplus, time and resources to fully evaluate all aspects of every natural asset, the true value of ecosystems, and range of primary valuation studies for aquatic ecosystem services. In addition, using GIS data in the benefits transfer method can sometimes be challenging as overlaying data and maps can sometimes cause inaccuracy, categorical imprecision, and issues of depiction of spatial homogeneity (Molnar et al., 2012).

How Valuation Can Translate into Policy
These natural asset appraisal values help in the decision-making process in providing a basis for development of restoration and protection initiatives. Furthermore, these studies provide a framework for developing policies and measures to account for trade-offs in investments (Molnar et al., 2012).

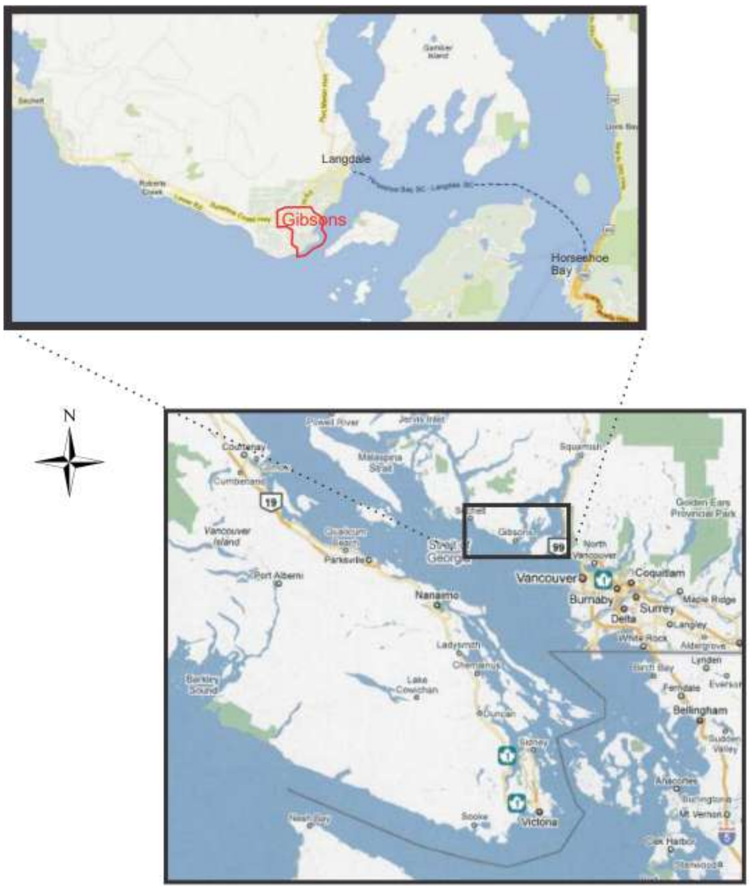
In terms of future evaluation and policy development, ongoing studies are needed to better examine natural capital, additional funding and research is required, natural capital accounting should take place, environmental impact assessments should be updated, and training should be provided to government bodies regarding the use of ecosystem service valuation tools. Studies on a local, small-scale level are beneficial rather than utilizing research from other areas; however, it is recognized that this is not always possible due to resource and time constraints (Molnar et al., 2012).

TOWN OF GIBSONS, BRITISH COLUMBIA

Location Background
The Town of Gibsons is located in the lower mainland coast of British Columbia, consisting of 4,400 people, and is the first municipality in North America to undergo a study to implement natural assets into their asset management. The process of natural asset valuation and management in the Town is based on Green Infrastructure, which encompasses natural assets (i.e. aquifers, forests, foreshores, creeks, and wetlands), enhanced assets (i.e. urban parks, stormwater ponds, rain gardens, bioswales, etc.), and engineering assets (i.e. green roofs, green walls, permeable pavement, etc.). In 2015, the Town developed a document outlining how it will eventually create an eco-asset strategy, accompanied by a document outlining the advancement of Municipal natural asset management in 2018. As a result of the Town's initiatives, the Municipal Natural Assets Initiative (MNAI) was undertaken in 2017 to provide direction for other municipalities to implement a similar framework (Town of Gibsons, 2015). A location map of the Town of Gibsons can be found in Figure 18 below.

Methodology for Valuing Natural Assets
The Town utilized an evidence-based approach through development of sophisticated asset management software. Proceeding in the future, asset conditions, worth, impact of increased asset demands, objectives for each asset, operational and maintenance plans, and financial plans need to be created to address the Town's natural assets. This, accompanied by an asset management policy, by-law, or financial statement, would direct municipalities to consider natural assets in their asset

Figure 18: Map illustrating location of Town of Gibsons (Town of Gibsons, 2012).



management strategies (Town of Gibsons, 2018). Given that the Town is also located in the aquatic valuation study area in the previous case study for British Columbia's Lower Mainland, valuation of assets within the Town was previously conducted and utilized through the natural asset valuation model, providing an integral benefit for the Town in developing their area specific policy and directional documents.

Weaknesses or Gaps in the Methodology

The lessons and methods used in this study are relatively new, and therefore, it is unclear at this time whether this same methodology would be applicable in other jurisdictions (Town of Gibsons, 2018). This implementation framework is an effective way to manage natural assets; however, the methodology/software utilized to value natural assets was not explicitly discussed in the Town's documents.

How Valuation Can Translate into Policy

The Town of Gibsons undertook the valuation of natural assets study to implement into their financial planning and reporting through their Asset Management Plan. Although such plans usually focus on sustainable service delivery of the physical infrastructure owned by the municipality, incorporating natural assets into the plan accounts for the fact that natural assets provide equal or superior services to most engineered assets. Such management allows for strategic and operational decisions based on the lifecycle of the infrastructure, rather than maintaining assets in short time intervals. It is important to note that natural asset financial reporting and registers do not have to be completed prior to incorporating natural assets into asset management plans, and incorporation of natural assets into financial planning can be fairly simple (Town of Gibsons, 2015).

The Town developed a natural asset policy that defines and recognizes natural assets as its own asset class, and outlines obligations to operate, maintain, and replace natural assets with traditional assets of the Town; as well as integrated natural assets into their financial statements (Town of Gibsons, 2018). This requires partnerships, and collaboration between various departments; as well as development of a long-term financial plan to account for all assets. This will primarily be outlined in an eco-asset strategy in the future. Overall, policy changes need to be implemented to enable eco-asset strategy frameworks for municipalities.

Furthermore, the MNAI was created to mimic the Town's approach into other municipalities. MNAI provides support to local municipalities in identifying, valuing, and accounting for their natural assets through asset management programs and financial planning. In this regard, the initiative provides a framework for municipal governments to implement direct asset management, shared asset management, and/or by-laws, plans, guidelines, and policies to manage such assets (Making Nature Count, 2017).

In terms of future research and policy development identified, the development of a natural asset accounting framework would be beneficial, knowledge in relation to municipal natural asset accounting development should be sought, funding for natural asset rehabilitation should have a clear direction from the Provinces and Territories, natural assets could be included in asset registers, development charges could help fund restoration and enhancement of natural assets, and further integration of natural assets into municipal documents should occur (Town of Gibsons, 2015).

RIO BRAVO CONSERVATION AREA, BELIZE

Location Background

Rio Bravo Conservation Area is located in the north-western portion of Belize, a country on the eastern coast of Central America. The conservation area contains approximately 1,000 square kilometres (100,000 hectares) of land and is the largest terrestrial area in Belize, containing 4% of the country's total land. The area consists of tropical rainforest, swamp, and savannah. There has been an absence of studies conducted in the area, thus there is a lack of information on the natural assets of the area. A benefits transfer analysis was applied to evaluate the natural assets and determine the ideal locations for development that would minimize the loss of important natural heritage (Eade & Moran, 1996). A location map of the Conservation Area can be found in Figure 19.

Figure 19: Map illustrating location of Rio Bravo Conservation Area (Eade & Moran, 1996).

Methodology for Valuing Natural Assets

Eade & Moran (1996) examined the natural assets of Rio Bravo by using a benefits transfer analysis, where the costs of natural assets generated from other areas of similar topography and characteristics were used. By borrowing the prices from other studies, the costs to conduct the assessment were significantly reduced as each area does not require extensive investigation. There were two types of assets identified: direct use assets and indirect use assets. Direct use assets are products that can be created or farmed using the land, and indirect use assets are the environmental goods and services humans benefit from (Eade & Moran, 1996).

Firstly, the natural assets were mapped, with factors which can affect the quality of the feature identified. The restrains created a ratio depending on the asset's quality, which affects the costs generated for that natural feature. The data was in raster format with 50 metre cells, which allows information to be stored cell by cell. Each cell contains information on the different types of assets within that cell, along with its ratio. Some of the natural assets considered were the number of plant species, soil conservation, flood control, tourism, carbon storage, and products produced. Information on certain assets had to be assumed using indexes found from other literature, as the data was not available for the study (Eade & Moran, 1996). Figure 20 below outlines the application of market value for each cell in the raster.

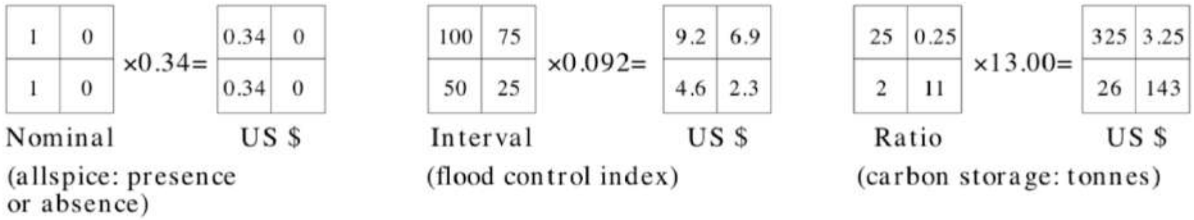


Figure 20: The quality assessment for assets and the application of the market value for each cell in the raster created for the Rio Bravo Conservation Area (Eade & Moran, 1996).

The next step was to find the market value of each asset. When the costs were found, it had to be formatted in a consistent manner and adjusted for currency and inflation. The format was in USD currency and in cost per hectare. After the costs were found for all assets, they were multiplied to each cell to find the costs of each asset within; and finally summed to find the total cost of each cell mapped in the Conservation Area (Eade & Moran, 1996). Figure 21 below illustrates the resulting asset valuation map.

Weaknesses or Gaps in the Methodology

The limitation to this methodology is the completeness of the assets found in the area. If an asset is missing, then the entire product can be misleading, with the severity depending on the importance of the asset. Extensive data collection is required for the entire area to ensure assets are not miscounted or missed, and also to eliminate any needs for assumptions. Also, since the market values are borrowed from other sites, it may not reflect the exact costs of those assets in Rio Bravo Conservation Area. Each feature may be valued differently depending on how it interacts with other assets; and thus without extensive research, these relationships may be identified and reflected in terms of value (Eade & Moran, 1996).

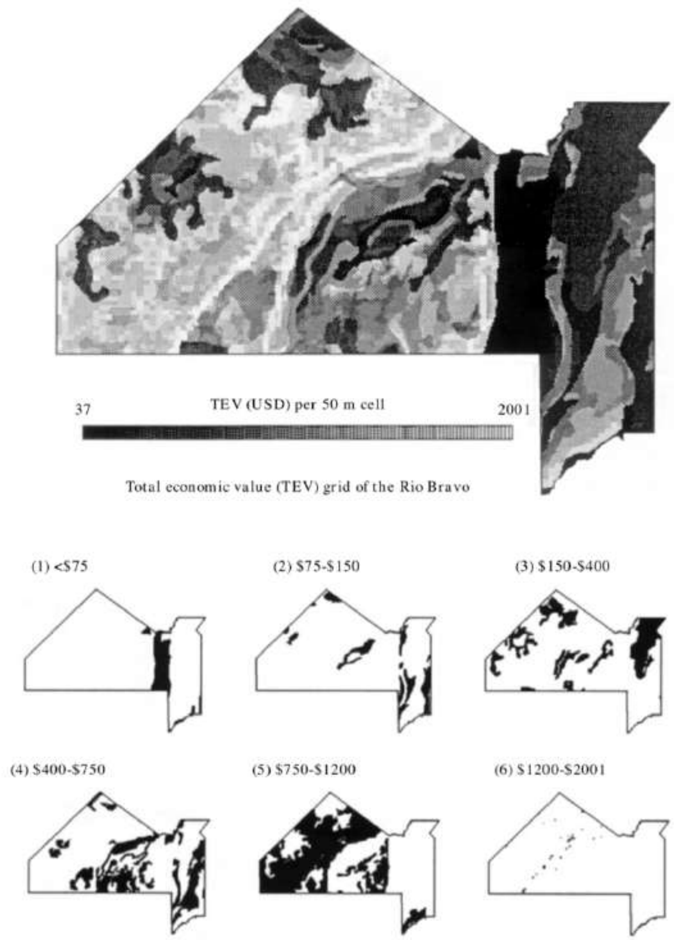


Figure 21: An asset valuation map of the Rio Bravo Conservation Area (Eade & Moran, 1996).

How Valuation Can Translate into Policy

The main strength of this methodology is the ability to add new assets to the map. Whenever a new asset is identified, the total value of the assets can be added to the map without having to repeat the entire process again. Also, since each asset has its quality evaluated, it reflects the true value of the asset for that area. It is also an inexpensive methodology since the most complicated part, the economic values of the assets, are found through other literature and therefore, additional resources to generate those figures are unnecessary. The product generated from this methodology can be an inexpensive way to help decision-makers resolve where development should occur, and which areas should be protected at all costs (Eade & Moran, 1996).

TOWN OF AURORA, ONTARIO

Location Background

Situated in central York Region in the GTA (illustrated in Figure 22), Aurora is a town with an approximate size of 49 square kilometres (4,900 hectares) situated largely on the Oak Ridges Moraine. In 2013, the Town released a report that valued the Town's natural capital assets in order to place a dollar value on its eco-services to help guide the Town's decisions for future growth. Much of the Town's data is based on the David Suzuki Foundation's *Ontario's Wealth, Canada's Future: Appreciating the Value of the Greenbelt's Eco-Services* released in 2008, which involved using a benefit transfer method to evaluate the Ontario Greenbelt's existing ecosystem services and their perceived economic values (other studies used include: research from the Canadian Urban Institute, Ducks Unlimited, and Credit Valley Conservation Authority) (Kyle, 2013).

Figure 22: Map illustrating location of the Town of Aurora (Kyle, 2018).

Methodology for Valuing Natural Assets – Ontario's Wealth, Canada's Future: Appreciating the Value of the Greenbelt's Eco-Services

The study was conducted using data taken from the 2000-2002 Southern Ontario Land Resource Information System (SOLRIS) and the CITYgreen application, and data elements were measured using the benefit transfer method (also known as value transfer) which involves the adaptation of existing valuation information or data to new policy contexts. In this case, the David Suzuki Foundation would use studies conducted in other parts of Ontario and North America (Wilson, 2008a).

According to the David Suzuki Foundation, there are several methods to determine economic value for non-market ecosystem services. These methods include (Wilson, 2008b):

- Associated economic costs/damages should these services be lost
- Willingness of someone to pay for a good and/or service
- Willingness to accept compensation for losses

As previously stated, CITYgreen is a GIS application that conducts complex statistical analyses of ecosystem services, and calculates benefits (in dollar value) based on specific site conditions. In this report, CITYgreen was used to calculate (Wilson, 2008b):

- Total annual carbon sequestered by tree canopy cover within the Greenbelt
- The value and amount of air pollutants removed by tree canopy within the Greenbelt
- The amount of water runoff controlled (i.e. water regulation) by tree cover (forest and urban parks) in relation to conversion of land-use
- Value of forest water filtration services was based on the "would-be" replacement costs to replace eco-services in the Watershed (i.e. how much it would cost to clear and replace services). Furthermore, forest water treatment costs were calculated using the City of Toronto's

current water treatment costs (i.e. in order for water to be deemed safe, the costs of treating water so it's potable).

- Carbon stored in forests calculated using Canada's Forest Carbon Budget estimates:
    - Kurz, W. A. & Apps, M.J. (1999). A 70-Year Retrospective of Carbon Fluxes in the Canadian Forest Sector. *Ecological Applications*, *9*(2), 526-547.
- Soil organic carbon data from Soil Organic Carbon database of Canada was used to assess carbon stored in soils of wetlands (i.e. by wetland type including open water, bog, swamp, fen, and marsh wetlands) and agricultural soils:
    - Tarnocai, C. & B. Lacelle. (1996). *Soil Organic Carbon Database of Canada*. Eastern Cereal and Oilseed Research Centre, Research Branch, Agriculture and Agri-Food Canada, Ottawa, Canada.
- The capacity for waste treatment of excess nitrogen and phosphorus by wetlands was estimated based on averages from published studies; the amount of excess nutrients was estimated from agricultural studies.

Because much of Aurora is situated within the Lake Simcoe Watershed (a small portion of the Town falls within the Lake Ontario Watershed), most of the data used in the Town's valuation was taken from the David Suzuki Foundation's *Ontario's Wealth, Canada's Future*; in addition to the *Lake Simcoe Basin Natural Capital* and *Canada's Wealth of Natural Capital: Rouge National Park*. The following tables (Tables 15-17) are a summary of Aurora's potential non-market ecosystem services values based on these previously published reports, covering the various portions of the Town of Aurora.

Therefore, the value of natural assets within Aurora was estimated to be approximately $7.4 million per year (Kyle, 2013).

Table 15: Aurora's potential non-market ecosystem service values in the Lake Simcoe portion of the Town (Wilson, 2008a)

Land Cover Type	Value per hectare ($/hectare/year)
Forest	$4,798
Grasslands	$2,727
Wetlands	$11,172
Water	$1,428
Cropland	$529
Hedgerows/Cultural Woodland	$1,453
Pasture	$1,479
Urban Parks	$824

Table 16: Aurora's potential non-market ecosystem service values in the Rouge National Park portion of the Town (Wilson, 2012).

Land Cover Type	Value per hectare ($/hectare/year)
Forest	$5,149
Plantations	$3,802
Wetlands	$9,651
Croplands	$378
Grazing/Pasture	$1,728
Hedgerows	$3,110
Idle Land	$1,728
Green Space	$785
Rivers	$1,421
Shoreline	$541
Average	$2,846

Table 17: Aurora's potential non-market ecosystem service values in the Greenbelt portion of the Town (Wilson, 2008b).

Land Cover Type	Value per hectare ($/hectare/year)
Wetlands	$14,153
Forest	$5,414
Grasslands	$1,618
Rivers	$335
Cropland	$477
Orchards	$494
Hedgerows	$1,678
Idle Land	$1,667

Weaknesses or Gaps in Methodology

This valuation provides a comprehensive analysis to develop guiding policy documents for the protection of natural assets within the municipal context; however, natural assets have not been identified as stormwater management assets in the valuation, even though they typically function as such facilities and provide monetary benefits as a result. In addition, golf course lands were not included in the Town's capital assets; therefore, further research is required to determine the contribution of such lands to asset values given their natural features and functions. Furthermore, the natural asset benefits and values of trails may not have been fully comprehensive as public health and tourism were outside the scope of the study's valuation, even though trails are essential to providing these benefits (Kyle, 2013).

How Valuation has been Translated into Policy

The study of natural assets in the Town of Aurora identified a number of existing features, policies, and initiatives within its boundaries; as well as various benefits for protecting ecosystems as follows.

Existing Features (Kyle, 2013)

- North-East Aurora Urban Wildlife Park: Approximately 0.7 square kilometres (70 hectares) in size, Aurora's North-East urban wildlife park serves as a buffer zone between two urban expansions in the northeast corner of Aurora. The park consists of the East Holland Wetland Complex and associated woodlands, wildlife habitat, streams and grasslands.
- Ducks Unlimited Property: Situated at the heart of the urban wildlife park is approximately 0.25 square kilometres (25 hectares) of land owned by Ducks Unlimited which contains a mix of coniferous and deciduous forests, wetland areas, open water, watercourses and wildlife habitat.

- McLeod Wood Nature Reserve: A separate entity from the Wildlife Park is the McLeod Wood Nature Reserve, a 0.16 square kilometres (16 hectare) lot rich in wildlife that forms a portion of the upper headwaters of the east Holland river subwatershed.
- Aurora Community Arboretum: Initially created in 2009, a joint venture between the Town of Aurora and Lake Simcoe Region Conservation Authority. The arboretum functions as a community point of interest and educational tool in promoting familiarity and appreciation of ecological diversity. The future of the arboretum is guided through the Town's Master Plan. For more details, see (www.auroraarboretum.ca).
- Conservation Areas
    - Case Woodlot: Designed in the Oak Ridges Moraine Core Area, and consists of a mixture of deciduous species, wildlife habitat, trails, wetland area and watercourses with the Town owning 0.27 square kilometres (27 hectares).
    - Sheppard's Bush Conservation Area: Consists of 0.23 square kilometres (23 hectares), and listed as a cultural heritage site, owned by Ontario Heritage Trust and managed by the Town and Lake Simcoe Conservation Authority.
    - Vandorf Woodlot: Made up of 0.34 square kilometres (34 hectares) owned by the Town, consisting of mature deciduous and coniferous trees, wetlands, wildlife habitat, trails and watercourses.
    - McKenzie Marsh: Consists of approximately 0.22 square kilometres (22 hectares) in total, and only portions of which are owned by the Town, with the remainder owned by the McKenzie family. The Town constructed a trail system and boardwalk to connect the Nokiiddaa Trail to Newmarket's trail system.
    - Anne Bartley Smith Property: Containing 0.38 square kilometres (38 hectares) owned by the Ontario Heritage Foundation (OHF), and consisting of coniferous woodland, wildlife habitat, trails and grasslands. The Town is working with the OHF to develop management plans.
- Stronach Eco-Park: In 2012, Stronach Group submitted a proposal to develop an "Eco-Park", whereby the parkland would include: wildlife habitats, nature trails, boardwalks and lookouts, watercourses, wetlands, and wooded areas. The Eco-Park was also proposed to include soccer fields and an "Environmental Interpretation Centre". The proposed partnerships include the Town, Stronach Group, Lake Simcoe Region Conservation Authority and the Windfall Ecology Centre.

In addition to the above, this valuation assisted in developing the Aurora Northeast (2C) Secondary Plan to guide future growth, redevelopment, and intensification within the Town in order to better protect the environment, while enabling well-designed residential neighbourhoods. The 2C Secondary Plan was adopted in 2010 to guide land use decisions, and develop community and enhancement plans, and is expected to be the Town's leading edge policy document in implementing green building technologies and best management practices. Green Development standards were also adopted and implemented in the Official Plan to address Low Impact Development (LID) standards, energy efficiency, active transportation, water runoff and filtration, and greenhouse gas emissions through development applications (Kyle, 2013).

Benefits for Protecting Ecosystems
There were a number of benefits identified as a result of protecting the ecosystems within the Town's boundaries, including (Kyle, 2013):

- Pollutant Regulation: Regulation of carbon monoxide, sulfur dioxide, ozone, and others; and production of oxygen.
- Water Regulation and Treatment: Regulation of water flows in several ways, including evaporation, infiltration, and natural flow restrictions. Wetlands are also instrumental in removing numerous contaminants and waste.
- Waste Treatment: Wetlands are very efficient in removing excess nitrogen and breaking down many components of waste.
- Pollination: Insect pollination is necessary for most fruits and vegetables such as tomatoes, peppers, strawberries, apples and peaches.
- Recreation: Recreational opportunities such as biking, hiking, bird watching, etc. These activities also greatly benefit tourism and yield economic benefits.

APPENDIX D: GAPS IN MUSKOKA'S POLICY FRAMEWORK

Following the academic literature review and case study analysis, an examination of Muskoka's current policy framework was conducted. In analyzing Muskoka's framework, gaps and areas for improvement for a number of specific policy documents within the District pertaining to natural asset valuation and protection were identified. These policy documents include: the Draft District of Muskoka Official Plan, Area municipality Official Plans, the District's Asset Management Plan, the District Economic Strategy, Area municipality Economic Strategies, the Muskoka Growth Strategy, the Muskoka Tourism Policy Review, and Muskoka Watershed Report Card. This section is meant to identify the potential areas for policy improvements within the District to be addressed through the valuation of natural assets model, and policy recommendations in Phase 2 and 3 of this study.

DISTRICT OF MUSKOKA AND AREA MUNICIPALITY OFFICIAL PLANS

In regards to the Draft District Official Plan policies, the draft policies surrounding natural heritage features, including Section F1.5.2 "Natural Asset Planning", provide a solid policy framework foundation to help protect natural heritage features within the District. Therefore, the following sections will outline potential policy sections that could integrate the findings from Phase 2 of this study into the Draft Official Plan (District of Muskoka, 2017):

- D1.3 "Creating and Maintaining a Strong Tourism Sector" - explicit links to water resources and subsequent natural assets should be incorporated and/or created where applicable
- Section F1.1 b) "Objectives" does not provide general direction for implementation of more detailed monitoring systems and techniques for the evaluation and protection of natural heritage features and areas to address the ongoing floodplain mapping initiative, and natural asset valuation mapping
- F1.2.2 "Habitat of Endangered Species and Threatened Species" - could incorporate findings from Phase 2 to better protect identified endangered species and wildlife habitats
- Natural asset protection through alternative initiatives such as bonusing/incentive programs for protecting key natural features in return for appropriate development rights near natural heritage features (i.e. to integrate into Section F1.5.2 "Natural Asset Planning"), and/or "land swap" programs between the government and landowners/developers to acquire and effectively protect priority natural features identified (i.e. to integrate into Section F1.5.3 "Consideration of Cumulative Impacts") is not currently included in Muskoka's policy framework
- Section F2.5 b) "Watershed and Subwatershed Planning" does not provide additional reference to the natural asset valuation mapping initiatives, working in partnership with local Municipalities and other agencies, to coordinate watershed planning initiatives
- Policies surrounding identified disturbances and/or development restrictions should also be incorporated

Overall, once the preliminary valuation and analysis of Muskoka's natural assets is complete, Section F "Ecosystems of Muskoka: Natural Heritage and Water Resources", namely F1.2 "Natural Heritage Features in the District", should be updated to outline relevant natural asset importance and prioritization (i.e. further protection of wetlands, endangered species, habitats, etc.) based on the Phase 2 findings. Furthermore, natural heritage features policies could be altered to prioritize key natural assets based on the preliminary analysis and valuation model results, which could impact Section F1.3. "Development and Site Alteration", and more specifically F1.5.2, as well as provide additional Schedules to identify and protect key natural assets (District of Muskoka, 2017). With the draft policy F1.5.2 regarding "Natural Asset Planning", incorporation of the valuation of Muskoka's natural capital assets into the District's policy framework and creation of a natural asset planning strategy for the District could be expanded with criteria analysis of key natural assets, prioritization of these assets, comprehensive mapping of protection areas, and implementation policies in the District Official Plan to outline protection requirements through the development application process; as well as address natural asset planning more comprehensively (i.e. not just focusing on natural assets from an infrastructure perspective). In order to achieve this, a clear process is needed to value natural assets within the District and watersheds at different scales and contexts (being the goal of this study in compiling and presenting this process with policy implementation recommendations). District Official Plan policy recommendations, mapping, and analysis would then be implemented into the local municipality Official Plans and subsequent Zoning By-laws in the following policy sections:

- Town of Huntsville Official Plan: broad environmental objectives in 2.4.2; Section 3 Environment together with Appendices 1-4 Natural Features; Section 8 – Waterfront; and Section 10.10 Stormwater Management (Town of Huntsville, 2006)
- Town of Bracebridge Official Plan: broad goals in A6.5, A7.4, and A7.10; B9.0 Development Constraints; B10.0 Environmental Constraints together with Appendix A; Section F – Waterfront; and I5.0 Stormwater Management (Town of Bracebridge, 2013)
- Town of Gravenhurst Official Plan: broad goals referring to protection of natural heritage and environment in A4.4 and B2; Section D – Waterfront; and Section I Natural Heritage and Environment (including stormwater management) together with Schedule B (Town of Gravenhurst, 2016)
- Township of Muskoka Lakes Official Plan: Section B Waterfront with broad objectives of natural area protection in Section B.4; Section B.7 Waterfront Natural Areas; Section B.8 Areas of Use Limitation together with Appendix 2; Section C.7 Urban Centre Natural Areas; Section D.8 Communities Natural Areas; and Section E.10 Rural Natural Areas (Township of Muskoka Lakes, 2013)
- Township of Lake of Bays Official Plan: Section D Environment, namely Section D-2, D-3, D-5, and D-12 regarding water resources together with Schedule C1 and C2; Section E Development Constraints; and Section H Waterfront (Township of Lake of Bays, 2016)
- Township of Georgian Bay Official Plan: broader goals and objectives in B.1.1, B.2.1, and B.2.5 Environment and Resources; Section D Resources together with Appendix 4-1, 4-2, 4-3, 6, 7, 8, and appendices 9; Section F Waterfront; and F.2.3 Water and Sewage Servicing and Stormwater Management (Township of Georgian Bay 2014)

Although all official plans contain policies surrounding specific environmental features (i.e. wetlands, floodplains, fish and wildlife habitat, endangered and threatened species, forested lands, steep slopes and erosion areas, etc.), and they outline development setbacks from some protected features (i.e.

wetlands, lakes, and rivers), they are not all consistent in outlining protection policies for these features. Therefore, there is a need for consistent natural asset mapping and protection policies in place at the District level, to then be implemented at the local level into Official Plans (to be in conformity with the District Official Plan), followed by the municipal Zoning By-laws. More specifically, there could be additional development restrictions implemented into the District and local municipality planning documents based on the natural asset and disturbance findings from Phase 2 of this study.

DISTRICT OF MUSKOKA ASSET MANAGEMENT PLAN

The District of Muskoka's *Asset Management Plan for Roads, Bridges, Water and Wastewater Assets* does not mention or incorporate natural assets into the District's long-term financial planning (Watson & Associates Economists Ltd., 2014). As a result of the case study analysis of the Town of Gibsons, which explained the policy implementation method utilized by the Town of incorporating natural asset valuation into their asset management framework and eco-asset strategy, incorporation of the Muskoka natural asset valuation into the District's Asset Management Plan (and subsequent Area Municipality Asset Management Plans) could be explored. In this regard, utilization of the Municipal Natural Asset Initiative (MNAI) could be applied in the context of Muskoka if such natural asset policy incorporation is feasible. This could provide a possible method for increasing protection for the key natural assets identified in the District as a result of analysis from Phase 2 of this study.

DISTRICT AND AREA MUNICIPALITY ECONOMIC STRATEGIES

The District of Muskoka has an economic strategy document which outlines key economic data within the municipality, as well as the prospects and economic framework for the future. In terms of Gross Domestic Product (GDP), the most important sectors in Muskoka are manufacturing ($309 million); construction ($220 million); and real estate, rental and leasing industries ($199 million). Manufacturing is expected to continue to decline, while tourism, seasonal residential and retirement related demands will be the most important sectors within the District's economic and population growth. In terms of tourism, there has been a decline of smaller resorts over the past few decades, with most ownership being from large-scale hotel type resorts. For natural resources, it mentions how there is a decline in the amount of marketable timber and how since the District is located on the Canadian Shield, there is limited land for different types of industries (MGP, 2008). That being said, there is no mention of natural assets and how the natural environment and protection of it would provide benefits to the economy. This is a clear gap that is missing in this strategy since protecting environmentally sensitive landscapes can provide significant long-term savings. An additional gap identified is that there is a need for a less fragmented tourism marketing strategy in Muskoka. More focus should be placed on one coherent message that spans across the municipal boundaries.

Some of the lower-tier municipalities within the District of Muskoka also have developed their own economic development strategies. These include: Gravenhurst, Huntsville, Lake of Bays, Muskoka Lakes, and Georgian Bay. All of the lower-tier municipalities that have an economic development plan indicate the importance and strong reliance on the tourism industry. However, none of them discussed the valuation of the natural environment, or how natural assets can be identified and how these relate to their economy. Below is a list of each lower-tier municipalities' economic development strategy:

- Town of Gravenhurst (Romanin, 2013)
  - *Economic Development Strategic Plan*
  - Mentions importance of Muskoka's heritage and natural environment for their vision, but does not expand on how that can be of economic benefit
  - Focus on the importance of tourism
- Town of Huntsville (Town of Huntsville, 2017)
  - *Strategic Plan 2017 and Beyond*
  - Includes how the Town plans on integrating sustainability principles into their planning and development policies, as well as commitment to protecting the natural environment
    - However, there is no mention of this in the economic development section
- Township of Lake of Bays (McSweeney, 2017)
  - *Economic Development Strategy*
  - Identifies tourism as a major economic activity and how it will enhance tourism marketing
  - There is no mention of the economic importance of environmental services
- Township of Muskoka Lakes (Township of Muskoka Lakes, 2008)
  - *Economic Development Strategy*
  - Tourism is mentioned; however, once again no economic importance is given directly to natural assets
- Township of Georgian Bay (MM Consulting, 2014)
  - *Community Based Economic Development Strategy*
  - Identifies that the economy, environment, society, and culture are all important factors for sustainability

MUSKOKA GROWTH STRATEGY

Under the Provincial Policy Statement (PPS), the District of Muskoka is required to help manage future growth by identifying areas where development will occur, and forecast housing and employment projections. The Muskoka Growth Strategy calculates these projections for the District and determines future trends. It is determined that employment growth will be concentrated around tourism, business services, health care, and construction. In terms of population, it is aging slightly more quickly than the Province of Ontario as a whole. The permanent population base in the District is forecasted to grow between 0.6% and 1.3% annually during the next 30 years, while the seasonal population base is forecasted to grow slower between 0.2% and 0.6% annually during the same timeframe (District of Muskoka, 2013).

The Muskoka Growth Strategy recommends that the District and lower-tier municipalities develop aggressive policies to encourage development in designated urban areas and restrict rural development activity (District of Muskoka, 2013). While encouraging development in designated urban areas is good, there should be specific zones within the watershed that do not permit development. These zones could be a floodplain, an area where endangered species reside, or an environmentally sensitive landscape. These areas should be explicitly shown to ensure development that has the potential to harm the natural environment does not occur. Furthermore, new policies could be in place that require new developments to be environmentally-friendly by enhancing, incorporating, or protecting the environment with the development.

MUSKOKA TOURISM POLICY REVIEW

Tourism plays an important role in Muskoka's economy. In particular, adventure tourism and ecotourism (such as camping) will continue to be a growing opportunity for Muskoka's tourism industry. In order to ensure that the industry continues to thrive, policy could be enhanced by developing a framework which is more permissive in order to allow for more tourism investment in appropriate areas.

That being said, there are a few things to be cautious about. First, the District should understand that changing their policy framework to be more permissive for tourism does not necessarily guarantee new development. Furthermore, when development does occur, it is important to ensure it is not destructive to the aesthetics and health of Muskoka's landscape, but rather enhances it. Finally, new development could have negative impacts on the waterfront character and landscape in Muskoka. When new tourist sites get developed, the District should conduct an analysis to ensure there will not be negative implications to the aesthetics of the landscape, or disruption to the watershed or the overall environment.

MUSKOKA WATERSHED REPORT CARD

The Muskoka Watershed Council publishes a Muskoka Watershed Report Card summarizing the environmental health of the watershed and subwatersheds, as well as the current conditions of the land and its resources. The latest Report Card was released in 2014 with the previous one being in 2010. In terms of a gap related to this document, there could be more frequent releases of the Report Card since the last one was published four years ago. There could be annual or biannual reports that summarize the latest watershed analysis to ensure all information is up-to-date. These reports do not have to be as long or in-depth as the current ones are, but rather provide an update on the health of each subwatershed; as well as what action item have been completed since the last update and what still needs to be improved upon. The Muskoka Watershed Report Card indicates multiple stressors that impede on the watershed and explains how each stressor could manifest into other potential issues. It then recommends action items that would be required to tackle these issues. However, another gap is that there are no incentives for the District to implement policies that would achieve these actions. For example, one stressor that the Report Card indicates is how there is too much sodium in lakes from the road salt, and the Report Card lists a potential action to reduce the amount of road salt used during the winter (Muskoka Watershed Council, 2014). The District could take this particular action and create a policy that limits the amount of road salt used during storm events. This way, the actions that the Muskoka Watershed Council outline could be implemented to improvement the watershed health.

APPENDIX E: SUPPLEMENTARY FINDINGS – BEYOND THE SCOPE OF THE STUDY

Extending beyond the scope of this study, a number of administration and governance gaps have been identified pertaining to data availability, multiple jurisdictions, and comprehensive natural asset and watershed management.

In regards to data availability, since the District spans over such a large and diverse geographic area, there is difficulty in collecting and updating data for the entire District, including the entire Muskoka River Watershed. This is largely due to limited staff resources, time and funding on a permanent basis to gather and create necessary natural asset data. Therefore, there is lack of detailed and accurate natural asset data for entire watersheds, as available data is limited to inside the District boundaries (as further discussed in Phase 2 above). This is related to the issue of the District being too diverse on a multi-watershed authority (containing three unique watersheds with competing resource bases). Moreover, adjacent watershed authorities and jurisdictions (i.e. Lake Simcoe Region, Kawartha, and North Bay Matawa Conservation Authorities) upstream or downstream dramatically impact the District's natural assets and policy basis.

In relation to the database gap, there is lack of support for governance regarding floodplain mapping and risk analysis in the rural areas (as floodplain mapping is more accurate and complete in the urban areas); however, a floodplain mapping project is ongoing in Muskoka that will assist in filling the gap to supply up-to-date floodplain mapping. Furthermore, although there is limited development already in place around floodplains within the District, there are multiple authorities that regulate floodplains, wetlands, Areas of Scientific Interest (ANSI), etc. (i.e. Ministry of Natural Resources and Forestry, Ministry of Environment and Climate Change, Federal Department of Fisheries and Oceans, etc.) Therefore, there is a lack of a singular natural asset governance body with legislative authority, staff and enforcement basis to ensure a comprehensive natural asset management system for the Muskoka River Watershed as a single entity. With management of natural assets in Muskoka presently being comprised of 6 municipal governance and policy authorities, there is a multitude of policy, implementation frameworks, and enforcement directions causing potential management inconsistency. As a result, a single governing authority (i.e. a Conservation Authority or similar authority) with capabilities to legally govern the natural assets, receive long-term funding, create a comprehensive database, and contain adequate staffing and enforcement approval rights could be implemented. District and area municipal policies and development approvals could then be coordinated with the 'watershed authority' policy and approvals. Below is an overall analysis of the benefits and challenges of implementing a Conservation Authority.

The overall challenges with implementing a Conservation Authority is potential lack of support from some members of the public due to increase in taxes (through municipal levies) to the Conservation Authority, as well as resistance for implementing an additional level of development review authority. Although these are potential challenges of implementing a Conservation Authority, there are many benefits of such an authority that could outweigh the challenges. Firstly, Conservation Authorities are organized on a watershed basis, legislated under the *Conservation Authorities Act, 1946*, encouraging a balanced approach to managing the interests of the environment, human and economy on an integrated watershed management level (Conservation Ontario, 2018). Such authorities manage watersheds, flooding, source water protection, stormwater management, watershed stewardship, risk management, and environmental education (Conservation Ontario, 2018). In terms of the role of Conservation Authorities in land-use planning, they are a delegated authority responsible for representing provincial interest in natural hazards through review of policy documents and development applications, are a planning advisory body for municipalities (i.e. addressing water quality and quantity, stormwater studies, environmental impacts, any activities near sensitive natural features, and various technical expertise), and an agency for watershed-based and local resource management (Conservation Ontario, 2018). As a result, Conservation Authorities increase adequate mapping and resources, funding, expertise, regulation, policy creation and implementation power, regulation and protection of watersheds through the development application process, and data availability for the entire watershed.

To help address the potential public opposition for implementing a Conservation Authority, here is a brief cost analysis for such an authority. In funding a Conservation Authority, the breakdown of funding is typically as follows: municipal levies 54%; self-generated revenue 34%; Provincial grants and special projects 9%; and Federal Grants or Contracts 3% (Conservation Ontario, 2018). Development review fees can also apply to properties that fall within the authority's boundaries. The *Conservation Authorities Act* outlines the Conservation Authority Levies payable to an authority by a municipality on a land use ratio basis through a current value assessment by property classes. This current value assessment of all lands within a municipality falling within the authority's boundaries are added, and then the factor value is applied, as illustrated in Table 18 below (Province of Ontario, 1990). The modified assessment of participating municipalities is then calculated "by dividing the area of the participating municipality within the authority's jurisdiction by its total area and multiplying that ratio by the modified current value assessment for that participating municipality" (Province of Ontario, 1990). The levy amount is divided between participating municipalities based on the benefit each municipality receives from the authority services.

Table 18: Current Value assessment of Municipal Levies for a Conservation Authority based on property classes(Province of Ontario, 1990).

Property Class	Factor
Residential/Farm	1
Multi-Residential	2.1
Commercial	2.1
Industrial	2.1
Farmlands	0.25
Pipe Lines	1.7
Managed Forests	0.25
New Multi-Residential	2.1
Office Building	2.1
Shopping Centre	2.1
Parking Lots and Vacant Land	2.1
Large Industrial	2.1

As an example, Halton Region calculated the funding for three Conservation Authorities within its region, as outlined in Table 19 below:

Table 19: Municipal Levies to Conservation Authorities in Halton Region (Halton Region, 2015).

Conservation Authorities Levy Funding History (Budget)							
	2010	2011	2012	2013	2014	2015	Average Annual Increase (over 10 years)
Grand River Conservation % increase	$178,710 (20.9%)	$193,818 (8.5%)	$207,903 (7.3%)	$219,766 (5.7%)	$241,036 (9.7%)	$250,780 (4.0%)	11.6%
Credit Valley Conservation % increase	$389,622 (6.7%)	$399,680 (2.6%)	$420,935 (5.3%)	$430,297 (2.2%)	$467,353 (8.6%)	$500,222 (7.0%)	10.6%
Conservation Halton % Increase	$6,046,478 (7.0%)	$6,496,329 (7.4%)	$6,881,282 (5.9%)	$7,057,628 (2.6%)	$7,308,403 (3.6%)	$7,631,871 (4.4%)	9.1%
Total Conservation Authorities	$6,614,810	$7,089,827	$7,510,120	$7,707,691	$8,016,792	$8,382,873	

Based on the population within the Grand River Watershed boundary being 970,000; and 757,600 within the Credit River Watershed; the levy funding in 2015 for a Conservation Authority in the Halton Region was approximately $0.26 - $0.66/person (Halton Region, 2015; Wilson & Kennedy, 2009; GRCA, 2014).

Based on the above analysis, there are many benefits to comprehensively managing significant natural features through a Conservation Authority. Therefore, it is essential to determine whether governance should continue to be on an individual municipal basis through policy regulations, or on a watershed management basis through a Conservation Authority. Furthermore, review of development applications/building permits by a regulating authority is an effective way to enforce necessary protection.

Another option to further protect Muskoka's water resources could be the implementation of a source protection authority under the *Clean Water Act* for the Muskoka River Watershed. There is also the opportunity to implement a second watershed-level body, being the source protection committee for each source protection region made up of local citizens in the watershed selected by the source protection authority. Coalitions of source protection regions can also occur, with a lead source protection authority. Source protection planning under the *Act* requires development of a term of reference, assessment report, and source protection plan with delineation of threats and protection areas (i.e. into Wellhead Protection Areas, Surface Water Intake Protection Zones, Highly Vulnerable Aquifers and Significant Groundwater Recharge Areas). These documents and the enforcement authority protect the quality and quantity of drinking water sources from potential threats (Lake Simcoe Region Conservation Authority, 2015; Trent Conservation Coalition Source Protection Committee, 2014). Therefore, with the implementation of a Conservation Authority, a source protection authority could be created as a result of the development of terms of reference, assessment report, and source protection plan (where applicable) to further protect essential water sources. However, it is important to note that the majority of the District is not subject to the Source Water Protection Act, and therefore not bound by the requirement to complete Source Water Protection Plans.

APPENDIX F: LAND COVER COVERAGE MAPS

The following maps show the coverage and compositions of each land cover category used in this study, namely wetland, forest, water, protected lands, and cropland.

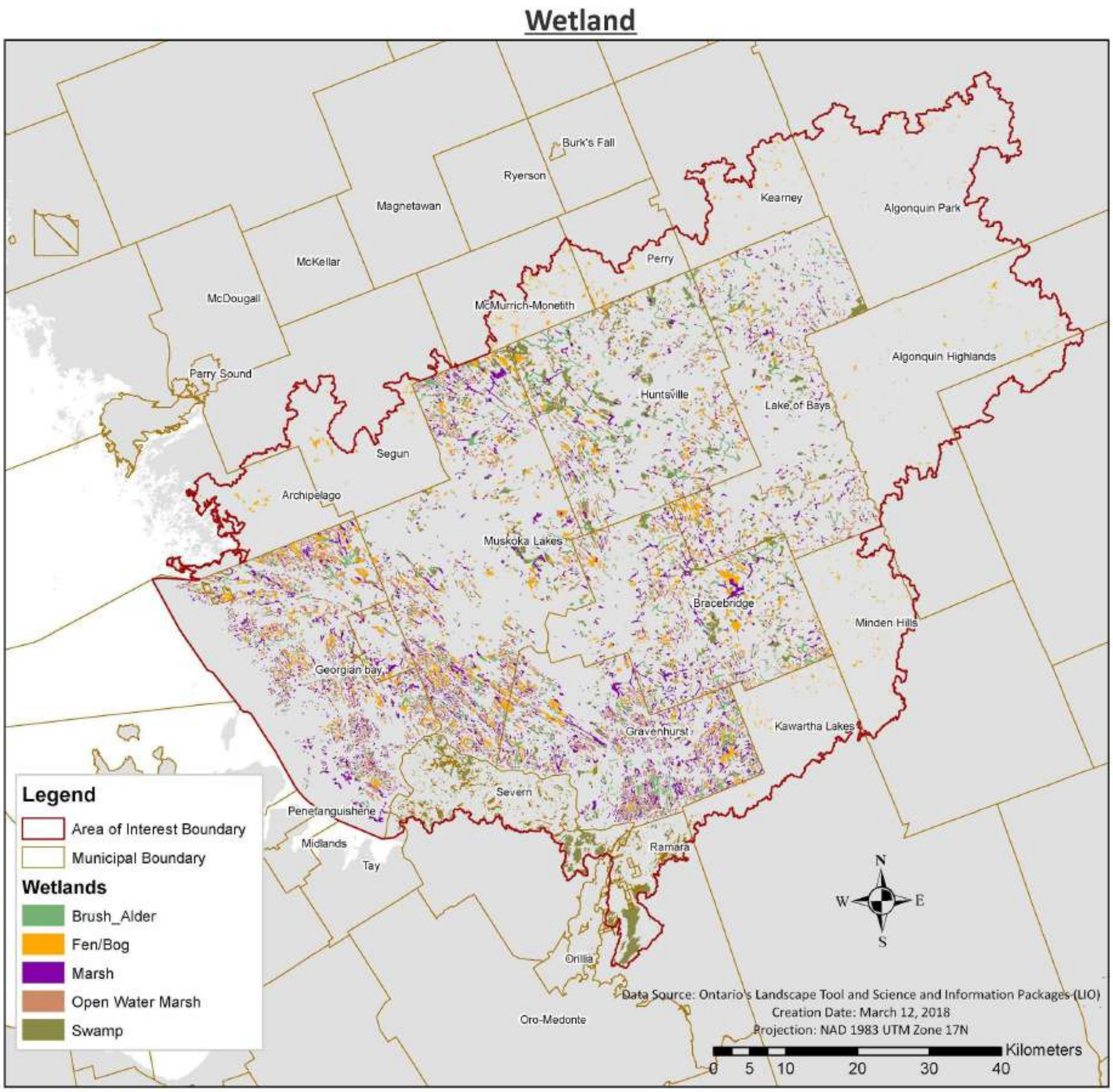


Figure 23: A map showing the composition of the Wetland land cover category.

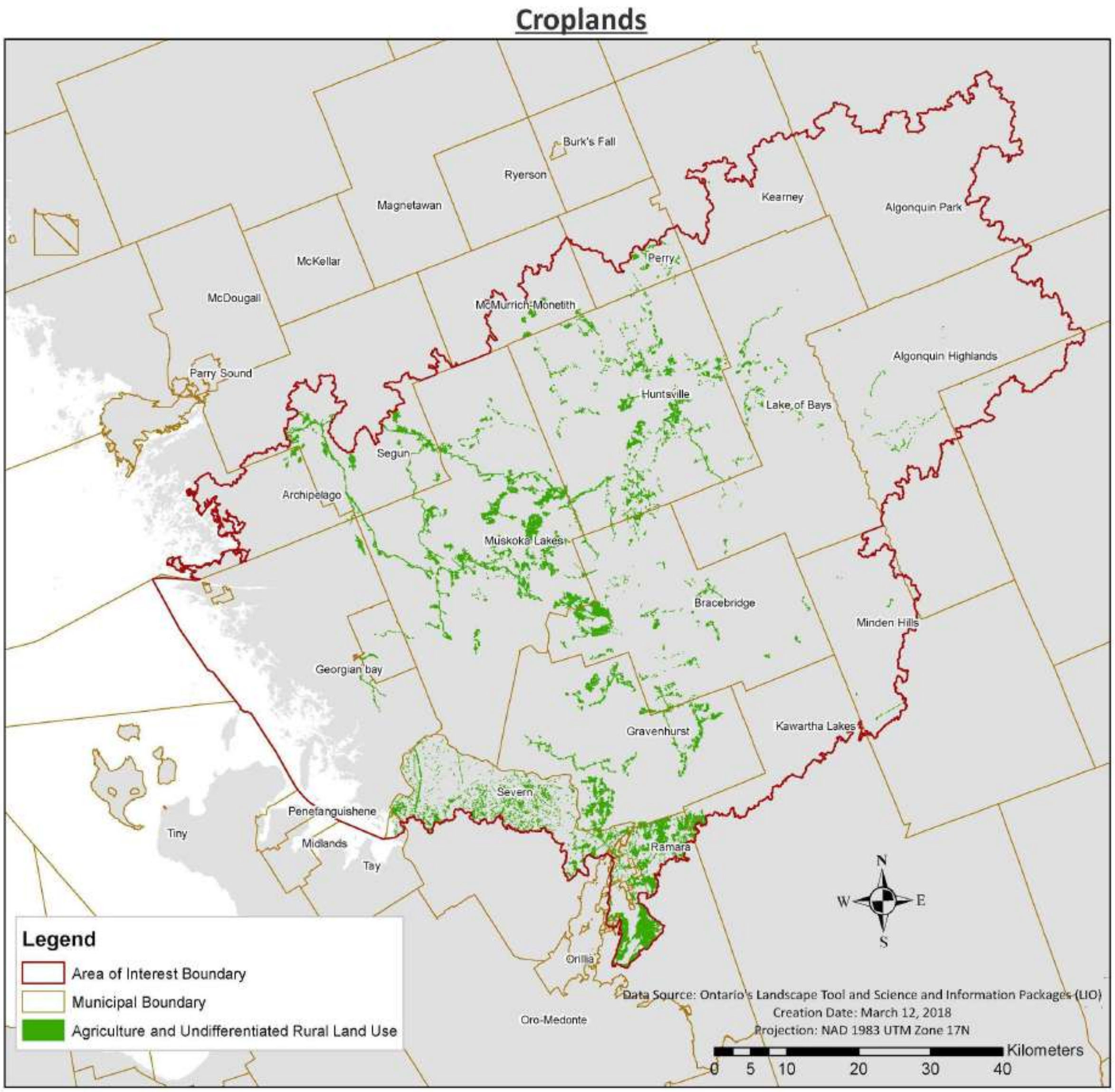


Figure 24: A map showing the composition of the Cropland land cover category.

Forest

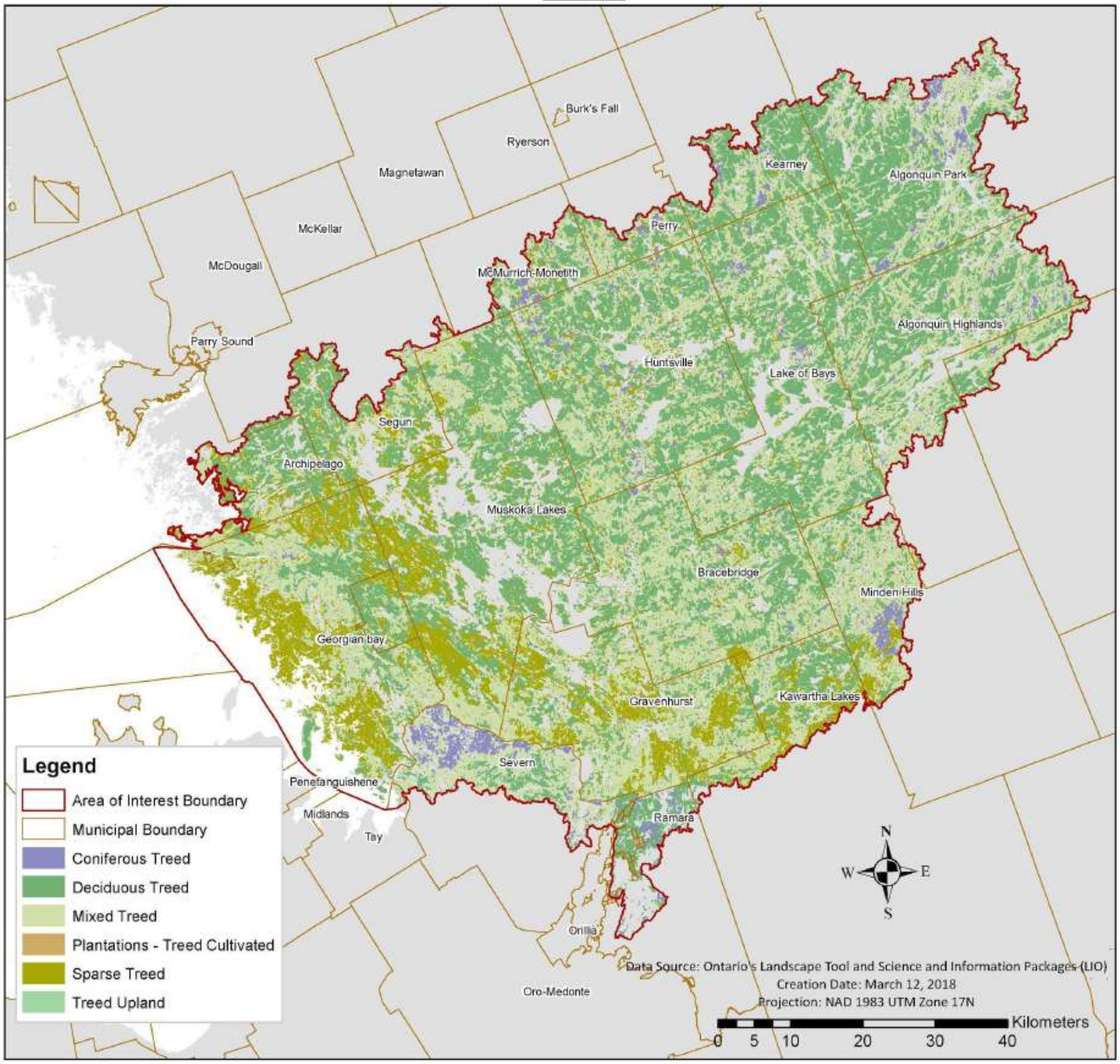


Figure 25: A map showing the composition of the Forest land cover category.

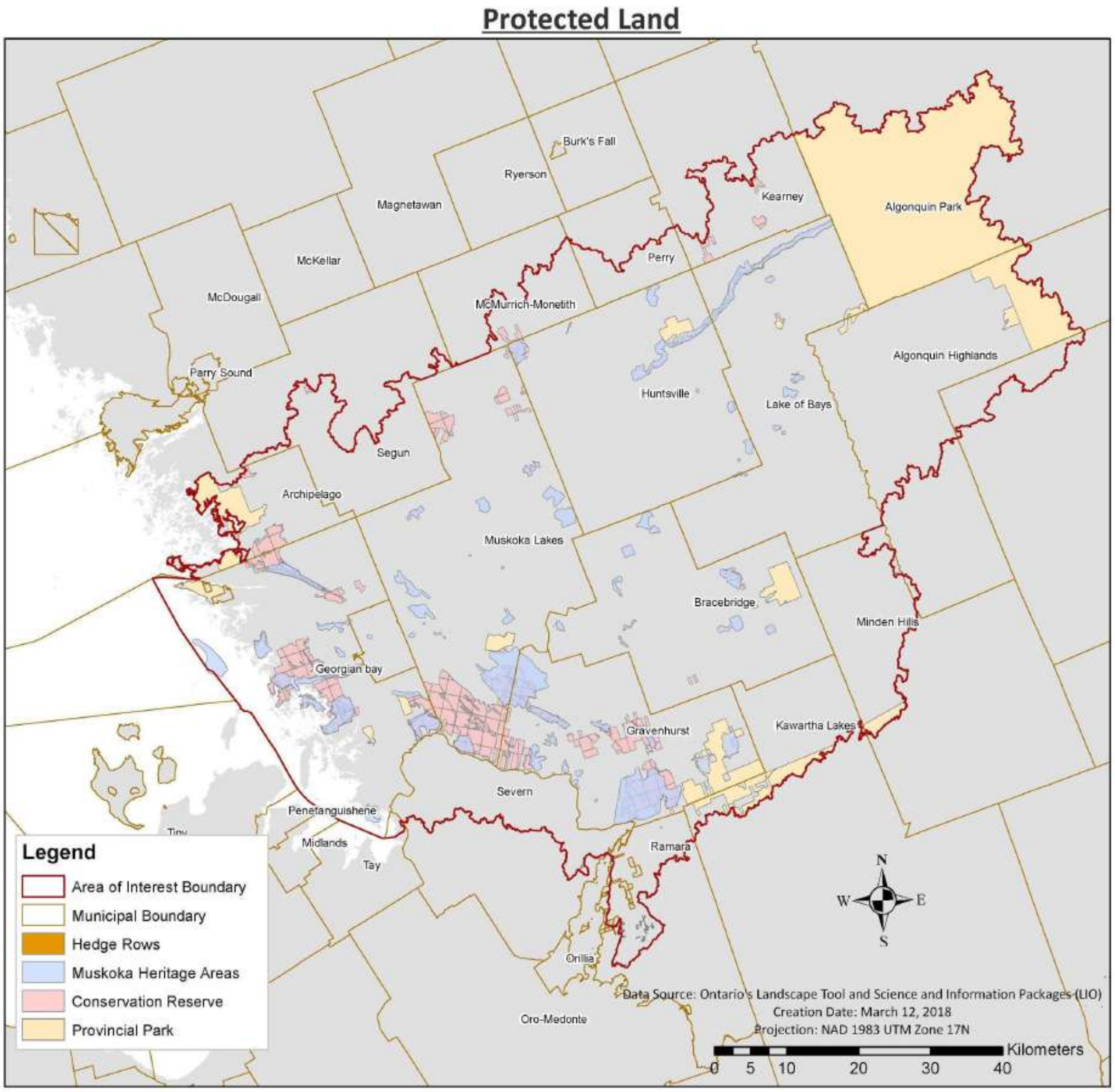


Figure 26: A map showing the composition of the Protected Lands land cover category.

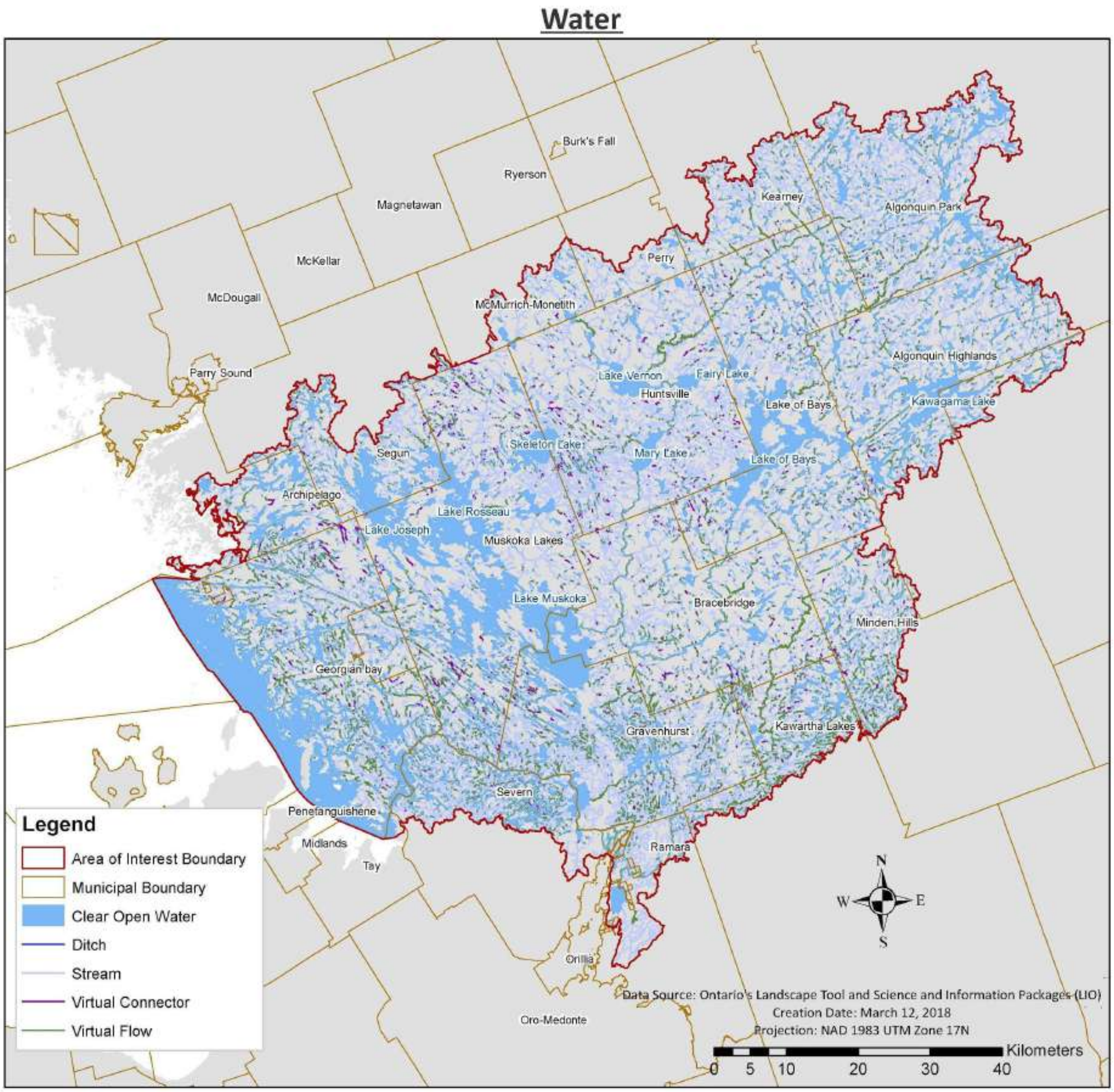


Figure 27: A map showing the composition of the Water land cover category.

APPENDIX G: MINIMUM, MAXIMUM AND VALUE-DIFFERENCE MAPS

The following map shows the difference in value between the minimum and the maximum map. This can help identify areas where further studies could be conducted locally to configure a more accurate cost for the study area.

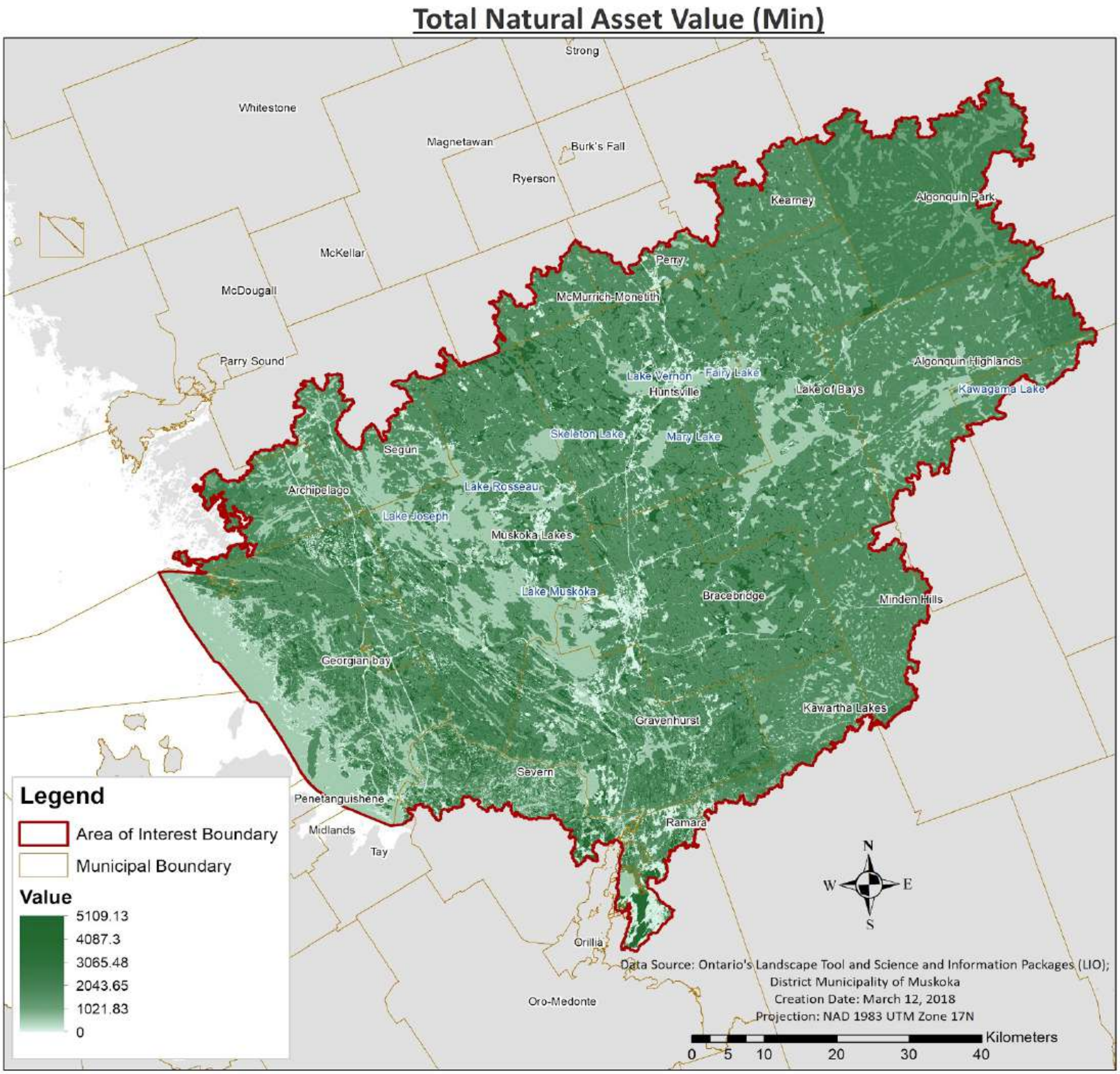


Figure 28: A map showing the distribution of minimum total value of the natural assets in Muskoka watersheds

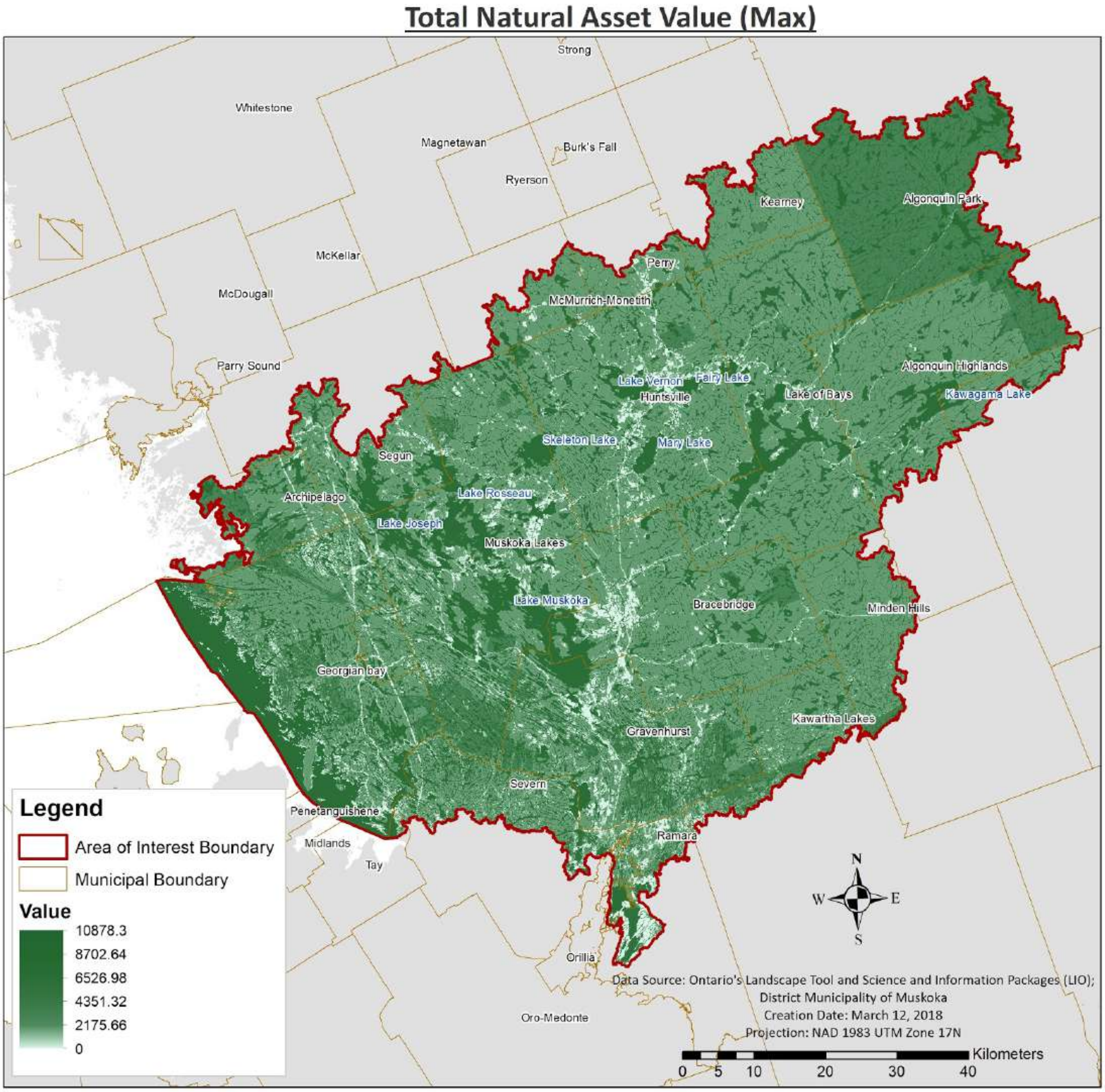


Figure 29: A map showing the distribution of maximum total value of the natural assets in Muskoka watersheds.

Difference in Price for the Minimum and Maximum Natural Asset Values

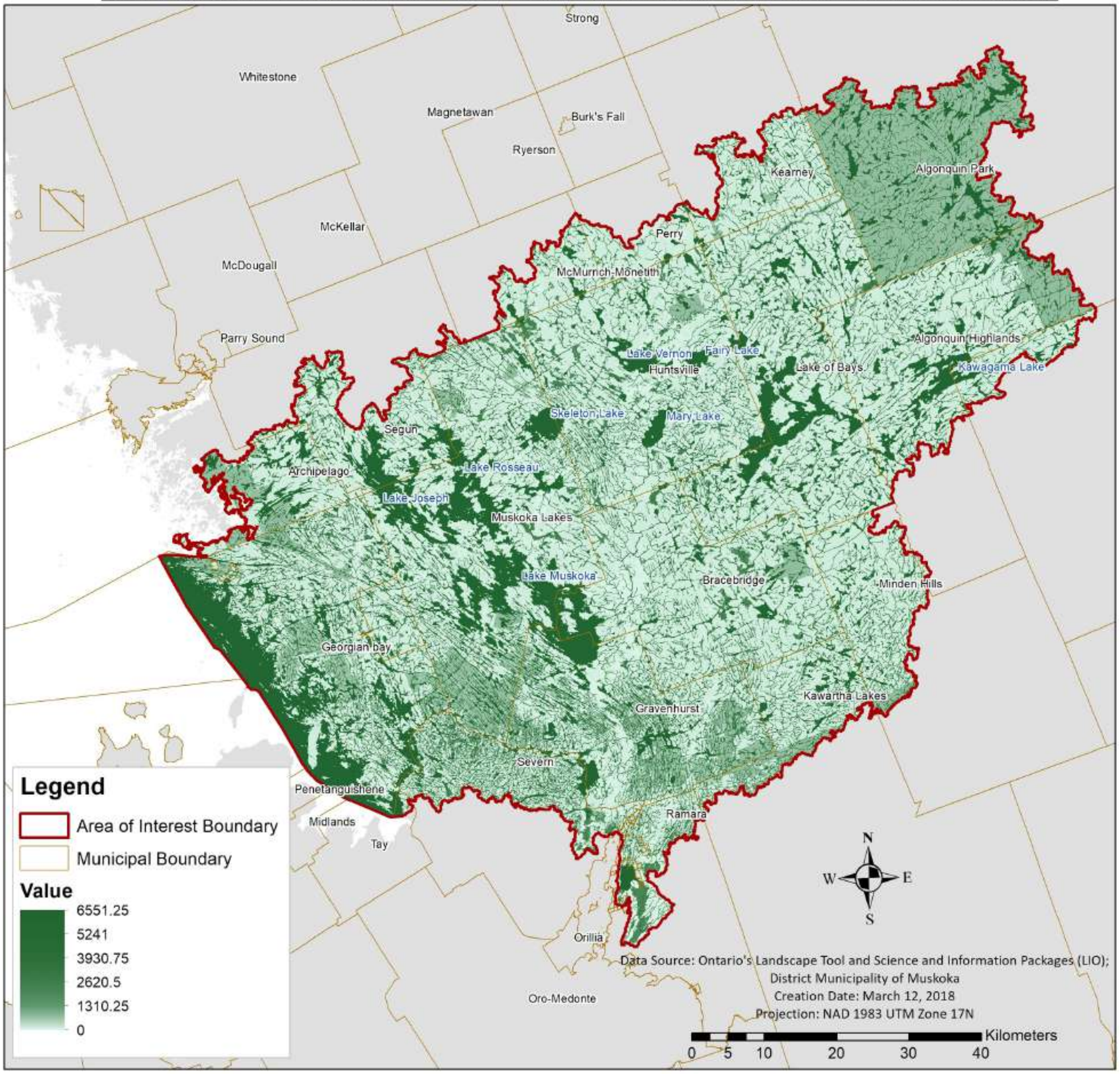


Figure 30: A map showing the value difference between the maximum and minimum value of natural assets.

APPENDIX H: EXISTING INFRASTRUCTURE MAPS

The following maps indicate the distribution of Muskoka's existing development and infrastructure. This data can be used in future research to examine the impact of human development on the value of Muskoka's natural assets. It could also be a useful tool in the policy enhancement process to identify the key protection areas.

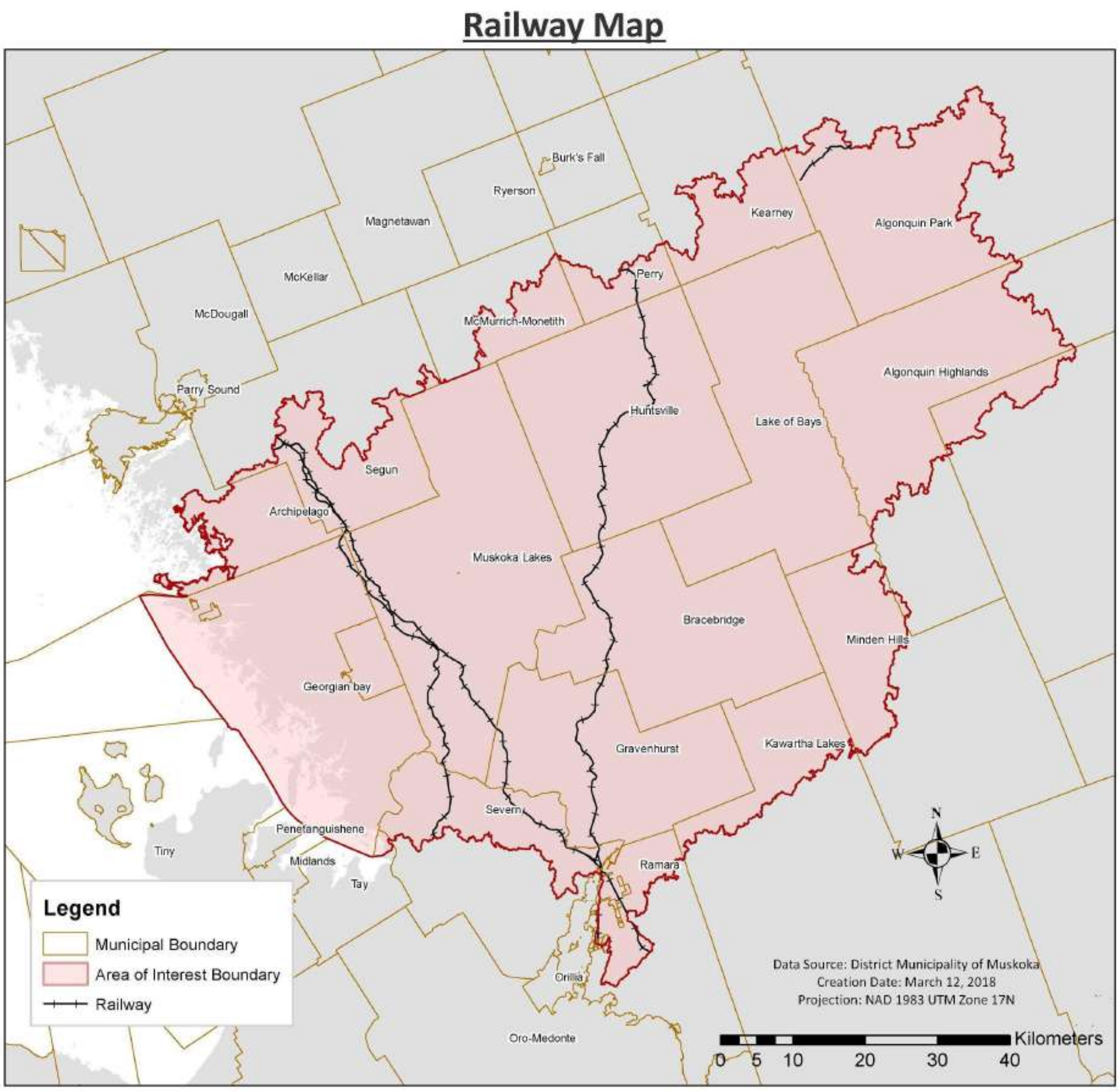


Figure 31: A map showing the location of railways in the Muskoka watersheds.

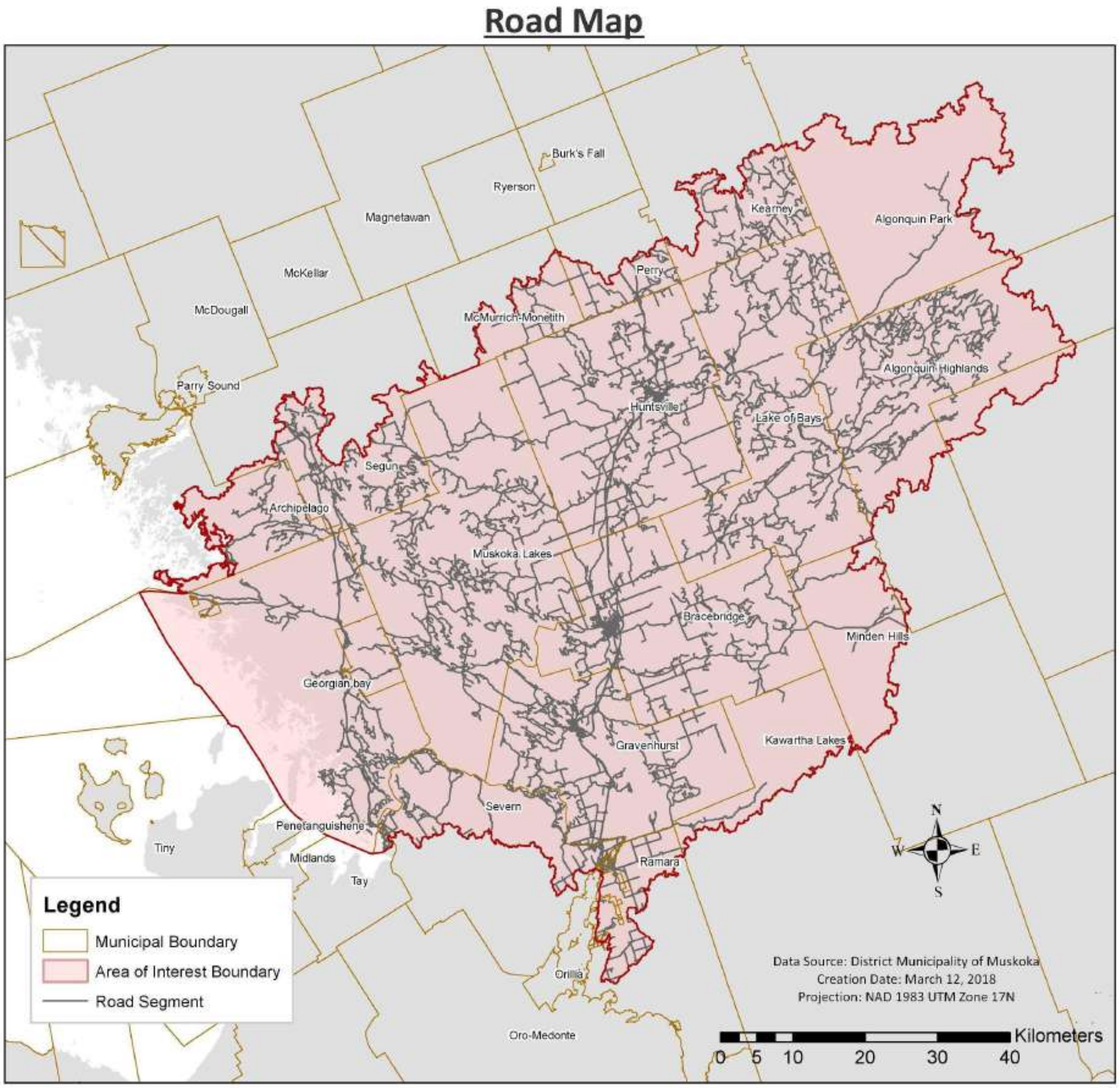


Figure 32: A map showing the presence of road networks in the Muskoka watersheds.

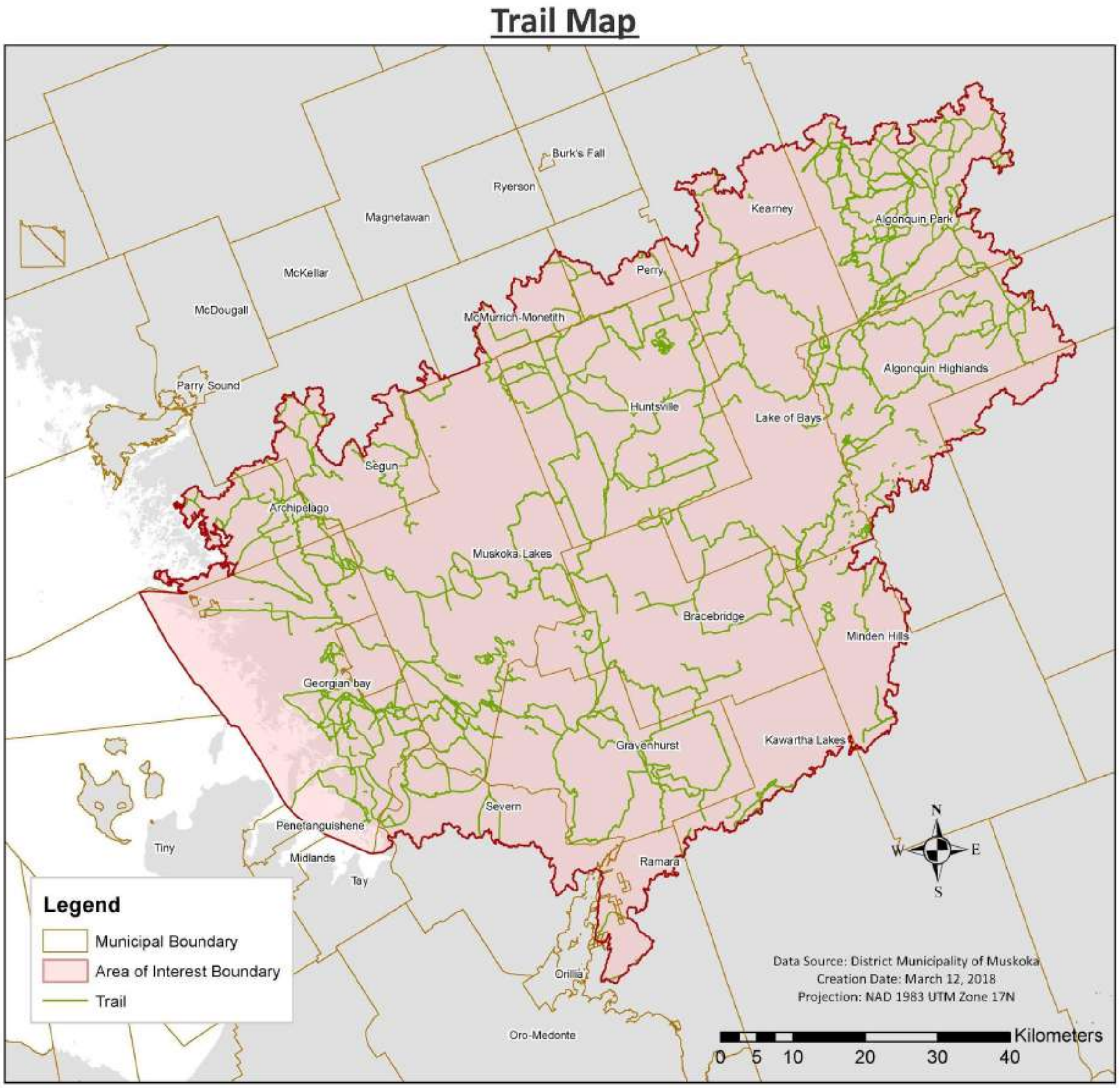


Figure 33: A map showing the location of trails in the Muskoka watersheds.

Utility Map

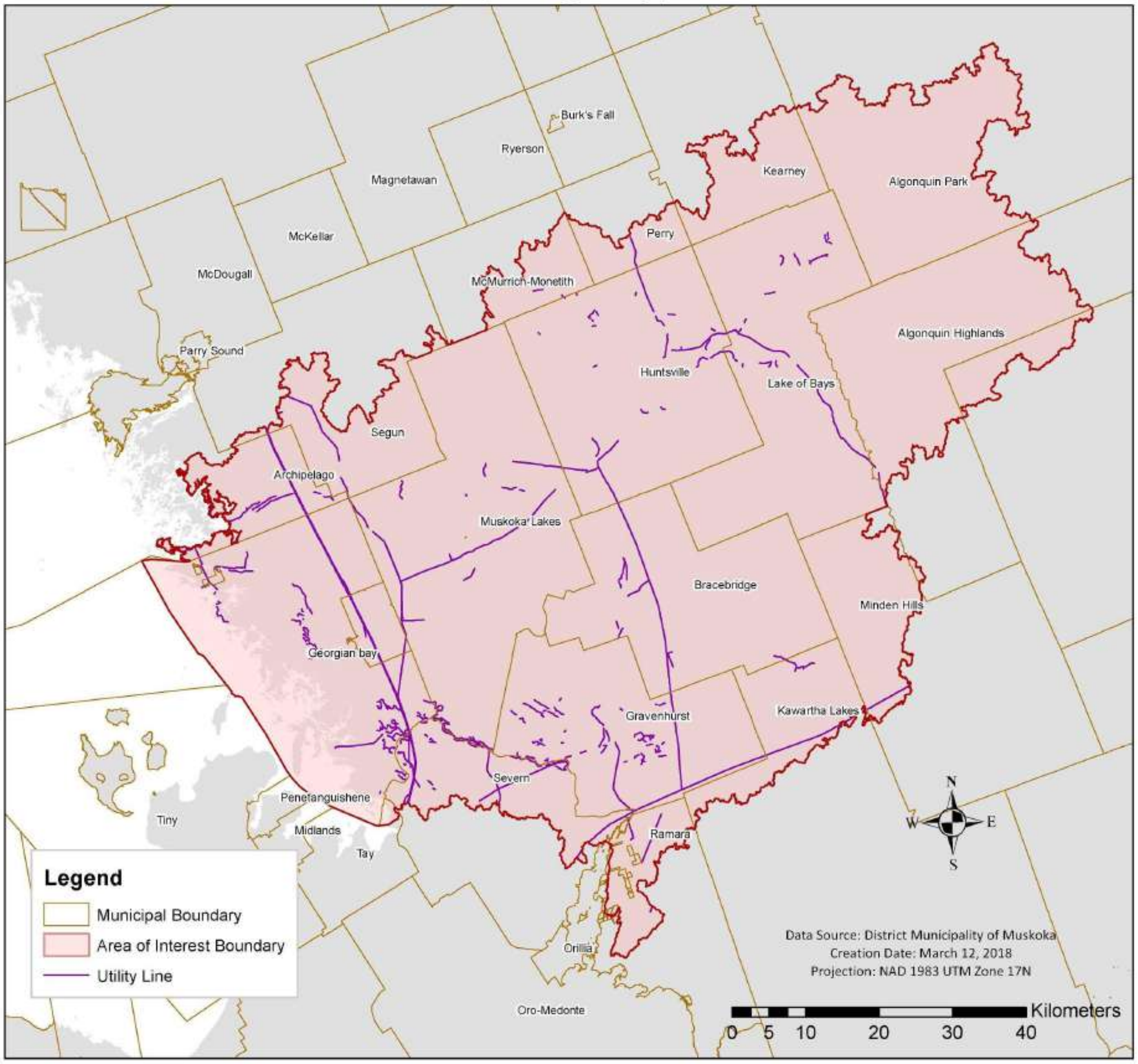


Figure 34: A map showing the location of utility lines in the Muskoka watersheds.

Building Points Map

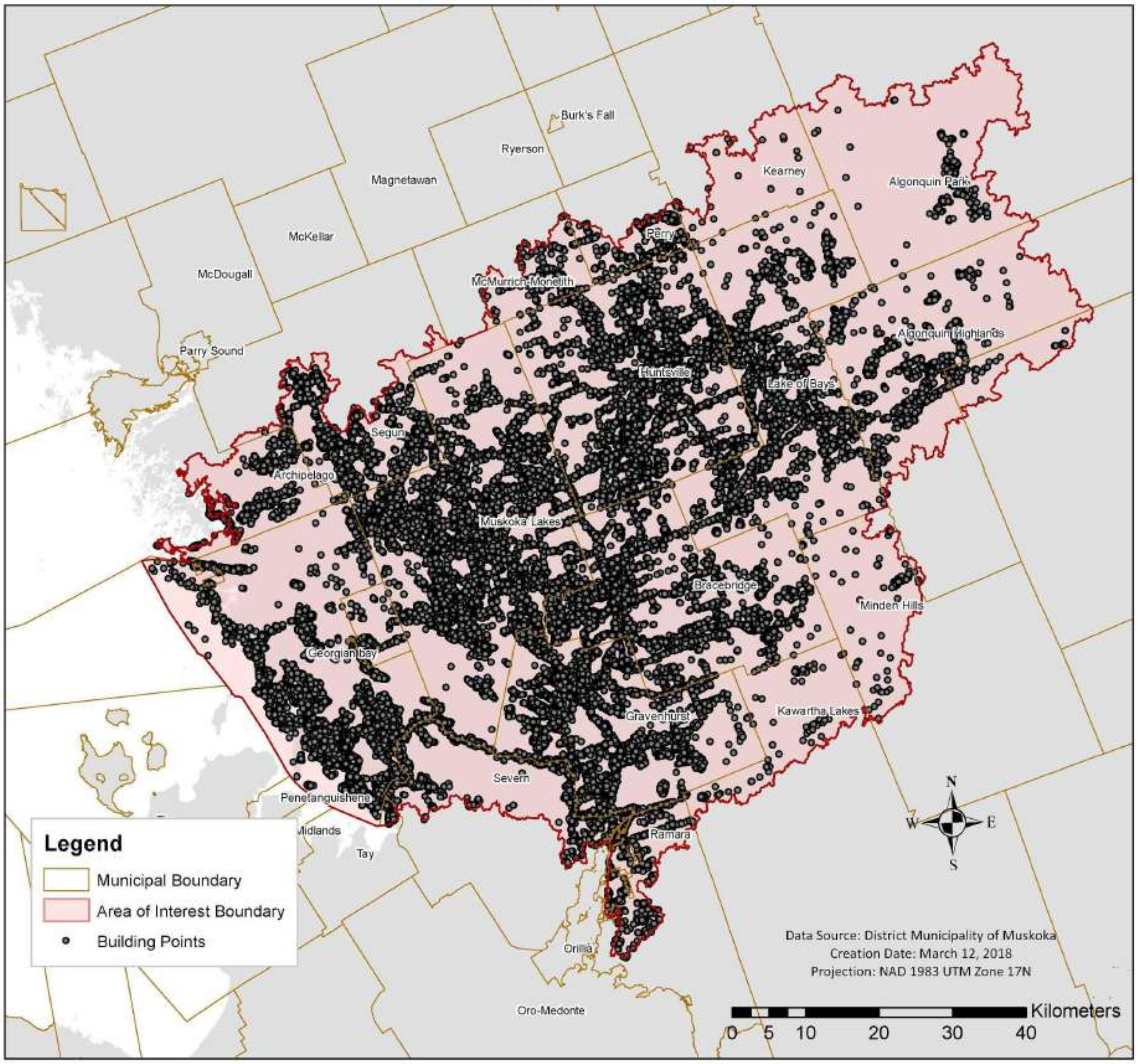


Figure 35: A map showing the location of building points in the Muskoka watersheds.

Community Boundaries Map

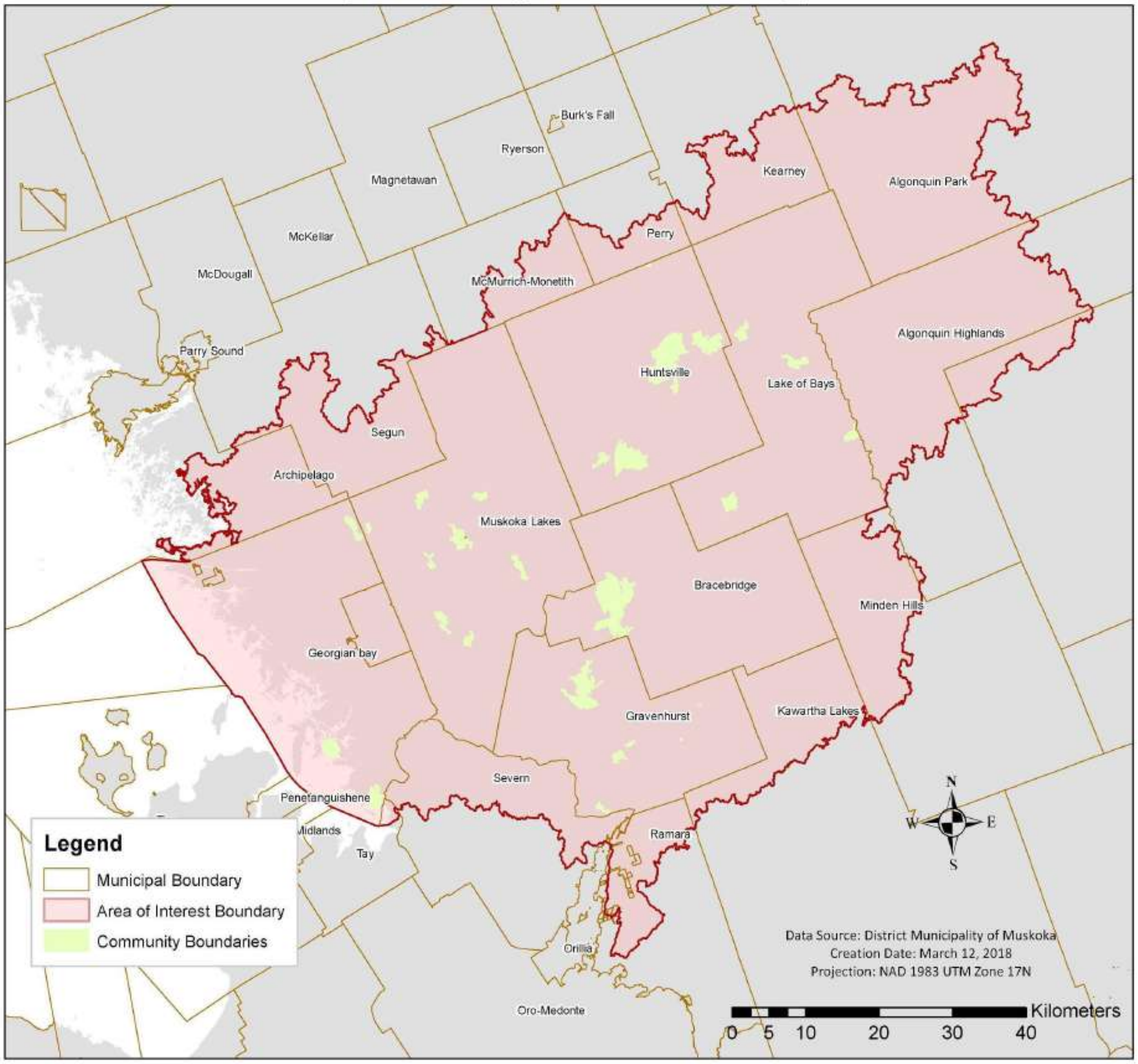


Figure 36: A map showing the location of communities in the Muskoka watersheds.

APPENDIX I: SPECIES AT RISK MAPS

The following maps identify the hotspots of species at risk within the District of Muskoka. Because wildlife habitats are beneficial to the natural environment, more wildlife habitat information can be gathered to enhance policy development for wildlife and habitat preservation.

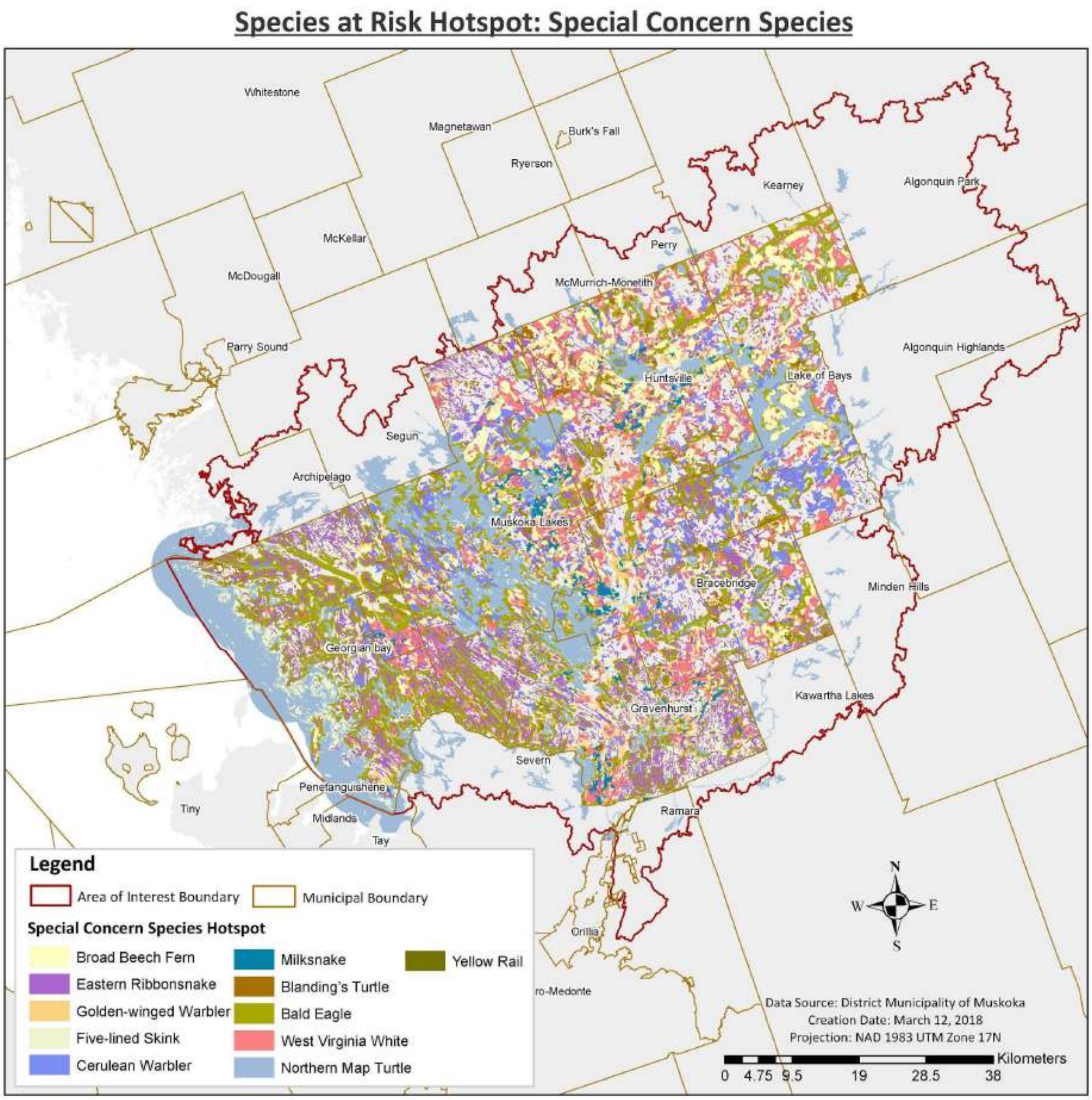


Figure 37: A map showing the composition of species with special concern in the Muskoka watersheds.

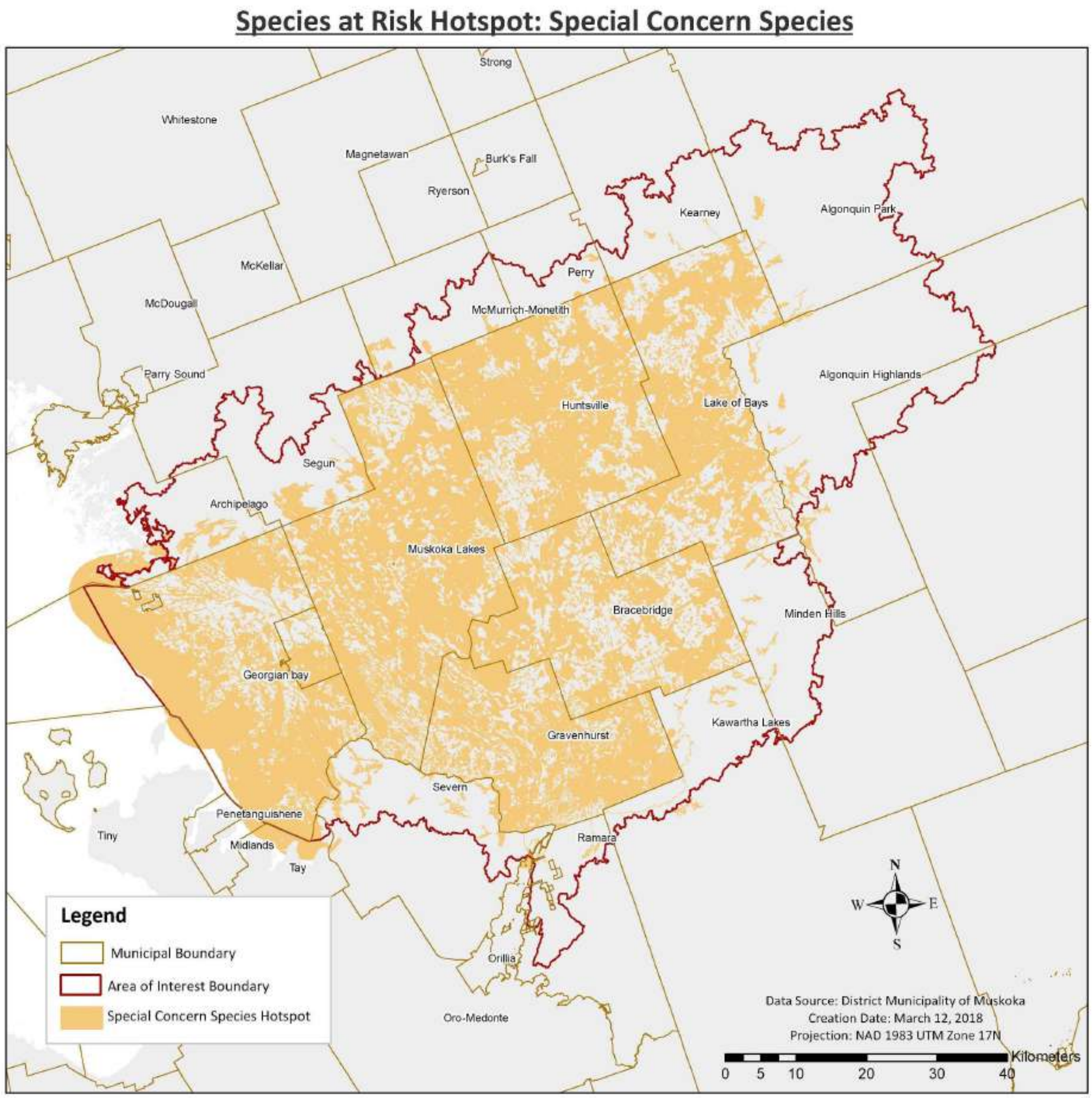


Figure 38: A map showing distribution of hotspot of species with special concern in the Muskoka watersheds.

Species at Risk Hotspot: Threatened Species

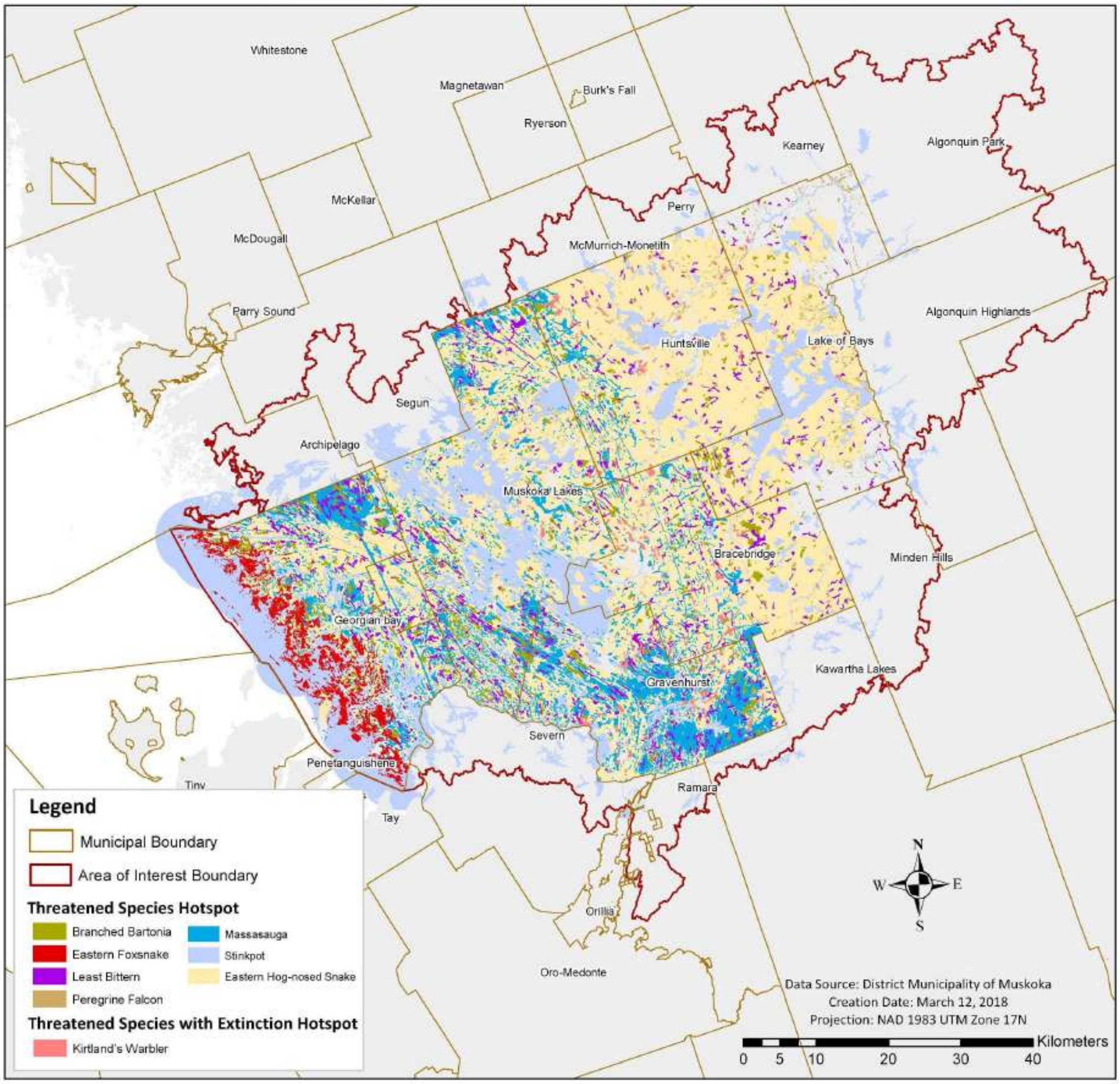


Figure 39: A map showing the composition of threatened species in the Muskoka watersheds.

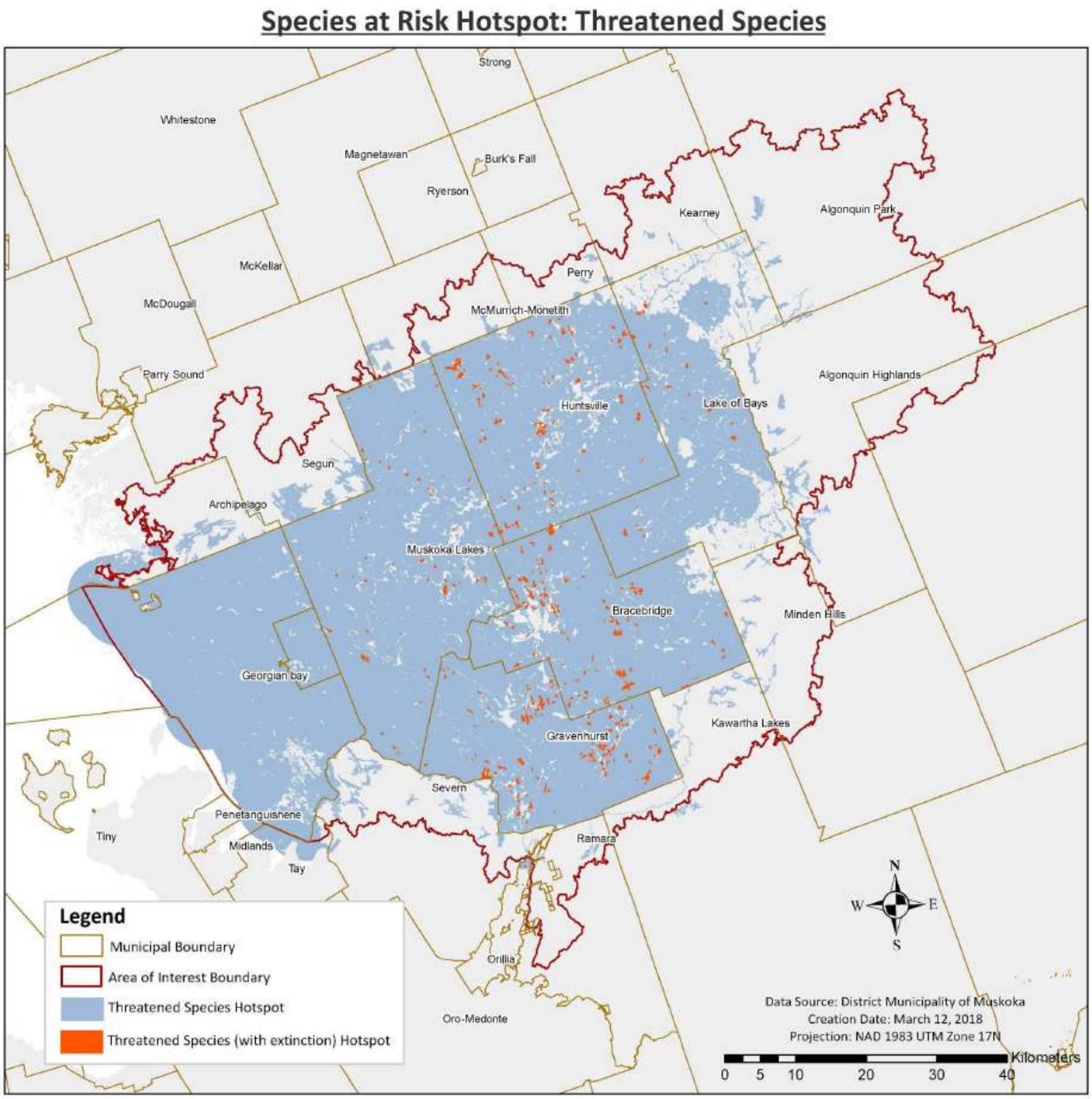


Figure 40: A map showing the distribution of threatened species in the Muskoka watersheds.

Species at Risk Hotspot: Endangered Species

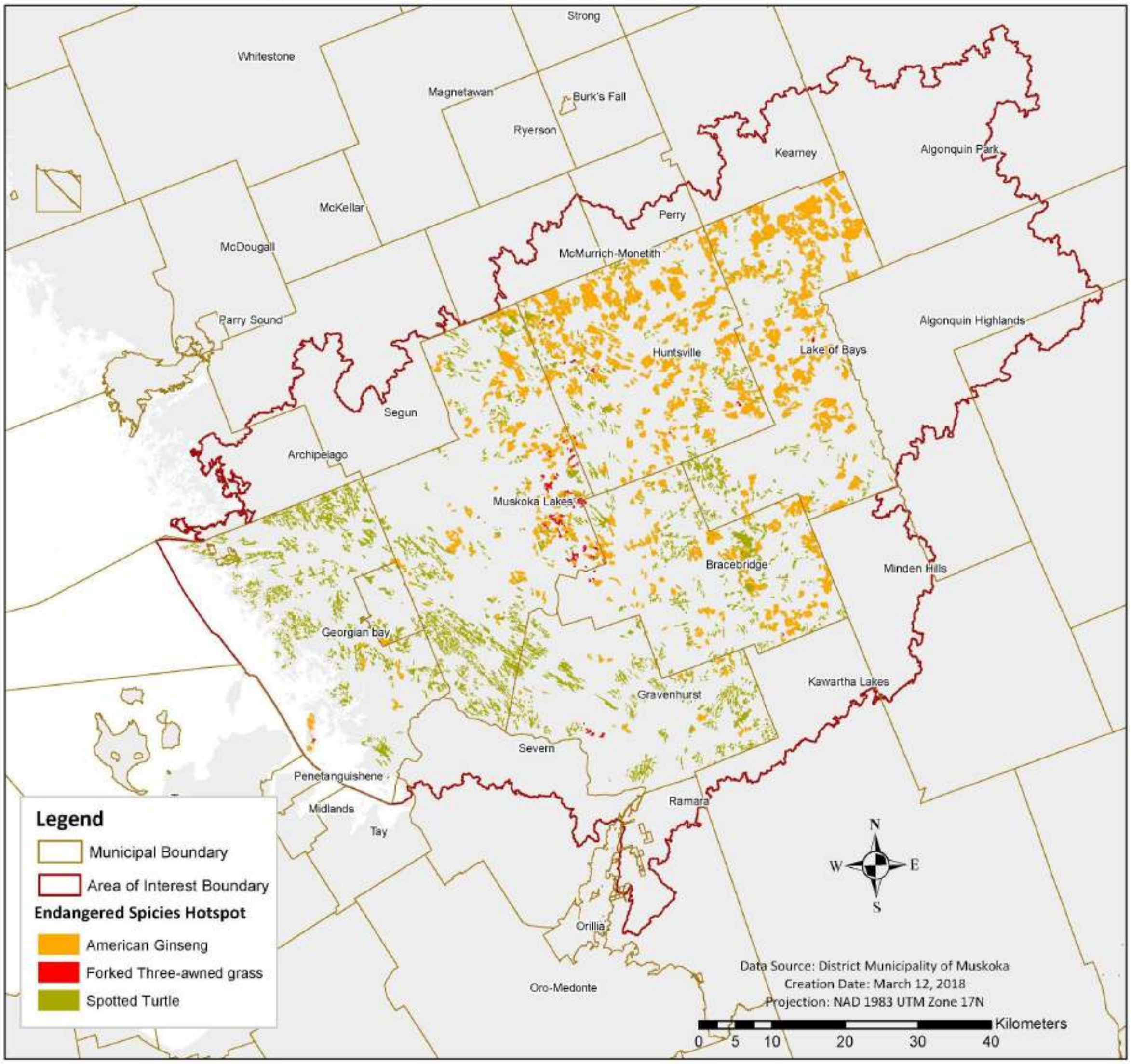


Figure 41: A map showing the composition of endangered species in the Muskoka watersheds.

Species at Risk Hotspot: Endangered Species

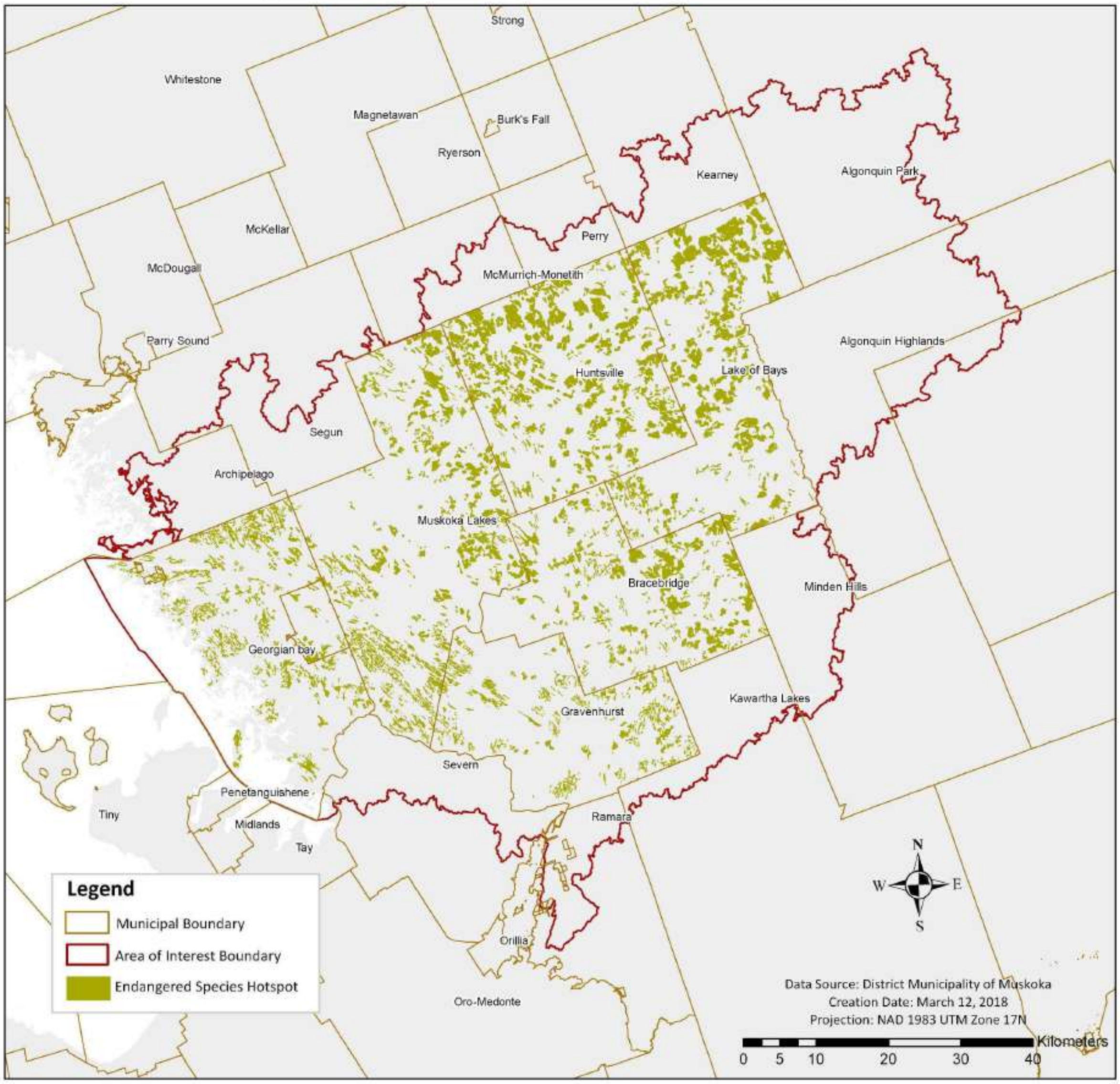


Figure 42: A map showing the distribution of endangered species in the Muskoka watersheds.

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