The Georgina, Fox and Snake Islands Subwatershed Plan

GEORGINA ISLAND

Lake Simcoe Region conservation authority

2017

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2017

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Glossary of Ojibway Words

Aki – Earth

Assaikamig – Moss

Gamiin – Lakes

Getsidjig – Elders

Gigoonh – Fish

Giizhik Mtig – Cedar Tree

Gizhimnidoo – Creator

Mgizi – Eagle

Mnoomin – Rice

Mshiikenh – Turtle

Mshkakimekwe – Mother Earth

Mshkiigmin – Cranberries

Mshkikiwan – Medicines

Naadziwin – Way of Life

Nesoobgak – Clover

Nibi – Water

Nibi-waawaaskone – Water Lily

Noodin – Air

Semaa – Tobacco

Shcode – Fire

Wiigwaasoi Mtig – Birch Tree

Wiingashk – Sweet Grass

Wiisgaak – Black Ash

Ziisbaakwad – Sugar Maple

The Georgina, Fox and Snake Islands Subwatershed Plan (2017) Executive Summary

WHAT IS A SUBWATERSHED PLAN?

Subwatershed planning is a process whereby the components of the environmental system are characterized, the stresses and demands on that system are identified, and actions are recommended to guide the management of the subwatershed. These demands can be from urban and agricultural land uses and recreation and also include the ecological needs of the system. Social and economic factors are also considered through the subwatershed planning process.

A subwatershed plan will normally include recommendations around:

- Maintenance or enhancement of fish habitat;
- Improvement of water quality;
- Protection of the integrity of both hydrological and hydrogeological functions;
- Conservation of wetlands and woodlands;
- Conservation and restoration of ecologically functional natural features and corridors; and,
- Land-use planning.

Maintenance of the ecological processes of the subwatershed through the retention of key natural heritage features, sufficient supplies of ground and surface water, and the protection of water quality and aquatic habitat, while planning for urbanizing land uses and landscape restoration, are integral to the subwatershed planning process.

CONTEXT

This subwatershed plan studies the three islands and mainland area that make up the Georgina, Fox and Snake Islands subwatershed, located in the southern portion of Lake Simcoe. The subwatershed is owned by the Chippewas of Georgina Island First Nation and falls within the Regional municipality of York. The total subwatershed area is 14 km^2, comprising 0.5% of the Lake Simcoe watershed.

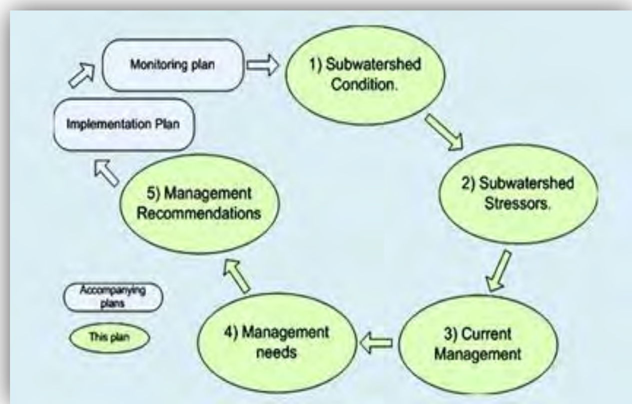
The dominant land use in this subwatershed is natural heritage features (forests, wetlands and grasslands), which account for 88% of the overall land base. Other land uses include residential development, agriculture and aggregate. The majority of the subwatershed's development falls around the Lake Simcoe shoreline, and a large portion of the islands' shoreline have been developed to accommodate residential properties and seasonal cottages.

This subwatershed plan was prepared by the Chippewas of Georgina Island First Nation (GIFN) and the Lake Simcoe Region Conservation Authproty (LSRCA) to identify impacts on the islands' natural features, ensure that the cultural values of the First Nation as being keepers of Mother Earth are captured and integrated into the efforts put forth to restore and protect such features for future generations, as well as to be consistent with the efforts that are on-going within the Lake Simcoe watershed.

It should be noted that the Lake Simcoe Protection Plan (LSPP) and the LSRCA's Integrated Watershed Management Plan (IWMP) also influenced the development of this subwatershed plan. Although it was not required under the LSPP, the plan will reflect the goals, objectives, and targets of the LSPP. The IWMP is considered to be a road map that outlines the future direction of the protection and rehabilitation of the entire Lake Simcoe watershed. Its broad-scale recommendations provide the basis for a number of this plan's recommended actions for the smaller scale Georgina, Fox and Snake Islands subwatershed.

APPROACH

The initial focus of this subwatershed planning exercise used an ecosystem approach. This approach takes into consideration all of the components of the environment to assess the overall health of the environment in the subwatershed, including consideration of the movement of water through the system, land use, climate, geology, and local species. Everything is intricately related; changes in any one area can have significant effects on others.



State-pressure-response framework

This subwatershed plan includes an analysis of water quality, shoreline and aquatic habitat, and terrestrial habitat (e.g. wetlands, forests, and grasslands). Each chapter follows a format loosely structured around a *state-pressure-response* framework. Each chapter begins with a description of the current condition (*state*), then describes the stressors likely leading to the current condition (*pressure*), and finally provides recommendations for improvement (*response)*.

Based on this analysis, a separate document, known as an "Implementation Plan", was developed to act upon the recommendations made in the subwatershed plan. The implementation plan was developed by the LSRCA and GIFN, and was reviewed through a community workshop. The Implementation Plan will become the common work plan used in long term protection and rehabilitation efforts.

STATUS

Water Quality – There is one water quality monitoring station on the east side of Georgina Island that has been sampled by the LSRCA. Water samples have been collected twice from this station in 2014; one 'high flow' sample, taken after a rain event, and one 'low flow' sample, taken during dry conditions. The samples were tested for a number of substances, such as phosphorous, chloride, and suspended solids. The substance concentrations were then compared to regulatory standards (PWQO and CWQG).

The data from the water quality station show that phosphorus is the main parameter of concern, with both samples exceeding the PWQO. The likely sources of phosphorus in this area include road runoff, erosion of sediment from some of the trails, and perhaps some natural release of sediment from the forest and wetland areas upstream. Concentrations of most metals for both the baseflow and event flow samples were well within guidelines, with most samples being below detection guidelines. The only exception to this was iron, which measured above the PWQO for both samples. The source of this iron is unknown, although it could be naturally occurring, and found in the soils on the island. All other parameters measured concentrations below relevant guidelines. The surface water quality was also assessed in terms of beach postings for *E.coli*. Beaches are posted when the geometric mean of the samples taken at each beach exceeds 100 colony forming units, a level of bacteria that can adversely affect public health. GIFN summer students collect samples at five beaches on Georgina Island to test *E.coli* levels. Between 2009 and 2013, there were nine postings, with seven of these occurring in 2010.

Aquatic Natural Heritage – Fish communities were assessed in the streams on Georgina Island as well as the nearshore area of all three islands. In 2014 and 2015, LSRCA staff sampled the fish communities within four streams on Georgina Island, and found a total of 24 individuals, representing six different coolwater minnow species. In 2014, the Chippewas of Georgina Island First Nation, in partnership with the Anishinabek/Ontario Fisheries Resource Centre also completed a nearshore small fish biodiversity study for all three islands, examining changes from 1996 and 2008 to 2014. In this study, a total of over 1,400 individuals of 16 fish species were captured at sites around the three islands in 2014, and populations were dominated by the invasive round goby (74%). Over the 18-year period, the overall fish biodiversity showed a decreasing trend, driven by the invasion of round goby.

Benthic invertebrate communities were also assessed in Georgina Island streams as well as in Lake Simcoe, around the islands. The benthic community on Georgina Island was sampled by LSRCA staff in 2014 and 2015, and the ecological integrity of the streams was assessed as ranging from fair to fairly poor, based on the Hilsenhoff Biotic Index. These ratings may be impacted by shoreline development, low water flow and barriers limiting the movement of invertebrates. The LSRCA has also monitored changes in benthic invertebrates within the lake since 2008. In 2009, the lake nearshore was dominated by invasive mussel communities composed of 75% zebra mussels (Dreissena polymorpha), and 25% quagga mussels (Dreissena rostriformis bugensis). Since then, zebra mussels have declined to the point where they represent only 5% of the community, while quagga mussels increased to 95%.

Shifts in aquatic plant communities within the lake have also been observed between two studies completed in 2008 and 2013. In 2008, a total of 16 species were recorded, and in 2013, 22 species were recorded. Three submerged aquatic plant species in Lake Simcoe are invasive: Eurasian watermilfoil (*Myriophyllum spicatum*), first reported in 1984; curly-leafed pondweed (*Potamogeton crispus*), also reported in 1984, and starry stonewort (*Nitellopsis obtusa*), first recorded in 2009. The studies also identified five areas of high aquatic plant growth in the lake, one of which is the channel between Georgina Island and the mainland. These areas of high growth are attributed to increased water clarity resulting from invasive mussels, increased soft bottom sediments, higher phosphorous concentrations in water and sediment, proximity to larger subwatersheds that provide higher amounts of phosphorus to Lake Simcoe, and a longer growing season due to climate change.

The health of the islands' shorelines, or riparian zone, was also assessed since it provides numerous important ecological functions, including bank stability, shade, food, and shelter for aquatic and semi-aquatic animals, and filtering of surface water runoff. A shoreline habitat assessment was completed in order to characterize the shoreline ecosystem of Fox and Snake Island, which found that shoreline substrate on the islands was comprised of boulders, cobble, gravel, sand, and muck. In 2014, a best management practices opportunity inventory was undertaken along the shorelines of all three islands as well as the mainland to identify potential areas for stewardship projects. This inventory identified, 1,964 project opportunities on the GIFN lands, with 937 on Georgina Island, 235 on Fox Island, 792 on Snake Island, and 20 on the mainland. These include areas of shoreline erosion, insufficient riparian buffers, surface runoff, and shoreline development features, among others.

The Terrestrial Natural Environment – These features include woodlands, wetlands, grasslands, and riparian (streambank) habitat, and account for approximately 88% of the land area in the subwatershed. Woodlands cover 75% of the subwatershed, which far exceeds Environment Canada's guideline of 30%, as outlined in its '*How much habitat is enough*' document. The Environment Canada guideline is seen as a minimum forest cover threshold (considered to be a 'high risk' approach that will not support the healthiest systems). The most common forest types are mixed and deciduous forests.

With respect to wetland cover, the subwatersheds have very healthy levels, at 24%; this is well above Environment Canada's recommended wetland cover level of 10%. Grasslands represent a further 10% of the subwatershed area. There are also fairly high levels of natural cover along the watercourses and shorelines of the subwatershed. Over 70% of streams on Georgina Island have at least 30m of natural cover, while the shoreline vegetated buffers on each island vary from 60% on Georgina Island to 20% on Snake Island. Environment Canada recommends that at least 75% of the 30 metre riparian buffer be in natural vegetation. Residential development, recreation, and climate change are the concerns for the natural environment features in these subwatersheds.

RECOMMENDATIONS

Recommendations based on analysis of the current conditions and stressors are provided in each chapter of this subwatershed plan. There are approximately 75 recommendations in total, with some pertaining to all of the partners involved in the development of the plan, including the LSRCA, GIFN, and the provincial ministries of Natural Resources and Forestry and Environment and Climate Change.

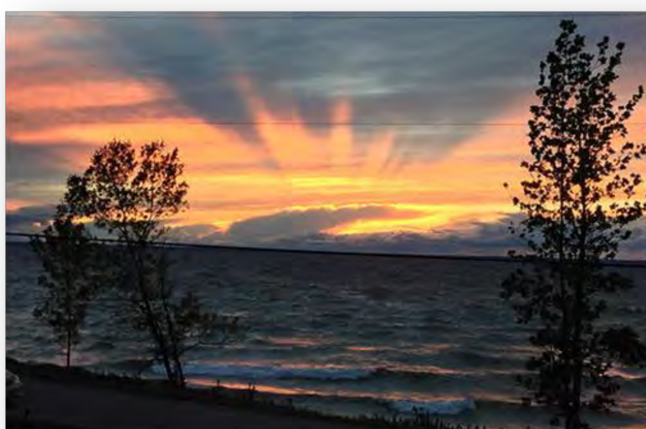
These recommendations include:

- Developing a shoreline protection program;
- Incorporating traditional teachings into stewardship projects;
- Developing and enforcing bylaws around site clearing and sediment and erosion control measures;
- Creating and Implementing a Management and Removal Plan for invasive species;

- Implementing Traditional ceremonies as a Community celebration to mark the changing of the seasons, giving thanks to the Creator for all She provides;
- Regulating and reducing traffic on the ice road to minimize the amount of salt and other pollutants from vehicles reaching the lake and the landings;
- Collecting Traditional Ecological Knowledge (TEK) 1-4 times per year from the community members;
- Developing a monitoring plan to identify gaps in existing research and prioritize research and monitoring needs; and,
- Developing a communication plans to notify community members of:
  - Extreme weather events
  - Ice conditions
  - Dry conditions (including fire bans and precautions)
  - Wind conditions
  - Beach closures

NEXT STEPS

These recommendations form the basis of the Implementation Plan, which is the framework and process for acting on the recommendations. The Implementation Plan prioritizes the recommendations, identifying activities to be carried out to achieve each of the priority recommendations. It also identifies the milestones to be met, specific deliverables, and partners' responsibilities. The implementation process will also include regular tracking of activities to ensure that milestones are being met.



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1 Subwatershed Plan Introduction

1.1 Introduction

The Georgina, Fox and Snake Islands subwatershed, located in the southern portion of Lake Simcoe, is comprised of three islands (Georgina Island, Fox Island and Snake Island), as well as a small area on the mainland. The total subwatershed area is 14 km^2, comprising 0.5% of the Lake Simcoe watershed. The subwatershed is owned by the Chippewas of Georgina Island First Nation and falls within the Regional Municipality of York (Figure 1-1).

The ancestors of the Chippewas of Georgina Island First Nation were inhabitants of the Lake Simcoe Region long before the arrival of white settlers. Chippewa Chief, Joseph Snake, and his people first lived on Snake Island, one of three islands (Snake, Fox and Georgina) not surrendered to the Crown.

In 1830, Snake and two other Chippewa communities (led by Chief Assance and Chief Yellowhead) were moved to 9,800 acres near what is now Coldwater, Ontario as part of the government's Coldwater Experiment to colonize the Chippewa people. Then, just six years later, the Chiefs were forced to surrender these lands under treaty. Chief Joseph Snake slowly moved his people back to Snake Island. By 1860, the band had outgrown small Snake Island and Chief Snake moved his people onto the larger and more spacious Georgina Island.

The majority of the islands' land cover is characterized by natural heritage features (forests, wetlands and grasslands), which account for 88% of the overall land base. Other land uses include residential development (9.6%), agriculture (0.3%), and aggregate (0.8%). There are several small streams present on Georgina Island that flow directly into the lake, and Virginia Creek B runs through the mainland area. All of these watercourses originate in wetland (treed swamp) areas. Fox and Snake Islands do not contain any watercourses and surface runoff there flows directly into the lake.

The majority of the subwatershed's development falls around the Lake Simcoe shoreline, and a large portion of the islands' shoreline have been developed to accommodate residential properties and seasonal cottages. Consequently, 47.8% of the overall shoreline length does not have sufficient vegetated riparian buffers that provide quality habitat to fish and wildlife and filtering capacity to surface runoff.

In the Lake Simcoe watershed, the various land uses have had considerable impacts on water quality and quantity, and aquatic and terrestrial habitats. In order to mitigate the impacts of land use changes in each of the subwatersheds, and to prevent future impacts, subwatershed plans are developed. This plan provides a framework for the implementation of remedial activities and a focus for community action. More importantly, it helps to prevent further serious degradation to the existing environment and can reduce the need for expensive rehabilitation efforts. Subwatershed plans provide a framework within which sustainable development can occur.

As part of the requirements through the Lake Simcoe Protection Plan (LSPP), subwatershed evaluations need to be developed and completed for priority subwatersheds within five years of the Plan coming into effect. Subwatershed plans for York Region (includes the East and West

Holland Rivers, Maskinonge River and Black River subwatersheds) were completed in 2010 and Durham Region (includes the Beaver River and Pefferlaw Brook subwatersheds) in 2012. Subwatershed plans for the City of Barrie (includes Barrie Creeks, Lovers Creek and Hewitts Creek subwatersheds) and the Town of Innisfil (includes Innisfil Creek subwatershed) were completed in late 2012. A subwatershed plan for the Oro and Hawkestone Creeks subwatersheds was completed in 2013. The Georgina, Fox and Snake Islands subwatershed plan was not required under the LSPP but was requested by the Chippewas of Georgina Island First Nation to help identify impacts on the islands' natural features, ensure that the cultural values of the First Nation as being keepers of Mother Earth would be captured and integrated into the efforts put forth to restore and protect such for future generations, as well as to be consistent with the efforts that are on-going within the Lake Simcoe watershed. Although it was not required under LSPP, the plan will reflect the goals, objectives, and targets of the LSPP and will be tailored to the needs and local issues of the area.

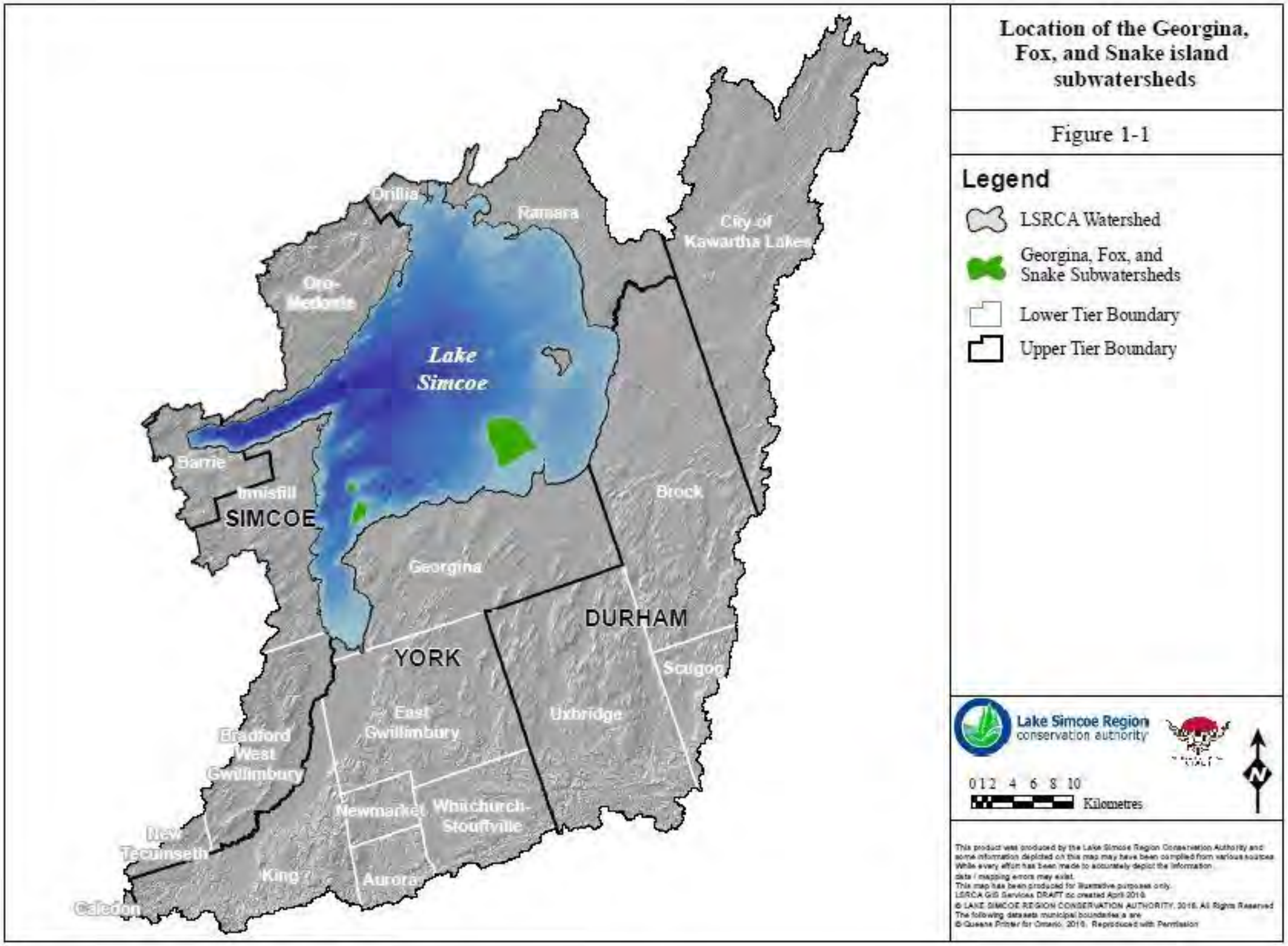


Figure 1-1: Location of the Georgina, Fox and Snake Islands subwatershed**.**

1.2 Subwatershed Evaluation Requirements within the Lake Simcoe Protection Plan

The Lake Simcoe Protection Plan (LSPP), released by the Province in 2009, aims to be a comprehensive plan to protect and restore the ecological health of the lake and its watershed. Its priorities include restoring the health of aquatic life, improving water quality, maintaining water quantity, and improving ecosystem health by protecting and rehabilitating important areas, as well as addressing the impacts of invasive species, climate change, and recreational activities.

Preparation of subwatershed evaluations/plans is identified as a crucial stage in implementation of the LSPP. The LSPP states that subwatershed plans "will be critical in prioritizing actions, developing focused action plans, monitoring and evaluating results… The plans will provide more detailed guidance for area-specific hydrologic and natural heritage resource planning and management"

Policies within the LSPP guiding the preparation of this subwatershed plan are:

8.1-SA Within one year of the date the Plan comes into effect, the MOE and LSRCA in collaboration with other ministries, the First Nations and Métis communities, watershed municipalities, the *Lake Simcoe Coordinating Committee* and the *Lake Simcoe Science Committee* will develop guidelines to provide direction on:

a. identifying sub-lake areas and subwatersheds of the *Lake Simcoe watershed* and determining which sub-lake areas and subwatersheds are of priority;

b. preparing subwatershed evaluations including, where appropriate, developing subwatershed-specific targets and recommending actions that need to be taken within subwatersheds in relation to:

   i. the phosphorus reduction strategy (Chapter 4),

   ii. stormwater management master plans, including consideration of the amount of impervious surfaces within subwatersheds (Chapter 4),

   iii. water budgets (Chapter 5),

   iv. instream flow regime targets (Chapter 5),

   v. preventing *invasive species* and mitigating the impacts of existing *invasive species* (Chapter 7),

   vi. natural heritage restoration and enhancement (Chapter 6),

   vii. increasing public access (Chapter 7), and

   viii. climate change impacts and adaptation (Chapter 7);

c. monitoring and reporting in relation to subwatershed targets that may be established; and

d. consultation to be undertaken during the preparation of the subwatershed evaluations.

8.2-SA In developing the guidance outlined in 8.1, the partners identified above will develop approaches to undertake the subwatershed evaluations in a way that builds upon and integrates with source protection plans required under the Clean Water Act, 2006, as well as relevant work of the LSRCA and watershed municipalities.

8.3-SA Within five years of the date the Plan comes into effect, the LSRCA in partnership with municipalities and in collaboration with the MOECC, MNRF, and OMAFRA will develop and complete subwatershed evaluations for priority subwatersheds.

8.4-DP Municipal official plans shall be amended to ensure that they are consistent with the recommendations of the subwatershed evaluations.

This plan is being developed to meet requirements of policy 8.3-SA, while also following requirements of policies 8.1-SA and 8.2-SA. Ensuring municipal Official Plans are updated in accordance with policy 8.4-DP is identified as an activity within the associate implementation plan.

This subwatershed plan aims to be consistent with the themes and policies of the Lake Simcoe Protection Plan to ensure a consistent approach is being taken by all of the partners toward improving watershed health.

The ecosystem approach to environmental management takes into consideration all of the components of the environment. These components include the movement of water through the system, the land use, climate, geology, human communities, and all of the species that comprise the community living in the system. These ecosystem components are all intricately related, and changes in any can have significant effects on the others.

To manage natural resources using an ecosystem approach it is essential to establish biophysical boundaries. In the Lake Simcoe watershed, the subwatersheds or river systems that drain into the lake have been identified as the best “fit” for the implementation of an ecosystem study because they are virtually self-contained water-based ecosystems (OMOE and OMNR, 1993). Watersheds are defined as the area of land drained by a watercourse and, subsequently, the land draining to a tributary of the main watercourse (Lake Simcoe is the “main watercourse” in this case) is called a subwatershed. For this plan, the three islands and the mainland area were identified as the study area, and it is a unique area since the islands are impacted by any change to Lake Simcoe resulting from surrounding land uses. Watershed processes are controlled by the hydrologic cycle (Figure 1-2). The movement of water influences topography, climate, and life cycles. It is due to this connectivity that any change within the watershed will impact other parts of the subwatershed.

Figure 1-2: The hydrological cycle (image courtesy of Conservation Ontario).

1.2.1 Subwatershed Planning Context

This subwatershed plan has been prepared as recommended by the Georgina Island First Nation Climate Change Adaptation Plan, as developed by the Chippewas of Georgina Island First Nation and the Ontario Centre for Climate Impacts and Adaptation Resources. However there are other documents that have influenced and fed into the development of this plan and its recommendations. LSRCA's Integrated Watershed Management Plan (2008) and the Lake Simcoe Phosphorus Reduction Strategy (2010) are the two main documents aside from the LSPP that have guided this plan's development.

The Integrated Watershed Management Plan, released by the Lake Simcoe Region Conservation Authority in 2008, was intended to be a roadmap to provide future direction for the protection and rehabilitation of the Lake Simcoe watershed ecosystem. Its broad-scale recommendations for the Lake Simcoe watershed provided the basis for a number of this plan's recommended actions.

The Lake Simcoe Phosphorus Reduction Strategy, released by the Province in 2010, was a requirement of the Lake Simcoe Protection Plan. The Phosphorus Reduction Strategy is a long term, phased approach that focuses on a constant reduction of phosphorus in Lake Simcoe through shared responsibility. The actions that come out of the Strategy are providing a foundation and early planning tool for the reduction of phosphorus. As this is a living document, it will be reassessed and updated a minimum of every five years to ensure that it includes the most up to date information and is following the best approach to reduce phosphorus within the watershed.

1.2.2 Subwatershed Planning Process

Preliminary Consultation

Start-up meetings were held with the Chippewas of Georgina Island First Nation, the Ministry of Environment and Climate Change (MOECC) and the LSRCA to go over the intended direction and scope of the subwatershed plan, the projected timeline and how it would incorporate any new information coming from studies currently underway.

Characterization

The initial focus of the subwatershed planning exercise has involved the completion and summarization of subwatershed characterization work. It also involved the development of water quality, quantity, aquatic, and terrestrial habitat models to assess the environmental impacts associated with potential changes in the landscape. Based on this important information, recommendations are developed to address the stressors as well as the gaps and limitations for each parameter.

Subwatershed Working Group – Review Committee

The Subwatershed Working Group (SWG) consists of representatives from the Chippewas of Georgina Island First Nation, Ministry of Natural Resources and Forestry, Ministry of Environment and Climate Change, and the Ontario Centre for Climate Impacts and Adaptation Resources. This is a voluntary committee that is essential to confirming that material presented in the subwatershed plans is tailored to the specific conditions of the islands. The SWG convenes as necessary to review workplans and discuss chapter content, and has had three meetings to date (April 13, 2015, October 14, 2015 and January 8, 2016). In 2016 meetings will likely continue on the same time schedule to review final chapters, plan public consultation and initiate the Subwatershed Implementation Plans (discussed further in following sections). Before each meeting, committee members are presented with characterization chapters and their associated recommendations. Comments received on the characterization material were documented and addressed, while comments received on recommendations were discussed, incorporated and re-distributed for further discussion/approval at the next meeting. This was done to ensure that all parties are fully aware of, and agree with, final recommendations that will be the basis of the Subwatershed Implementation Plans.

Public Consultation

Four public consultations took place in 2016 to educate both permanent and seasonal residents within the subwatershed about the area they live in, what the current conditions are in their subwatershed, what the immediate stressors are and how the recommendations will be carried out. The consultations were also intended to obtain public feedback on the issues affecting the subwatershed and what they hope can be done to address them.

A presentation was given to the Georgina Island community at their Earth Day event (April 21st) to present the subwatershed plan findings and to obtain public feedback. Another community workshop was delivered on October 26th to develop the Implementation Plan. In addition, two public consultation sessions were completed at the Georgina Island ferry dock and the Island

Grove Marina on July 10th and August 7th in order to present the subwatershed plan findings and to obtain feedback from the seasonal residents (ie. cottagers). Feedback from all of these sessions was incorporated into the Subwatershed Plan and Implementation Plan.

1.2.3 Subwatershed Implementation Process

Implementation Plan

Once the subwatershed plan is complete, the recommendations are used to form the basis of the development of the Implementation Plan for the subwatershed. The Implementation Plan is a framework and process for acting on the recommendations put forth in the Subwatershed Plans. It prioritizes the recommendations, identifying available options, the associated funding/ costing estimates, and partner's responsibilities.

Implementation

To ensure that this subwatershed plan remains current and relevant, it has been developed using an adaptive management framework. As such, the subwatershed plan will be updated every five years to ensure that it contains the best available science and monitoring data reflecting the health of the subwatershed. Between reviews, ongoing monitoring, assessing and evaluation of the subwatersheds as well as the extent and effectiveness of implementation of the recommendations of this subwatershed plan will be occurring, with new reports and studies being produced. Communications will need to be updated to coincide with these studies and implementation approaches will need to adapt to reflect the most current information available.

1.3 Guiding Policies and Documents

Several plans, policies and documents have helped guide the development of the goals and recommendations offered in this plan.

1.3.1 Guiding Policies

The following plans and policies provide a framework to aid in the development of the goals and recommendations of the Georgina, Fox and Snake Islands subwatershed plan.

- Lake Simcoe Protection Plan
- Provincial Policy Statement
- Environmental Protection Act
- Ontario Water Resources Act
- Clean Water Act
- Endangered Species Act
- Conservation Authorities Act and the Role of the LSRCA

1.3.2 Guiding Documents

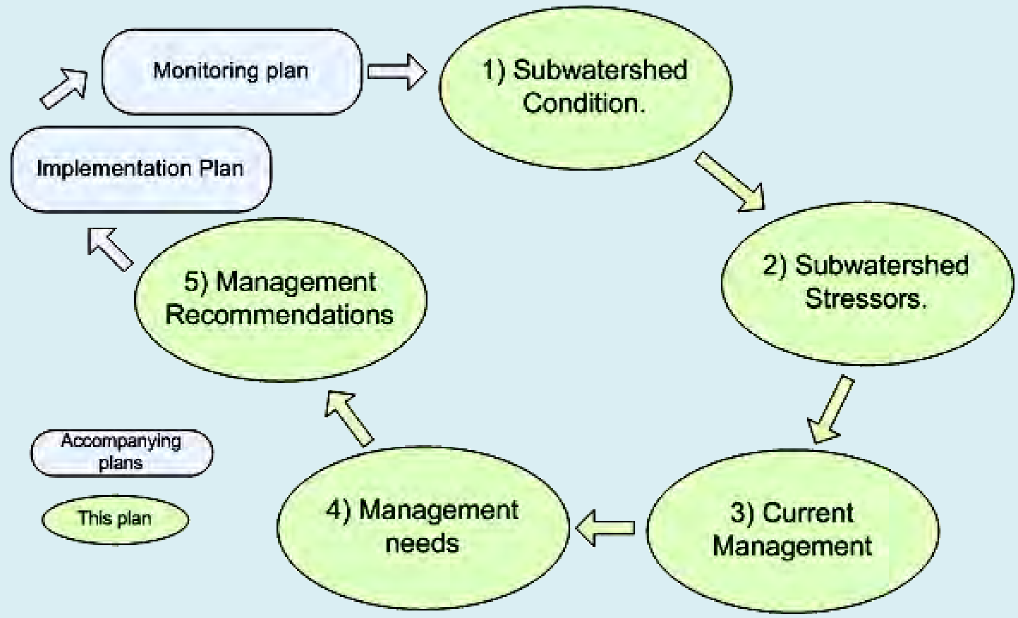
A number of documents and studies have been prepared with information and recommendations pertinent to Georgina, Fox and Snake Islands subwatershed and how to ensure its environmental health into the future. These documents cover a wide range of issues, and have influenced the formation of this subwatershed plan. They include:

- Assimilative Capacity: Pollutant Target Load Study for the Lake Simcoe and Nottawasaga River Watersheds (Louis Berger Group, 2006)
- Chippewas of Georgina Island First Nation Nearshore Small Fish Biodiversity (Anishinabek/Ontario Fisheries Resource Centre, 2014)
- Chippewas of Georgina Island, Georgina Island Wind Project: Geological Conditions (Hatch, 2011)
- Estimation of the Phosphorus Loadings to Lake Simcoe (Louis Berger Group, 2010)
- Final Report for the 2008 Species at Risk Assessment of Georgina Island First Nation (Oakridge Environmental Ltd., 2008)
- Fox and Snake Island Habitat Assessment (Anishinabek/Ontario Fisheries Resource Centre, 2012)
- Georgina Island First Nation Climate Change Adaptation Plan (Chippewas of Georgina Island First Nation and Ontario Centre for Climate Change Impacts and Adaptation Resources, 2015)
- Georgina Island Forest Management Plan 2000-2019 (Chippewas of Georgina Island, 1999)
- Lake Simcoe Basin's Natural Capital: The Value of the Watershed's Ecosystem Services (Wilson, 2008)
- Lake Simcoe Watershed Environmental Monitoring Reports (LSRCA, 2004-2006, 2013)
- Lake Simcoe Basin Wide Report (2008)
- Lake Simcoe Integrated Watershed Management Plan (2008)
- Lake Simcoe Protection Plan (2009)
- Lake Simcoe Phosphorus Reduction Strategy (2010)
- Lake Simcoe Climate Change Adaptation Strategy (2011)
- Natural Heritage System for the Lake Simcoe Watershed (Beacon Environmental and LSRCA, 2007)
- Spring/Summer Breeding Bird Survey, Chippewas of Georgina Island First Nation, Lake Simcoe, Ontario (E.P.D.I., 2015)
- State of the Lake Simcoe Watershed (2003)

- Wetland Evaluation on Georgina Island (Adopt-A-Pond Wetland Conservation Programme, 2014)

1.4 How this plan is organized

This plan includes a chapter dedicated to each of the four subwatershed features identified previously, these being study area & physical setting, water quality, shoreline & aquatic natural heritage, and terrestrial natural heritage. Each of these chapters follows an identical format, loosely structured around a pressure-state-response framework, in that each chapter firstly describes the current condition (state), secondly describes the stressors likely leading to the current condition (pressure), and finally recommends management responses in the context of the current management framework (response) (See the following text box).



Plan section:

1) ***Subwatershed Condition:*** Describes and analyzes the current state or condition of the subwatershed feature based on the best available data and information. This assessment is based on monitoring data, model output, surveys etc.
2) ***Subwatershed Stressors:*** Uses the best available information to identify and quantify the factors affecting the current condition of the watershed. For example, describing phosphorus loads from different land use activities.
3) ***Current Management:*** Establishes the relationship of the subwatershed plan to other legislation and planning documents;
4) ***Management needs:*** Identifies areas within the current management framework where improvements within this plan may be able to have greatest impact i.e. gaps or opportunities for the subwatershed plan to act upon.
5) ***Management recommendations:*** outlines resource management goals and objectives; as well as options for protection, rehabilitation, and enhancement of conditions in the subwatershed.

The resulting plan will protect the existing natural resources, facilitate informed planning decisions, and improve the efficiency of the development review process. An over-arching concept to keep in mind throughout the subwatershed planning process is that it is far more beneficial, both financially and ecologically, to protect resources from degradation than to rehabilitate them once they have been damaged.

FIRST NATIONS WATER DECLARATION IN ONTARIO

The First Peoples (First Nations) of this land were/are placed here on Turtle Island
otherwise known as North America by the Creator;
First Nations have responsibilities to their own territories that includes lands and waters;
As First Nations, the creator gave us a specific way of life,
which included teachings on how to care for our mother the Earth;
Water is the life giving gift that our mother the Earth provides for all of us and it is through the relationship that women have with our Mother Earth that they are the keepers of the special ceremonies needed to ensure waters are respected and that future generations will continue to experience this gift.

The Indigenous peoples of Turtle Island have kept alive the ceremonies given to our ancestors by the Creator, which are passed down through time in order for us to continue the way of life the Creator had intended us to and;
We need to respect, honour and share the spirits of the waters in the ceremonies given to us by the Creator;
First Nations have a direct relationship with all waters including the rain waters, waterfalls, mountain springs, swamp springs, bedrock water veins, rivers, creeks, lakes, oceans, icebergs and the seas - to ensure that the waters provides for all living things on a daily basis;
First Nations in Ontario have the laws and the protocols to ensure clean waters for all living things;
First Nations have knowledge, laws and our own ways to teach our children about our relationship to waters;
First Nations in Ontario made treaties with the non-indigenous people based on the continuation of all life and;
First Nations in Ontario's treaty making with the Crown created a relationship of rights for all parties and;
First Nations in Ontario's treaty relationships makes certain that our internationally protected right to give our free and fully informed consent on all issues related to use and care of waters as our right and were not given over with the making of Treaties;
First Nations in Ontario's fundamental water rights is a relationship based on an expression of a power relationship between ourselves and the Creator and;
First Nations have rights to determine the key properties of waters including distribution, contents and legitimacy of water rights to restore the balance;
First Nations in Ontario have reviewed the state of the waters within each of our territories;
First Nations in Ontario have seen the need to retain, declare and assert our relationship with waters to ensure that there are clean waters for the future generations;
First Nation peoples in Ontario have met in Garden River First Nation territory to raise our voices in solidarity to speak for the waters.

We announce and proclaim our role as holders of rights and carriers of responsibilities to defend and ensure the protection, availability and purity of freshwaters and oceans;
This is our responsibility to the future generations – for those children yet unborn – is set out in this Water Declaration.

Chiefs in Ontario (COO)
Suite 804-111 Peter Street, Toronto, Ontario M5V 2H1
Tel: 1(416)597-1266 • Toll-free: 1(877)517-6527

2 Study Area: The Georgina, Fox and Snake Islands Subwatershed

2.1 Introduction

Due to the need that was seen by the Anishnabek, Mushkegowuk and the Onkwehonwe to declare, retain, and assert our relationship with the waters to ensure that there is clean water for future generations, in October 2008 the Chiefs in Assembly at a Special Chiefs Assembly in Toronto passed Resolution 08/87 by consensus adopting the First Nations Water Declaration in Ontario.

http://www.chiefs-of-ontario.org/node/76

Georgina Island First Nation has undertaken the development of this Subwatershed Plan as reflected in the Water Declaration and our own inherent responsibilities and intimate relationships to *Nibi* within our territory, which includes Lake Simcoe, the rain waters, snow, streams, creeks, wetlands, bedrock veins and all other living things that are connected and depend on this gift. As the original caretakers of Turtle Island, we recognize the rights and responsibilities to defend and ensure the protection, availability, and purity of *Nibi* in our territory and Turtle Island as a whole for survival of the present and future generations. Through our teachings we have the responsibility to care for the land and the waters, respecting, honouring and sharing the spirit of these through the ceremonies given to us by our Creator. As life begins with women brining babies into the world through the breaking of *Nibi*, we have ceremonies from birth to death that relate to the care of the water.

The ecosystems in the world including those within our territory are under considerable stress from misuse and abuse and other factors such as changing climate and invasive species. *Nibi* is polluted with chemicals, pesticides, sewage, disease, and other pollutants, all in violation of our sacred laws given by the Creator, which are having an effect on all living things, including our people. It is our hope that this document will guide our community in the decision making process related to the care of the waters for the continuation of all to live as the Creator had intended.

2.2 Location

All of the lands within the Lake Simcoe watershed ultimately drain into Lake Simcoe, via one of the tributary subwatersheds. The Georgina, Fox and Snake Islands subwatershed is one of the 20 subwatersheds that make up the Lake Simcoe watershed; with its surface water runoff and the outlets of its tributary catchments discharging into the southern portion of Lake Simcoe (Figure 2-1).

The Chippewas of Georgina Island First Nation subwatershed is located both on and off the east shore of Lake Simcoe and is approximately 100 km north of the GTA, within the Township of Georgina. The First Nation Reserve No.33 consists of three separate Islands (Georgina 1,416 ha., Snake 135 ha., and Fox 20 ha.) and two mainland access points (Virginia Beach Marina and Island Grove Marina.

The subwatershed is owned by the Chippewas of Georgina Island First Nation and falls within the Regional Municipality of York. There are several streams present on Georgina Island that flow directly into the lake, and Virginia Creek B runs through the mainland area; Fox and Snake Islands do not contain any watercourses and surface runoff there flows directly into the lake. The subwatershed covers an area of 14 km^2, and has a total watercourse length of 3 km, which is approximately 0.07% of the combined watercourse length of Lake Simcoe's watercourses.

Figure 2-1: The Georgina, Fox and Snake Islands subwatershed

2.3 Human Geography

2.3.1 Population and Municipal Boundaries

As discussed earlier, the Georgina, Fox and Snake Islands subwatershed is owned by the Chippewas of Georgina Island First Nation and falls within the boundaries of the Regional Municipality of York. The population of the Chippewas of Georgina Island First Nation consists of 210 Band Members that reside on the reserve of approximately 700 members. There are also approximately 225 of seasonal cottages on Georgina Island, 115 cottages on Snake Island, and 50 cottages on Fox Island; the temporary seasonal population is much higher. The median age of the residents in 2011 was 36.8. This is much lower than both the national and provincial median ages, 40.6 and 40.4, respectively. This lower median age could be reflective of the large number of youth living on the island and the presence of younger families.

The municipal population for the municipality and estimated population density for the subwatershed is presented below in Table 2-1.

Table 2-1: Population and population density within the Georgina, Fox and Snake Islands subwatershed (Data Source: Statistics Canada, 2011 Community Profiles and the Chippewas of Georgina Island First Nation)

Subwatershed	Georgina, Fox and Snake Islands
Subwatershed area (ha)	1,448
Municipality	Regional Municipality of York
Total Municipal Population	1,032,524
% Municipality in Subwatershed	0.03
Estimated Municipal Population (2011) within subwatershed	210
Estimated Population Density (persons/km^2)	14.5

The level of education attained by a person can influence both their career choice and income level. Table 2-2 lists the percentage of the Regional Municipality of York population, 15 years and over, and their educational attainment compared to provincial standings.

Table 2-2: Educational attainment for the Township of Regional Municipality of York (Statistics Canada, 2011)

	Regional Municipality of York	Province of Ontario
No certificate; diploma or degree	17%	19%
High school certificate or equivalent	25%	27%
Apprenticeship or trades certificate or diploma	6%	7%
College; CEGEP or other non-university certificate or diploma	17%	20%
University certificate or diploma below the bachelor level	6%	4%
University certificate; diploma or degree	30%	23%

2.3.2 Land Use

Land use within the Georgina, Fox and Snake Islands subwatershed has been divided up into 11 classes including non-intensive agriculture, rural development, roads, aggregate, and natural heritage features (Figure 2-2).

Natural heritage features (88%) make up the largest proportion of land in the Georgina, Fox and Snake Islands subwatershed. Rural (residential) development accounts for 9.6% of the total land use. The smallest land uses are agricultural (0.7%), institutional (0.2%), and aggregate (0.8%).

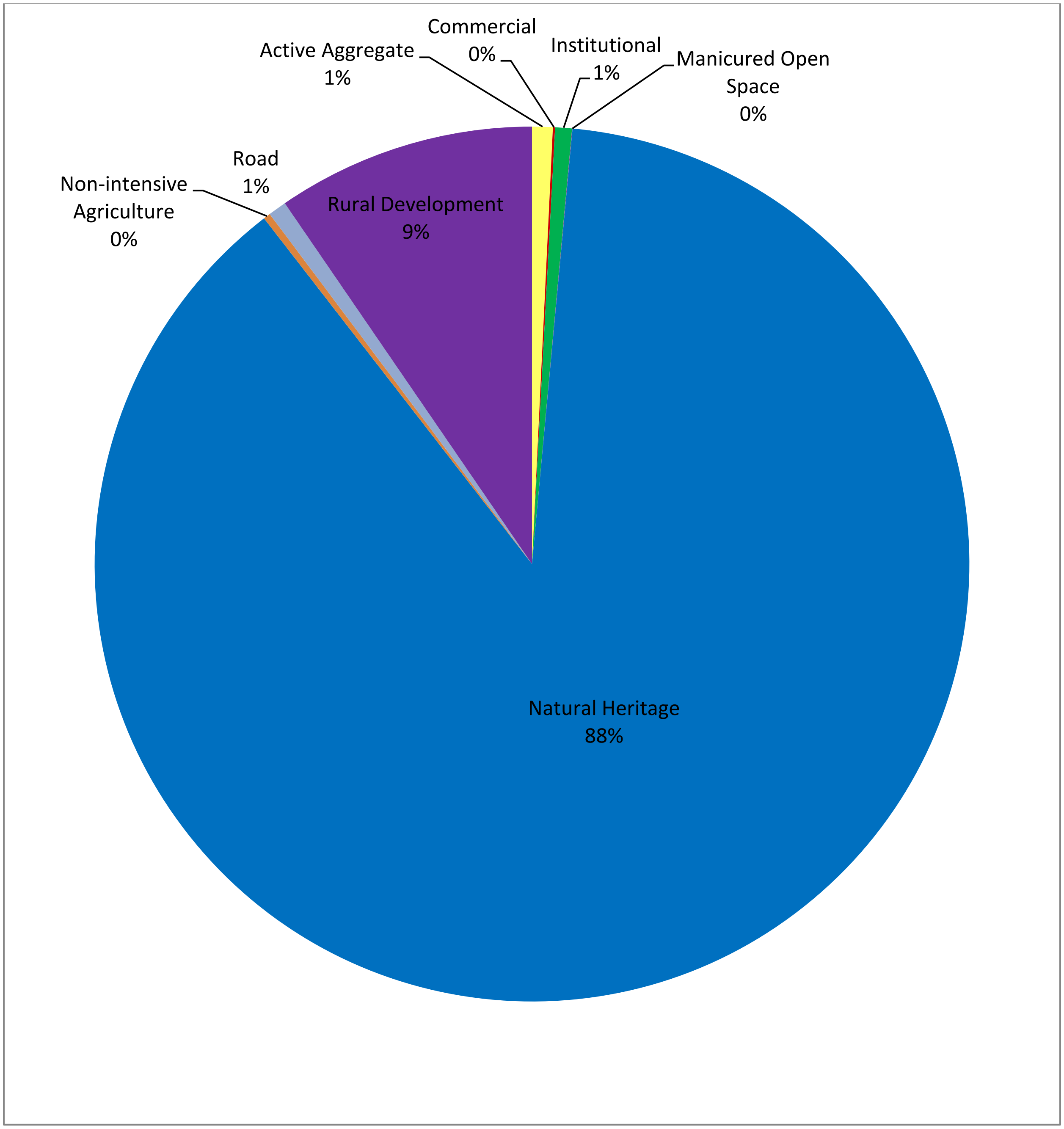


Figure 2-2: Land use distribution within the Georgina, Fox and Snake Islands subwatershed

The distribution of land uses within the subwatershed can be seen in Figure 2-3 below.

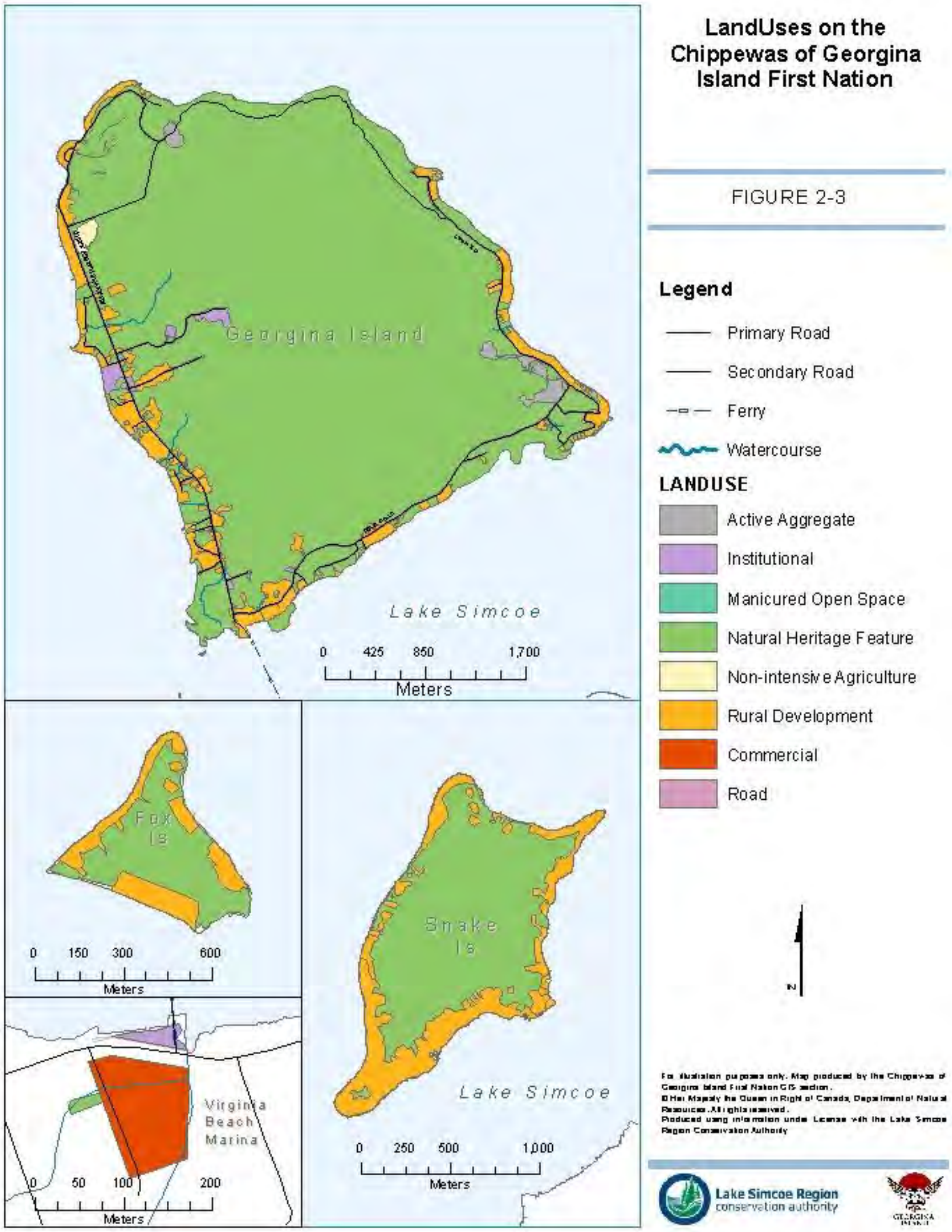


Figure 2-3: Land uses in the Georgina, Fox and Snake Islands subwatershed

To see how this subwatershed compares to the other subwatersheds in the Lake Simcoe watershed Figure 2-4 to Figure 2-6 illustrate all 18 of the Lake Simcoe subwatersheds from the subwatershed with the highest percentage of urban, natural heritage, and rural land uses to the subwatershed with the lowest percentage.

As can be seen in Figure 2-4, the Georgina, Fox and Snake Islands subwatershed has the lowest percentage (0%) of urban land use, while Barrie Creeks has the highest (62%).

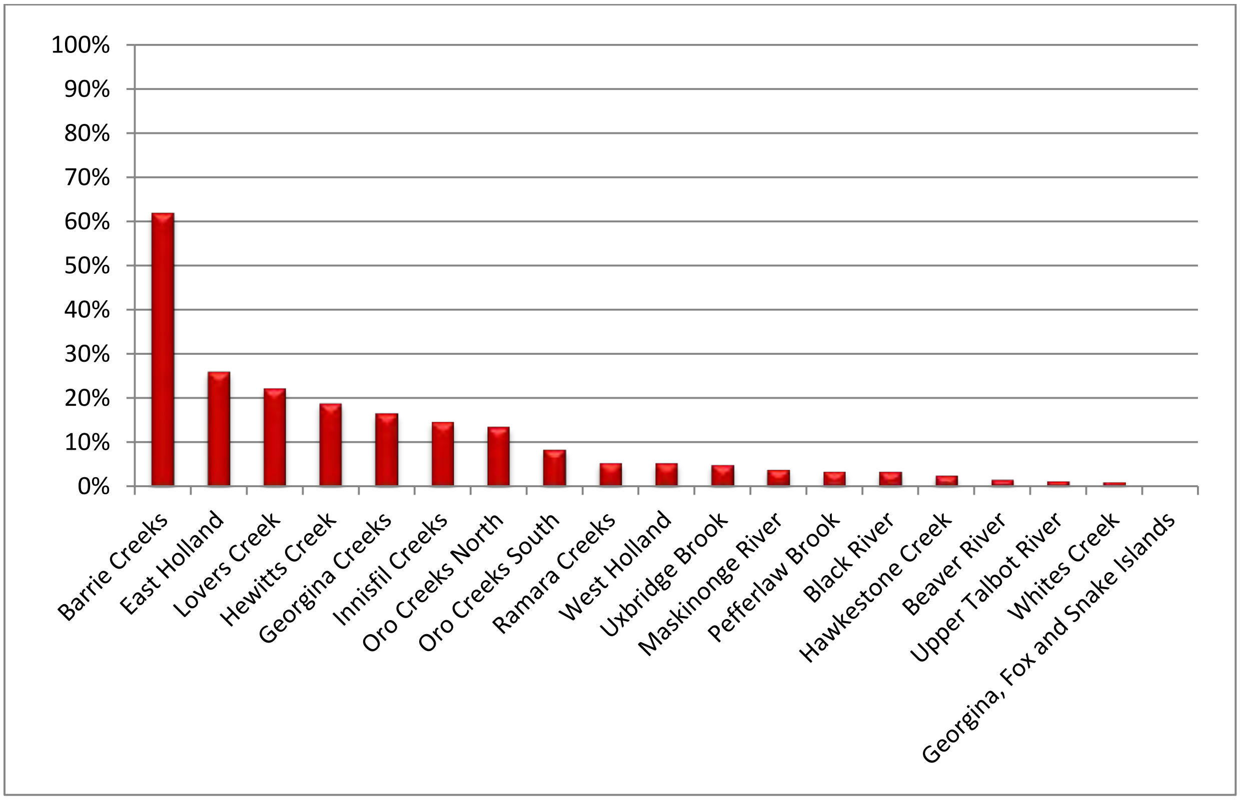


Figure 2-4: Urban land use in the Lake Simcoe subwatersheds

The Georgina, Fox and Snake Islands subwatershed has the highest level natural heritage cover of the Lake Simcoe subwatersheds, at 89%. This is in stark contrast to the Barrie Creeks subwatershed, which has the lowest level of natural cover in the watershed, with only 17% (Figure 2-5).

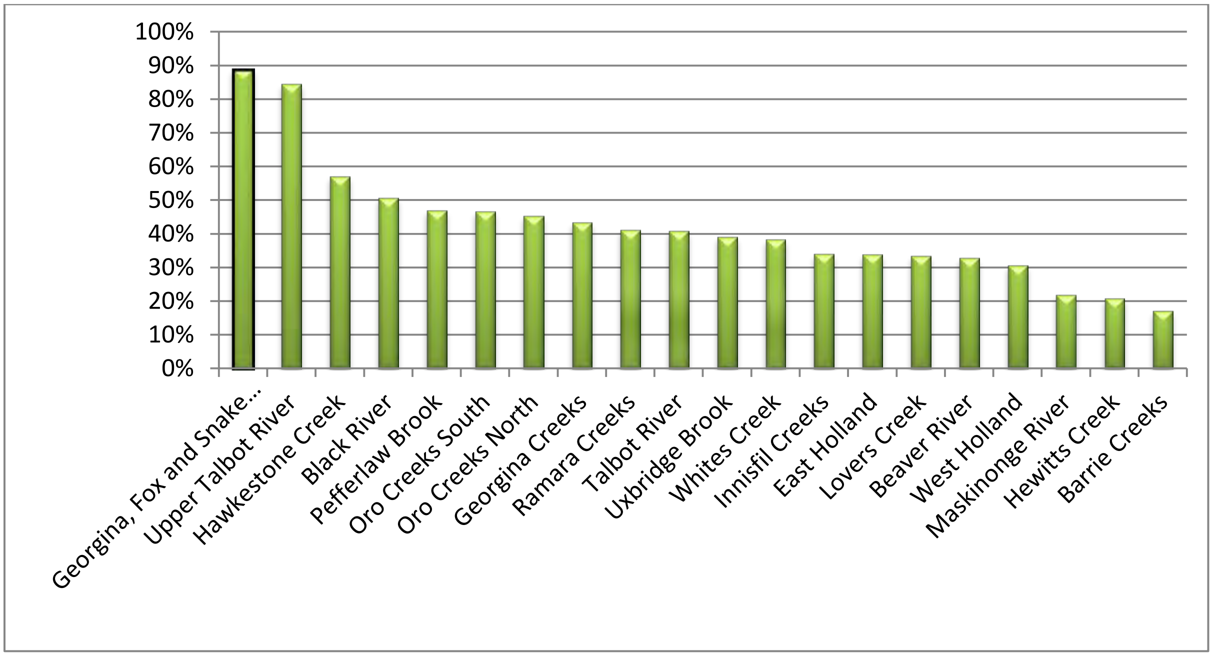


Figure 2-5: Natural heritage land cover in the Lake Simcoe subwatersheds

Figure 2-6 illustrates the rural land use in the Lake Simcoe subwatersheds. The Maskinonge River subwatershed in the southern part of the watershed has the highest percentage with 73%, while the Barrie Creeks subwatershed has the lowest (5%). The Georgina, Fox and Snake Islands subwatershed has the second lowest level of rural land use, and there is a large percentage gap between the three lowest (Barrie Creeks at 5%, Georgina, Fox and Snake Islands, and Upper Talbot at 12%) and of the fourth lowest subwatershed (East Holland subwatershed) which has 34%.

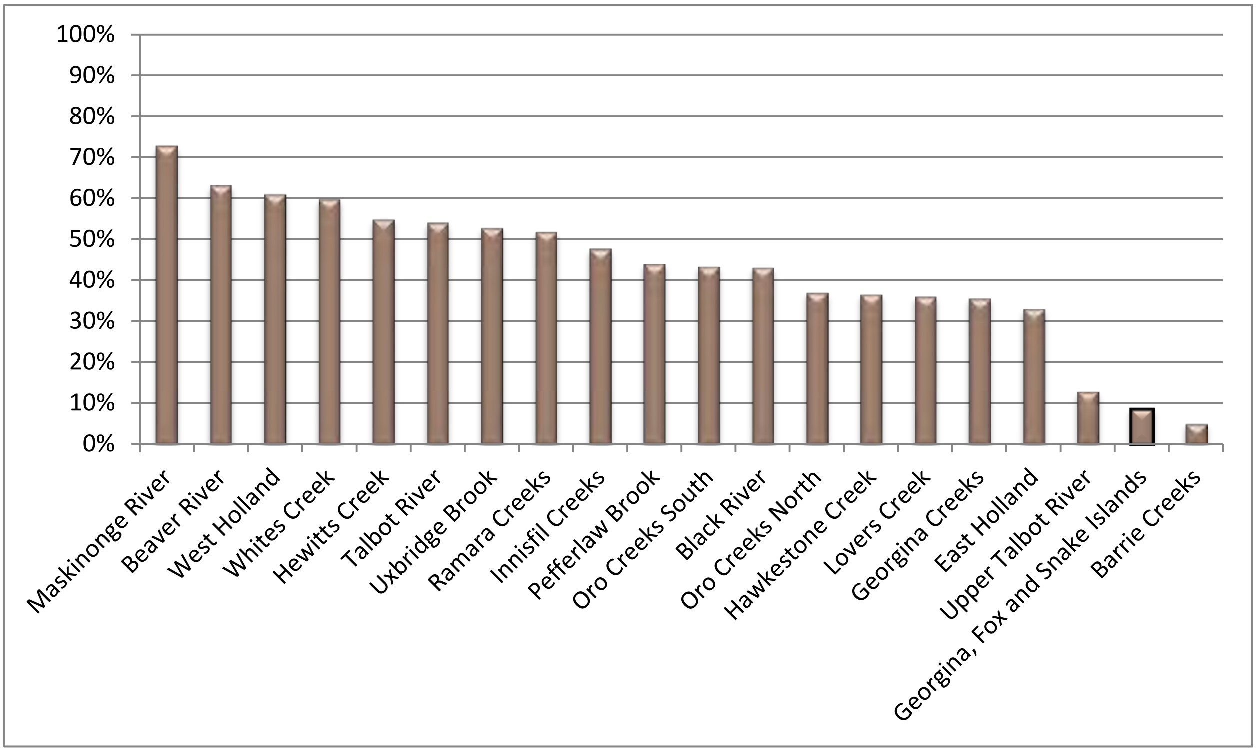


Figure 2-6: Rural land use in the Lake Simcoe subwatersheds

2.3.2.1 Impervious Surfaces

Impervious surfaces refer to hardened surfaces, such as roads, parking lots, and rooftops, which are made of (or covered in) a material impenetrable by water (i.e. asphalt, concrete, brick, rock, etc.)[1]. As these surfaces reduce the amount of water infiltrating down into the groundwater supplies and increases surface runoff, the hydrologic properties or drainage characteristics of the area are significantly altered.

Increasing levels of impervious surfaces, generally associated with urban growth, can impact the surrounding environment in a number of ways. These impacts include decreases in evapotranspiration, as there is little vegetation and the permeable soil is paved over; decreases

[1] For the majority of this report, impervious surfaces do not include features such as wetlands. These are sometimes considered impervious in hydrogeological models, such as those presented in Chapter 4 – Water Quantity.

in groundwater recharge; increases in the volume and intensity of surface runoff, leading to an increase in flow velocities and energy (which can alter the morphology of the stream through channel widening, under cutting of banks, sedimentation, and braiding of the stream); thermal degradation of the watercourses; decreases in water quality as pollutants are washed off streets into ditches which discharge to watercourses or directly into the lake; and impairment of aquatic communities (which can be negatively affected by all impacts listed above).

Environment Canada's *'How Much Habitat is Enough?'* guidelines (2013), suggest a limit of 10% imperviousness for urbanized subwatersheds, where subwatersheds should still be able to maintain surface water quality and quantity, and preserve the density and biodiversity of aquatic species. These guidelines further recommend an upper limit of 25-30% impervious cover as a threshold for degraded systems that have already exceeded the 10% impervious guidelines.

The Georgina, Fox and Snake Islands subwatershed falls below the 10% guideline, with just under 2% impervious area. This is in large part due to the prevalence of natural heritage features in the subwatershed and relatively low level of developed areas. There is some increase in developed area projected for the subwatershed; it will be important to undertake measures to maintain this low level of imperviousness in order to preserve groundwater recharge and flow patterns. This is of particular importance in this subwatershed where low flows are an issue, as will be discussed in later chapters. Figure 2.7 illustrates the impervious cover within the subwatershed.

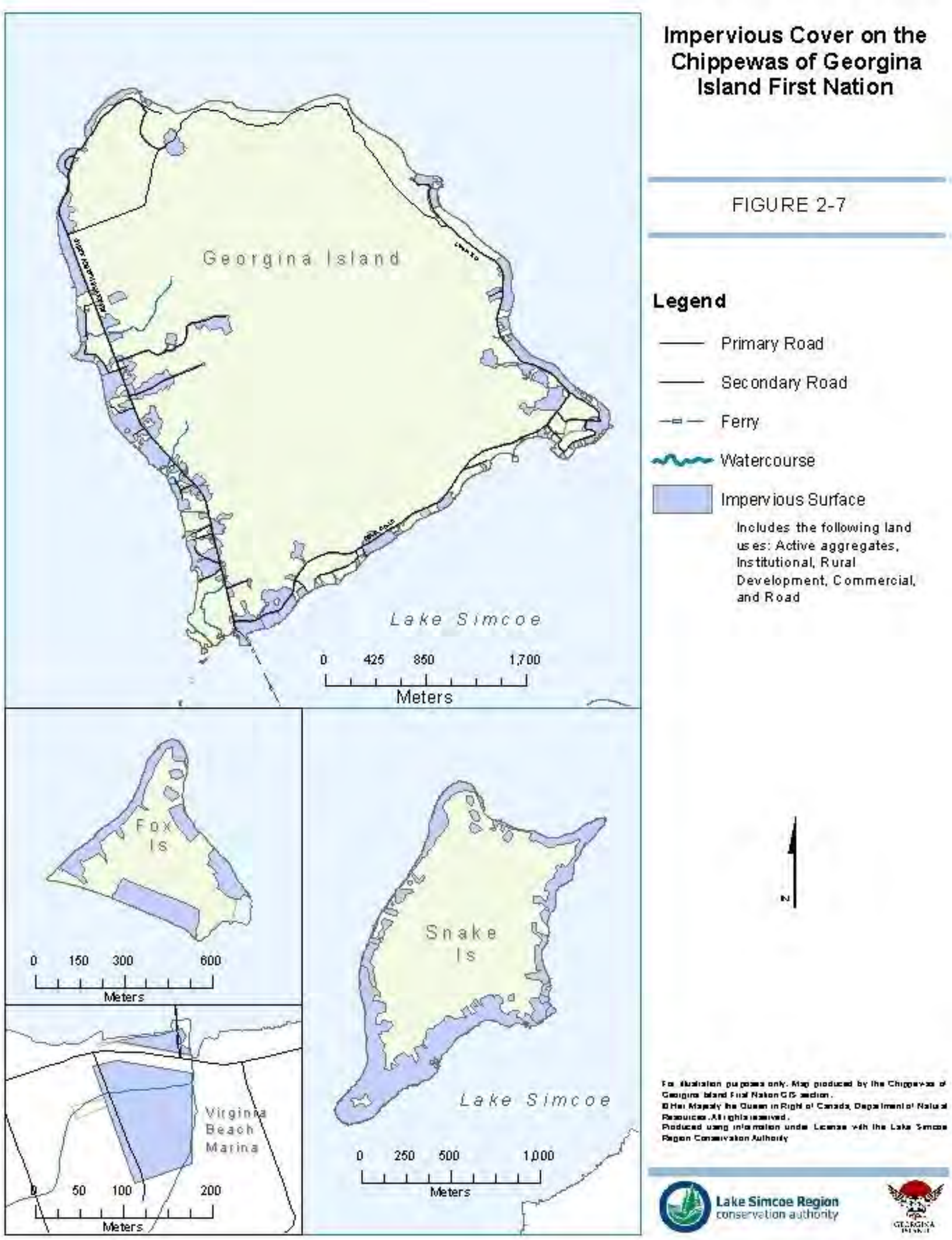


Figure 2-7: Impervious cover in the Georgina, Fox and Snake Islands subwatershed

2.3.3 Residential Development and Economy

The majority of the residential development in the study area falls around the shorelines of Georgina, Fox and Snake Islands. Two thirds of the overall shoreline area in the subwatershed is developed with homes and seasonal cottages. Georgina Island is the most developed island in the study area, with Infrastructure consisting of a ferry landing, an administration building, a health centre, a police station, a fire hall, a water treatment facility, a community centre, a church, a trails system, an outdoor rink, a childcare facility, a two-classroom school, a library, a marina, stores, a campground, as well as a landfill site and a sewage lagoon. There are main roads around the perimeters of Georgina and Snake Islands and for the most part, the interiors of each island remain undeveloped.

The Chippewas of Georgina Island First Nation's economy is varied, with employment across a number of different sectors (Table 2-3). Public administration (47%) is the largest industry, while the rest of the economy is equally spread between the construction (11%), transportation (11%), waste management and remediation (11%), health care and social assistance (11%), and arts, entertainment and recreation (11%) industries.

Table 2-3: Occupations in the Chippewas of Georgina Island First Nation (Data Source: Statistics Canada, 2011)

Industry	Number of people employed
Construction	10
Transportation and warehousing	10
Administrative and support, waste management and remediation services	10
Health care and social assistance	10
Arts, entertainment and recreation	10
Public administration	45
Total labour force	**95**

2.4 Human Health and Well-being

One of the major reasons for understanding and managing watersheds and their function is to protect the health and well-being of watershed residents. Figure 2-8 illustrates the watershed governance prism (Parkes *et al.,* 2010) and the four different aspects of watershed governance including "watersheds", "ecosystems", "health and well-being", and "social systems". The combination of all of the aspects of watershed management gives a comprehensive view of the way watershed governance can link the determinants of health and well-being to watershed management.

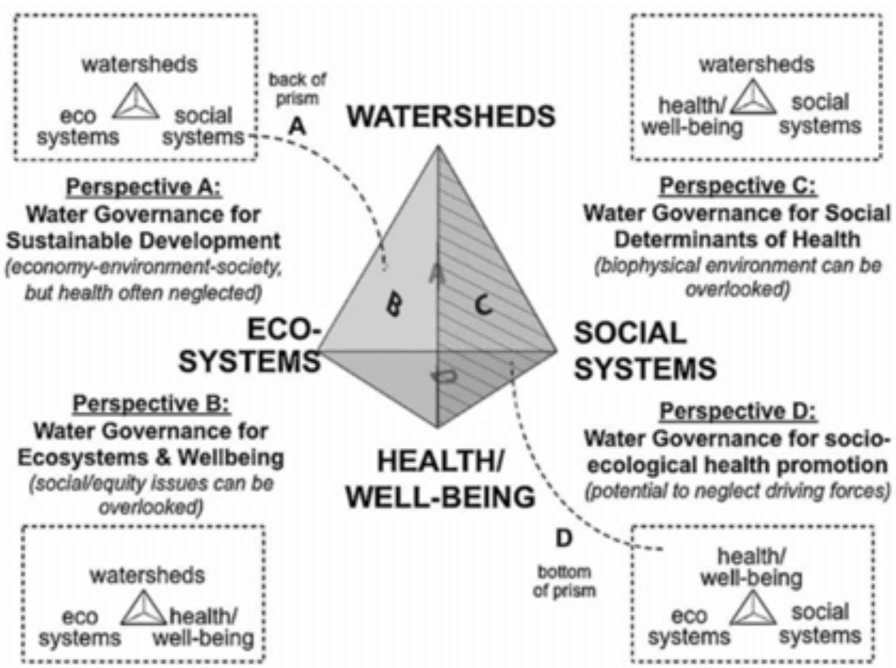


Figure 2-8: Watershed Governance Prism (Parkes *et al*. 2010).

The management of the Lake Simcoe watershed includes a number of these perspectives, incorporating issues related to human health and well-being, protection of wildlife habitats, and ensuring the preservation of water quality and water quantity.

2.4.1 Outdoor Recreation and Human Health

Within an urban setting, green spaces (including parks, conservation areas, forests, wetlands, streams and lake shore) are at a premium. Even within a more rural setting, these features are sometimes taken for granted when, in fact, they are an essential part of a healthy community.

2.4.1.1 Physical

Whether it’s an open soccer field, running/walking trails through forests or sandy beaches along the lake front, the green spaces within these subwatersheds provide a number of outdoor recreational opportunities for residents and visiting tourists. The different types of areas available offer a variety of physical activities that would not be available at a local gym and come at little to no cost. Parks and sports field provide areas for recreational or pick-up games of soccer, football or frisbee. Trails are areas to walk, run, or bike. Parks and conservation areas with forest and wetlands provide a range of recreational and aesthetic opportunities and the nearby lake shore and waterways offer residents a place to swim, canoe, kayak and fish. It is these types of areas that encourage the physical stimulation of individuals and families, creating a healthier lifestyle for people of all ages.

By encouraging children to be active outdoors at a young age, a number of health-related issues can be minimized or avoided all together. These include:

- Childhood Obesity: In Canada, over 30% of children ages 2-17 are currently overweight or obese (Childhood Obesity Foundation, 2015). Obesity can also lead to a number of other diseases including Type-2 diabetes, hypertension, asthma and cardiovascular disease (National Environmental Education Foundation (NEEF, 2015)).
- Vitamin D Deficiency: Most common diseases resulting from a lack of Vitamin D include rickets (children) and osteoporosis later in life (NEEF, 2015).
- Myopia: One study found that 12 year olds who spent less time doing near-work activities (reading, drawing, etc.) and more time doing outdoor activities were two to three times less likely to develop myopia than those who spent the majority of their time doing near-work activities (Rose *et al.,* 2008).

Georgina Island contains three community parks: the Neezh Meegwunun Campground, the Memorial Tree Parkland (a parkette created in 2013), and a parkette at the ferry landing. There are no public beaches or parks on either Fox or Snake Islands.

2.4.1.2 Mental

In addition to physical health benefits, there are a number of mental health benefits associated with natural areas. These areas, free of technology and the “jolts per minute” of contemporary life, allow people to take in their surroundings, and benefit from the serene and calming environment. Those who like to explore natural areas are mentally engaged to interact with the surrounding flora and fauna and associate these visual ‘pictures’ with other senses, such as touch, smell, and sound. Studies have also shown the benefits of nature on the social interactions, emotional status, and cognitive growth of children. Many young children have grown up watching television and playing on computers or with video games, with very little ‘play-time’ (unstructured, spontaneous activity) in their daily routine. Burdette and Whitaker (2005) suggest that through playing outdoors, a child’s social interactions, emotional status, and their cognitive growth are improved. In an unstructured, non-monotonous environment they will come across different situations that encourage them to problem solve, interact, and communicate with others and learn from the different experiences they are exposed to. Studies also show interactions with nature have positive impacts on those with attention-deficit/hyperactivity disorder (ADHD). Something as simple as a 20 minute walk through a park was found to increase concentration and elicit a positive emotional response (Faber and Kuo, 2008).

Recent studies have also linked walks in a natural environment with improvements in memory and mood in subjects suffering from depression; and exercise is often touted as one of the ‘natural cures’ for depression and other mood disorders.

It should also be noted that many individuals, especially First Nation, have an important spiritual connection to the environment. First Nation peoples have been gifted with the inherent responsibility to be the caretakers of Mother Earth and have a spiritual and ancestral relationship to the sacred elements of water, air, earth and fire, understanding their holistic interconnected relationship with each other and the balance needed to be healthy in mind body and soul.

2.4.1.3 Community Engagement and Cohesiveness

The more people recognize the benefits that the green spaces in their city or town have on their well-being, the more they will work to maintain and protect these areas. Green spaces can bring a community together to perform maintenance and restoration work, create fun and interactive environments, boost tourism (and in turn the local economy), and are places for community events, camps, or public forums. By putting effort into caring for the green spaces and enjoying the benefits they gain from them, people form an attachment to these areas, as well as their community as a whole.

2.4.1.4 Economic Benefits

While the previous section highlighted the social and health benefits of urban natural areas, studies have also shown the monetary benefits of having tree-lined streets and urban natural areas.

For example, the presence of mature trees in residential areas can increase the sale prices of neighbouring properties by 2-15% (Wolf, 2007; Donovan and Butry, 2009), and decrease the amount of time such properties are on the market (Donovan and Butry, 2009). The presence of larger natural areas nearby can increase property values by up to 32% (Wolf, 2007). Even during the initial development process, retaining mature trees on residential lots can increase their sale value by up to 7% (Theriault *et al*., 2002).

In addition to increasing property values, natural areas in or near residential neighbourhoods can act as a draw for white-collar workers working in high paying, creative jobs, who prefer to live in an urban setting that encourages their 'creativity', through a stimulating, diverse, cultural setting with easily accessible natural amenities for a healthy lifestyle. As a result, the preservation of urban green space can attract new businesses with highly paid staff, and strengthen the local economy (Florida, 2002). Commercial sectors can also benefit from an increase in urban tree cover. Studies have shown that shoppers tend to spend more time, and make more purchases, in downtown commercial and retail districts that have more trees, creating income both for the city and for store owners (Wolf, 2005).

2.4.2 Drinking Water

A threat to human health is the degradation and depletion of freshwater resources. Degradation of water quality can either be anthropogenic or natural in nature. Humans can impact their water through:

- Poor sanitation habits (crude solid waste disposal methods, improper filtration methods of waste water and drinking water);

- Removal of riparian buffers, allowing unfiltered run off from streets, lawns and agricultural fields to go directly into lakes and waterways;
- Improper storage of chemicals that can spill in to surface water or leach into the ground to reach the deeper groundwater resources;
- Warming of water temperatures (creates ideal temperatures for growth of bacteria) by connecting runoff systems to watercourses or creation of standing bodies of water that link to the watercourse.

Climate change can also impact water quality through changes in air temperature, precipitation and extreme events by:

- Releasing contaminants: extreme events and increases in precipitation may damage buildings/containers holding contaminants, cause the overflow of retention areas holding contaminants, and/or wash surface contaminants into watercourses;
- Transporting contaminants: extreme events can transport contaminants greater distances, potentially increasing the exposure to them;
- Creating warmer environments: surface waters become more hospitable to pathogens and other waterborne disease.

Poor water quality, either because of anthropogenic or natural conditions, can lead to an increase in water-borne diseases, loss of fisheries, contaminated food sources, and closures of beaches due to high levels of *Escherichia coli*. Residents can be directly impacted through sickness, increases in food costs (uncontaminated) or loss/decrease in income (loss of fisheries, farms with unusable, contaminated produce).

Depletion of available water is another major health concern. Low water quantity can result in water restrictions that lead to lower agricultural produce yields, increasing the cost of food. Less water available to residents also means that there is less water available to natural environments, leading to a loss of habitat through drying of wetlands and an increase in forest fires.

Drinking water within the study area is provided through private wells and surface water takings from Lake Simcoe. The Chippewas of Georgina Island First Nation provides drinking water to approximately 109 households on Georgina Island. This supply system has been in place since 1993 and intakes water from Lake Simcoe approximately 345m off of the western shore and treats it through the Georgina Island Water Treatment Plant.

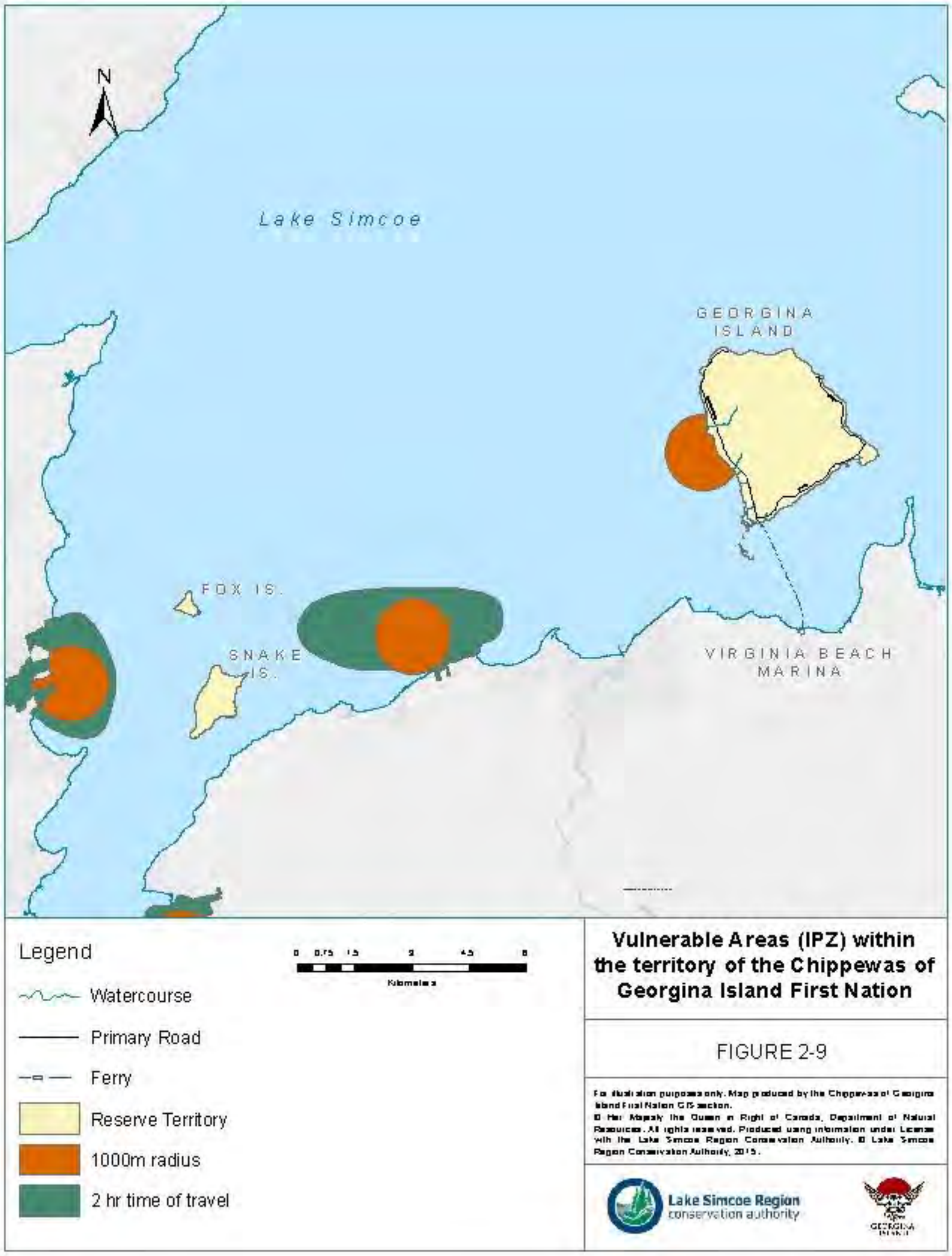


Figure 2-9: Source water vulnerable areas (drinking water intake protection zones (IPZ)) located within and near the Georgina, Fox and Snake Islands subwatershed

2.4.3 Ecological Goods and Services.

In addition to the direct benefits to human health provided by publicly accessible natural areas and clean drinking water, the environment also provides a range of other, less tangible, benefits, often termed 'ecological goods and services'. These benefits include the storage of floodwaters by wetlands, water capture and filtration by forests, the absorption of air pollution by trees, and climate regulation.

The forests, wetlands, and rivers that make up watersheds are essentially giant utilities providing ecosystem services for local communities as well as the regional and global processes that we all benefit from. Ecosystems provide many services including carbon storage and sequestration, water storage, rainfall generation, climate buffering, biodiversity, soil stabilization, and more (Global Canopy Programme, 2015).

These benefits are dependent on ecosystem functions, which are the processes, or attributes, that maintain the ecosystems and the species that live within them. Humans are reliant on the capacity of natural processes and systems to provide for human and wildlife needs (De Groot, 2002). These include products received from ecosystems (e.g. food, fibre, clean air, and water), benefits derived from processes (e.g. nutrient cycling, water purification, climate regulation), and non-material benefits (e.g. recreation and aesthetic benefits) (Millennium Ecosystem Assessment, 2003).

In 2008, the Lake Simcoe Region Conservation Authority partnered with the David Suzuki Foundation and the Greenbelt Foundation to determine the value (natural capital) of the ecosystem goods and services provided by the natural heritage features in the watershed in the report: *Lake Simcoe Basin's Natural Capital: The Value of the Watershed's Ecosystem Services* (Wilson, 2008). By identifying and quantifying ecosystem services within a watershed, environmental resources can be directed towards areas that are currently of high value or areas that have the potential to be of high value.

2.4.3.1 Valuing Ecosystems

There have been several techniques developed to estimate economic values for non-market ecosystem services. The method used for the 2008 study uses avoided cost (i.e. damages avoided) and replacement cost (cost to replace that service) for ecosystem service valuation, as well as contingent valuations or willingness-to-pay studies for cultural values. Some of the values were derived using direct analysis and some values were adapted from other studies. Table 2-4 summarizes the value of the various ecosystem services by land cover type in the Georgina, Fox and Snake Islands subwatershed, as well as for the whole Lake Simcoe watershed. All ecosystem service values have been updated to 2015 Canadian dollars.

The estimated values provided are likely a conservative estimate because our knowledge of all the benefits provided by nature is incomplete, and because these values are likely non-linear in nature (i.e. the value of natural capital and its services will increase over time, as natural areas become more scarce, and demands for services such as clean water or mitigation of climate change become greater). It is also important to note that without the earth's ecosystems and resources, life would not be possible, so essentially the true value of nature is priceless. The valuations of ecosystem services, however, provide an opportunity to quantitatively assess the current benefits and the potential costs of human impact.

Table 2-4: Summary of non-market ecosystem service values by land cover type (2015 values)

Land Cover Type	Total Georgina, Fox and Snake Islands subwatershed value ($ million/yr)	Total Lake Simcoe basin value ($ million/yr)
Cropland	0.0023	58.46
Forest	1.53	238.84
Forest/ Wetlands*	14.75	647.17
Wetlands	0.77	256.40
Grasslands	0.49	37.69
Hedgerows/ Cultural Woodland	0.034	10.20
Pasture	0.012	43.96
Urban Parks	0.0048	3.47
Water**	0.0067	123.64
Total	**17.61**	**1,419.82**

* This includes treed swamps.
** This does not include the value of Lake Simcoe

As has been demonstrated, the natural systems of the Georgina, Fox and Snake Islands subwatershed provide a number of goods and services. These so-called "free" ecosystem services have, in fact, significant value. The analysis in the 2008 report provided a first approximation of the value of the non-market services provided – totalling annually (in 2015 values) for the Lake Simcoe watershed $1.4 billion and at least $17.6 million for the Georgina, Fox and Snake Islands subwatershed. The most highly valued natural assets are the forests and treed swamps. For the Lake Simcoe watershed these were calculated to be worth $238 and $647 million per year, respectively. These values for the Georgina, Fox and Snake Islands subwatershed were calculated to be $1.5 million (forests) and $14.7 million (treed swamps).

The high value for forests reflects the many important services they provide, such as water filtration, carbon storage, habitat for pollinators, and recreation. Treed swamps and wetlands provide high value because of their importance for water filtration, flood control, waste treatment, recreation, and wildlife habitat.

It is important to note that while the value of Lake Simcoe is not included in the watershed total, it is of considerable value to all surrounding natural and human communities within the Lake Simcoe watershed, especially for Georgina, Fox and Snake Islands. The lake provides a vast number of recreational opportunities for locals and tourists alike, is a source of drinking water for eight municipal surface water intakes including Georgina Island, supports a substantial fishery and, as well as being a significant natural heritage feature, provides people with beautiful scenery. As such, the preservation of the lake and the rest of the natural heritage features within the watershed results in a significant cost savings in municipal infrastructure that would otherwise be needed to watershed residents and users.

2.5 Geology and Physical Geography

The geology, topography, and other physical features of a subwatershed provide the foundation for the subwatershed's hydrological and ecological processes, as they provide a strong influence on factors such as local climate patterns, types of land cover, land use practices, and surface water and groundwater flow paths.

2.5.1 Geology

A number of studies have contributed to the geologic understanding in the study area. A generalized description of the bedrock geology, quaternary geology, and geological history within the Georgina, Fox and Snake Islands subwatershed was compiled by Hatch (2011).

2.5.1.1 Bedrock Geology

The bedrock geology in the Georgina, Fox and Snake Islands subwatershed consists of flat lying, thin bedded sedimentary rock comprising limestone, dolostone, shale, arkose and sandstone of Ordovician age (450 million years old). This rock entirely underlies all of the islands, but is only locally exposed at ground surface in a northwest-southeast oriented zone on Georgina Island. Due to the strike and dip of the rock strata, the bedrock level will be slightly higher on the northeast side of Georgina Island, compared to the southwest side. Bedrock may also be exposed along the shoreline elsewhere on Georgina Island.

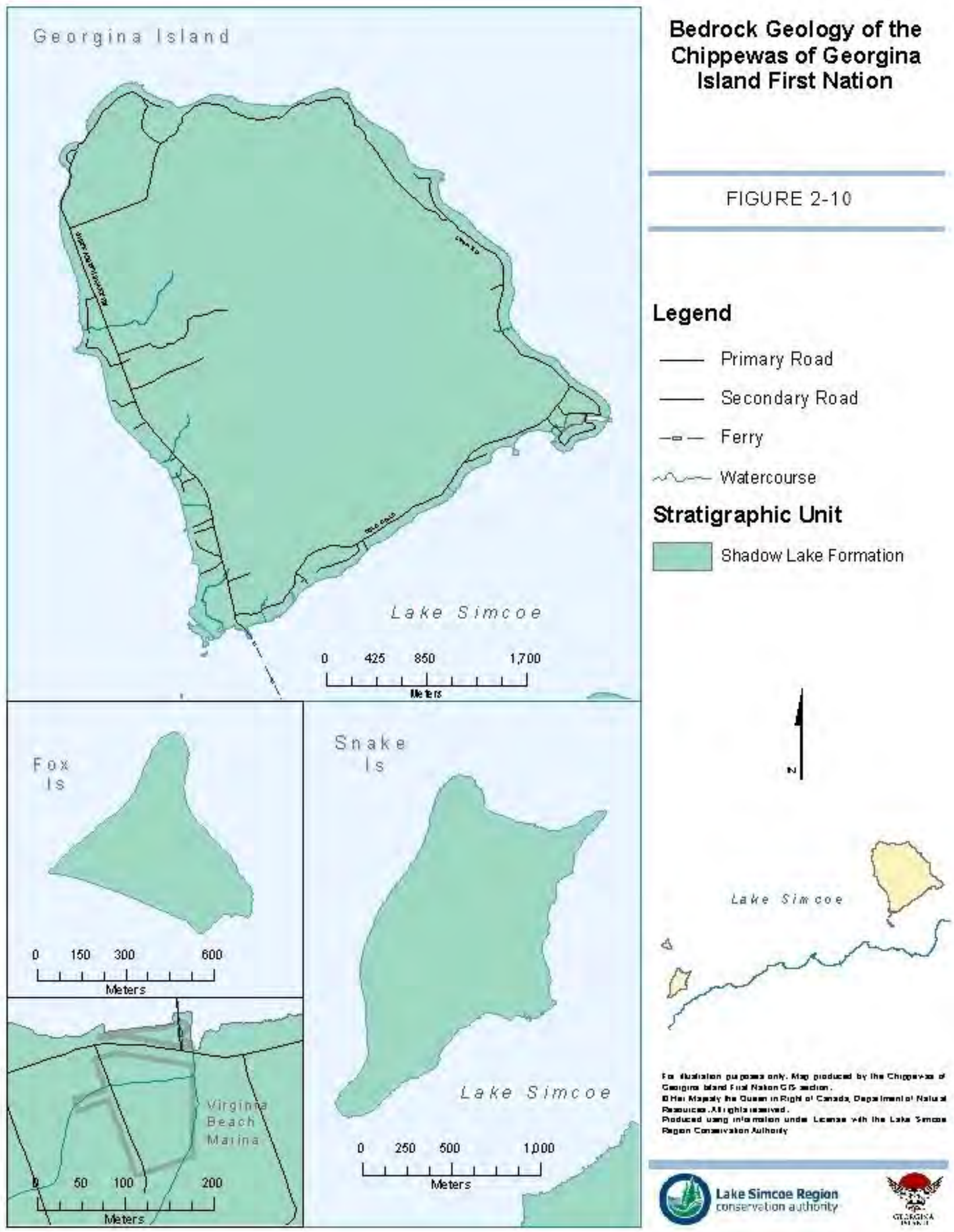


Figure 2-10: Bedrock geology in the Georgina, Fox and Snake Islands subwatershed.

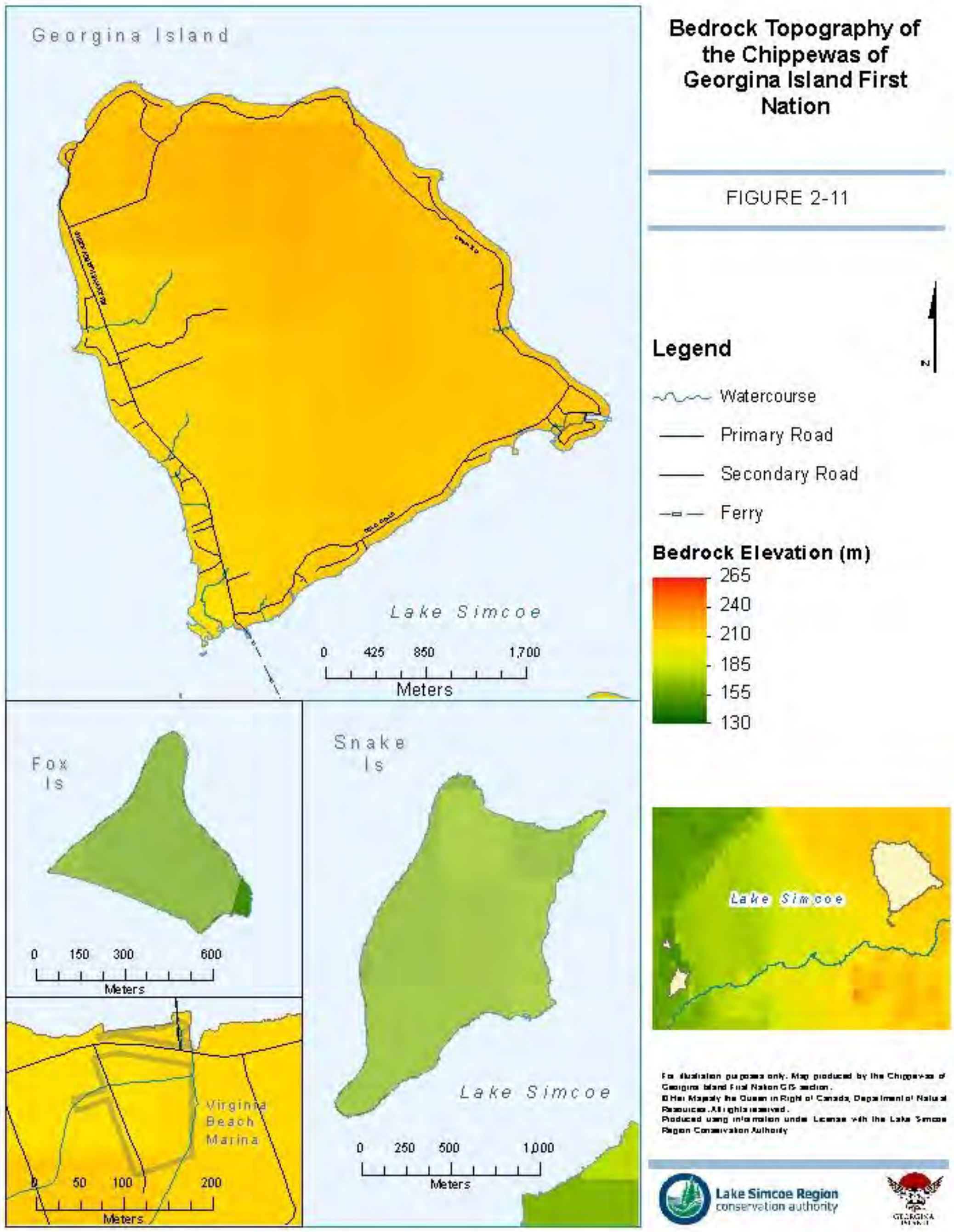


Figure 2-11: Bedrock topography within the Georgina, Fox and Snake Islands subwatershed.

2.5.1.2 Quaternary Geology

Glacial History

Like all of southern Ontario, the study area was repeatedly glaciated during the Pleistocene Epoch, although locally there is only clear evidence for glacial activity during the Wisconsinan, the final major glacial episode, which occurred in the last million years. The ice moved in a southwestern direction, scraping away all previously weathered rock and soil. As the glacier melted and retreated some 12,000 years ago, glacial till (i.e., silt, sand, gravel, cobbles and boulders) was deposited in areas of depressed bedrock, such as the southwest side of the island. At the same time, huge meltwater lakes developed along the edge of the ice. Glacial Lake Algonquin was one such lake and included Georgian Bay and Lake Simcoe. Fine grained, stratified deposits of silt and clay were deposited in this lake. These are present on the mainland around Lake Simcoe.

Islands are generally created, for example, as a result of erosion of surrounding terrain below water level or deposition of glacial materials above water level. Georgina Island and the other islands in Lake Simcoe appear to be the result of erosion, by the glacier and possibly pre-glacial rivers, as well as deposition of glacial materials during the glacial period.

Overburden Geology

The bedrock within the Georgina, Fox and Snake Islands subwatershed is overlain by unconsolidated sediments, known as the overburden, which were deposited during the Quaternary Period. The Quaternary period is the most recent time period of the Cenozoic Era on the geologic time scale. The Quaternary Period can be divided into the Pleistocene (Great Ice Age) and the Holocene (Recent) Epochs. During the Pleistocene, at least four major continental-scale glaciations occurred, which include, from youngest to oldest, the Wisconsinan, Illinoian, Kansan, and Nebraskan Stages (Dreimanis and Karrow, 1972).

All of the surficial deposits within the subwatershed, and within most of southern Ontario, are interpreted to have been deposited by the Laurentide Ice Sheet during the Wisconsinan glaciation. The Laurentide Ice Sheet is the glacier that occupied most of Canada during the Late Wisconsinan period, approximately 20,000 years ago (Barnett, 1992).

The quaternary deposits within the study area are shown on Figure 2-12. Much of the surfical geology described below is based on mapping and descriptions by the Ontario Geologic Survey (Barnett and Mate, 1998) and by Hatch (2011). As illustrated in the figure, the major surficial unit on Georgina Island, which covers the entire southwest portion, is glacial till (ie. a heterogeneous deposit of silt, sand, gravel, cobbles and boulders). Based on water well information records (MOECC 2016), the depth of overburden varies from 1m to 25m near the centre of the island, and is thinner on the northeast side of the island. There are also organic deposits present locally on the east side of the island and modern shoreline deposits are present along the southeastern point and in the sand islands.

The overburden on Fox Island is characterized by glacial till along the eastern half, and glaciolacustrine deposits (gravel and sand in raised shoreline features.

On Snake Island, there is a larger variety of overburden types, consisting of till (clay, silt and sand), glaciolacustrine deposits (silt, clay, sand and gravel), organic deposits (peat, muck and marl), and modern shoreline deposits of gravel and sand along the southern shore.

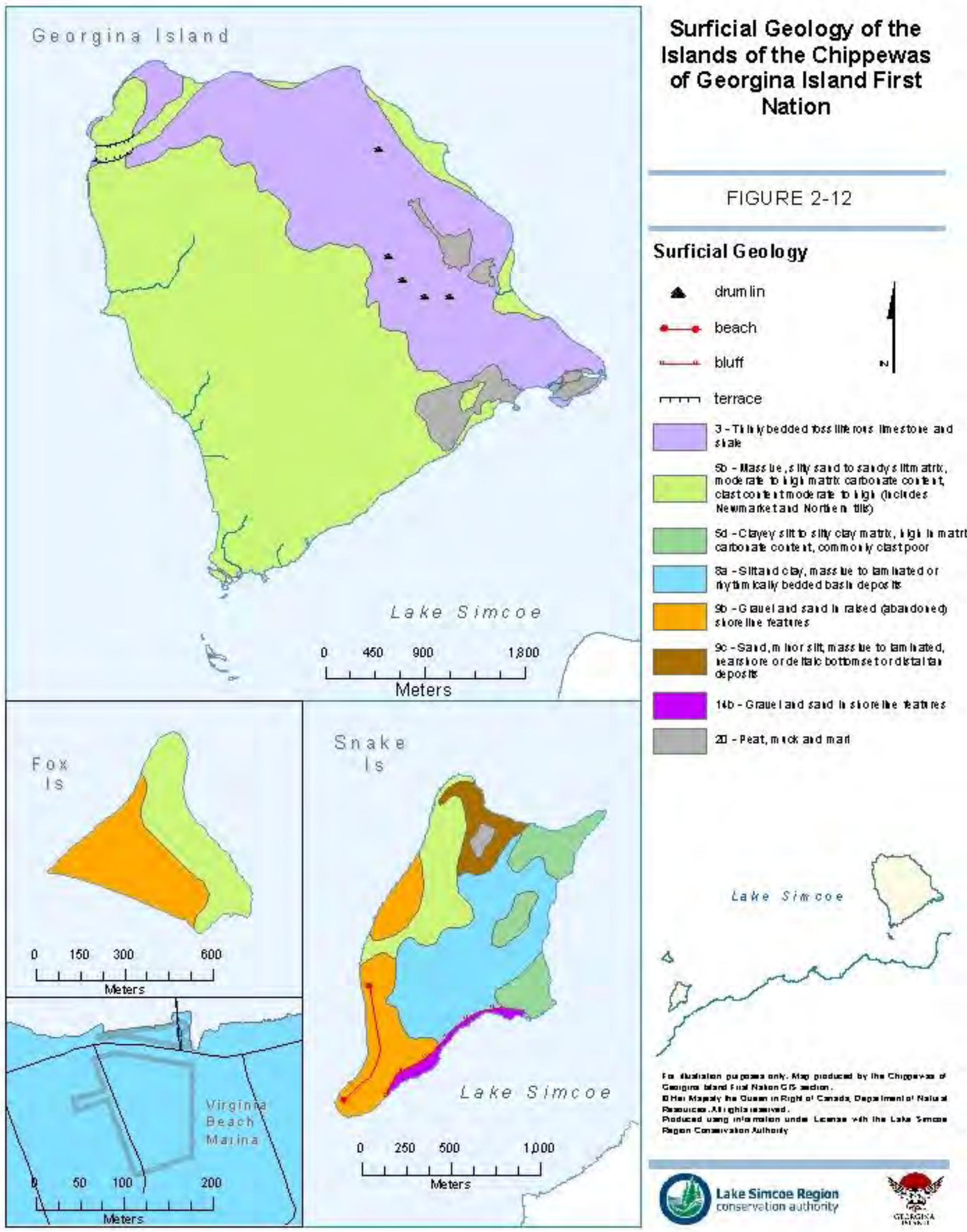


Figure 2-12: Surficial geology in the Georgina, Fox and Snake Islands subwatershed

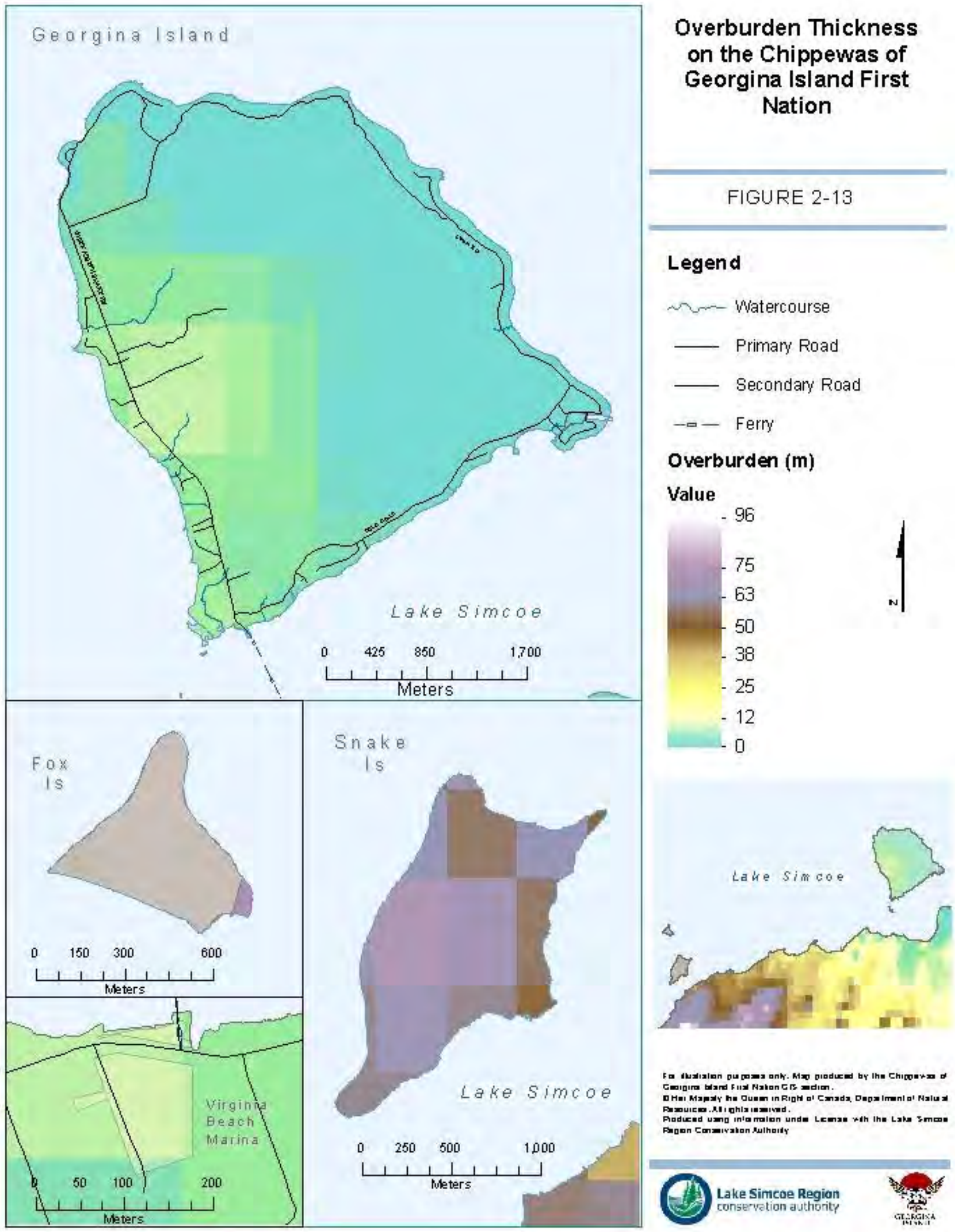


Figure 2-13: Overburden thickness in the Georgina, Fox and Snake Islands subwatershed

2.5.2 Physiography, Topography and Soils

2.5.2.1 Physiography

Physiography is the study of the physical structure of the surface of the land. A physiographic region is an area with similar geologic structure and climate, and which has a unified geomorphic history. The study of physiography is important from a water resource perspective as the knowledge gained from understanding the land composition aids hydrogeologists and hydrologists in understanding the groundwater and surface water flow systems. The physiography of an area is also important from a land use perspective as the sediments and landforms present at the surface influence the types of activities that are present in the study area, such as agriculture and aggregate extraction.

The physiographic regions within the Georgina, Fox and Snake Islands subwatershed are a direct result of the deposition and erosion of the quaternary sediments (overburden) during glacial and post-glacial events, and closely correspond to the topography discussed in the following section. According to Chapman and Putnam (1984), the main physiographic region of the subwatershed is the Simcoe Lowlands (Figure 2-14). The region is described as having lower elevations. The lowlands were flooded by glacial Lake Algonquin and are dominated by lake-deposited sediments, predominantly sand including silt and clay (Chapman and Putnam, 1984). There are also several drumlins located on the eastern side of Georgina Island.

2.5.2.2 Topography

The topography of the subwatershed closely corresponds to its physiographic regions (Figure 2-15). The topographic relief across Georgina Island is mostly subdued, especially along the southern end of the island. The lowest elevation is measured at 219 metres above sea level (masl) along the Lake Simcoe shoreline and a maximum elevation of 228 masl occurs around the northern upland portion of the island where there are steep cliffs along the shoreline. The land rises gently from west to east.

The elevations on Snake Island range from 220 masl along the shoreline, to 229 masl in the centre of the island. There is a sharp grade along the southern point, where elevations quickly rise from 220 masl to 226 masl.

Fox Island is characterized by a sharp grade along the shoreline particularly along the north side of the island, with a more subdued topographic relief inland. Elevations on the island range from 220 masl to 226 masl.

2.5.2.3 Soils

The soils present within a subwatershed influence the type and productivity of the vegetation communities commonly growing within it. Soils also influence the quality and quantity of water entering the ground and running along the surface. Traditionally, soils within the subwatersheds have been characterized based on the coarseness of their texture. Coarse-textured soils (gravel and sand) allow water to infiltrate better than finer-textured soils (clay, silty loam) do. The texture of the soil is important because it directly influences the landscape's ability to generate runoff. For example, during a heavy thunderstorm, rainfall that cannot infiltrate the ground will pool on the surface of an area with finer textured soils. Once enough water has collected it will start flowing overland as a result of gravity and in so doing can erode soil particles, washing them into ditches, streams, and lakes. OGS (2003) surficial geology maps were used to assign soil types found in the study area. Figure 2-16 depicts the spatial distribution of the soil types present throughout the subwatersheds.

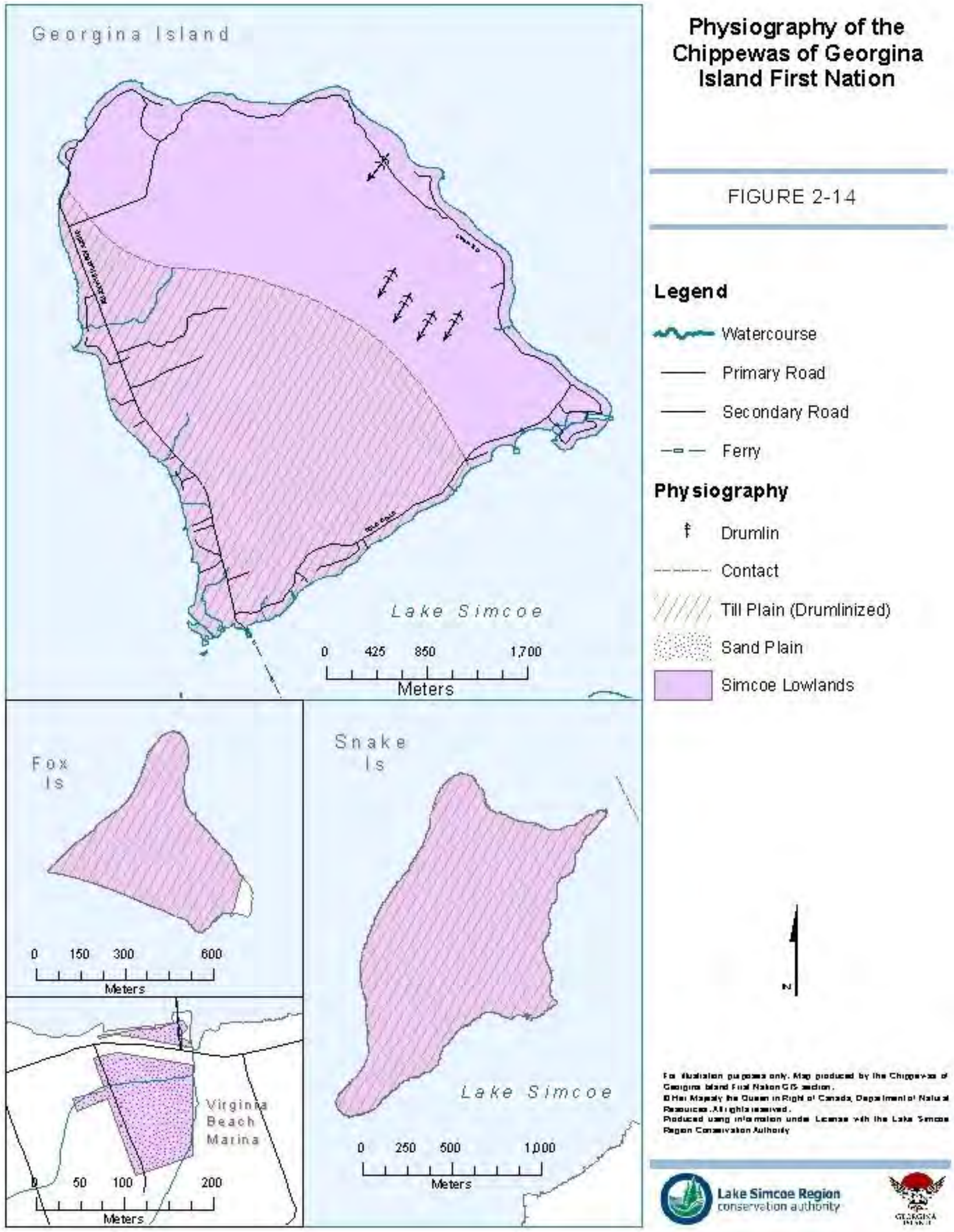


Figure 2-14: Physiography (from Chapman and Putnam, 1984).

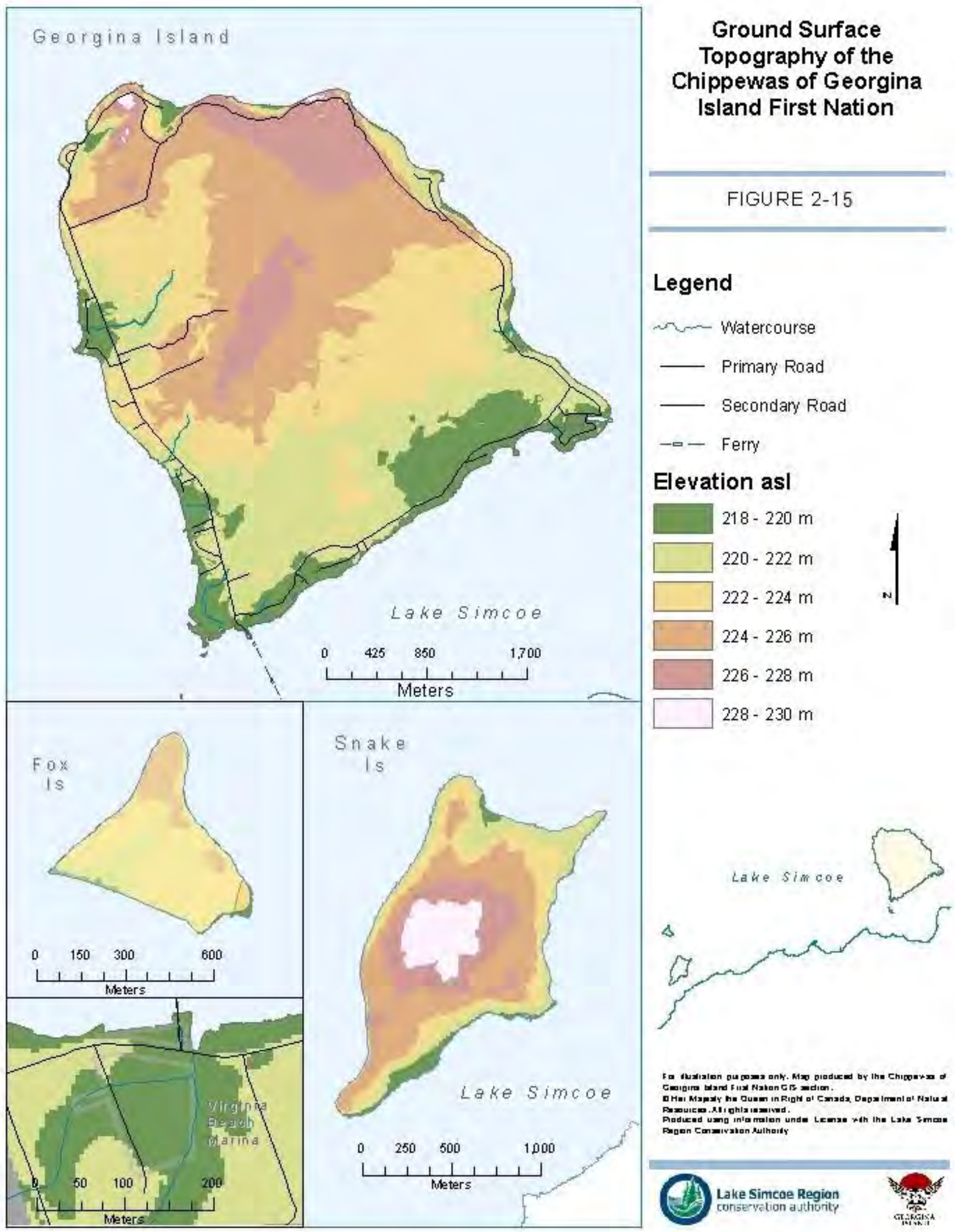


Figure 2-15: Ground surface topography (from 5-m Digital Elevation Model)

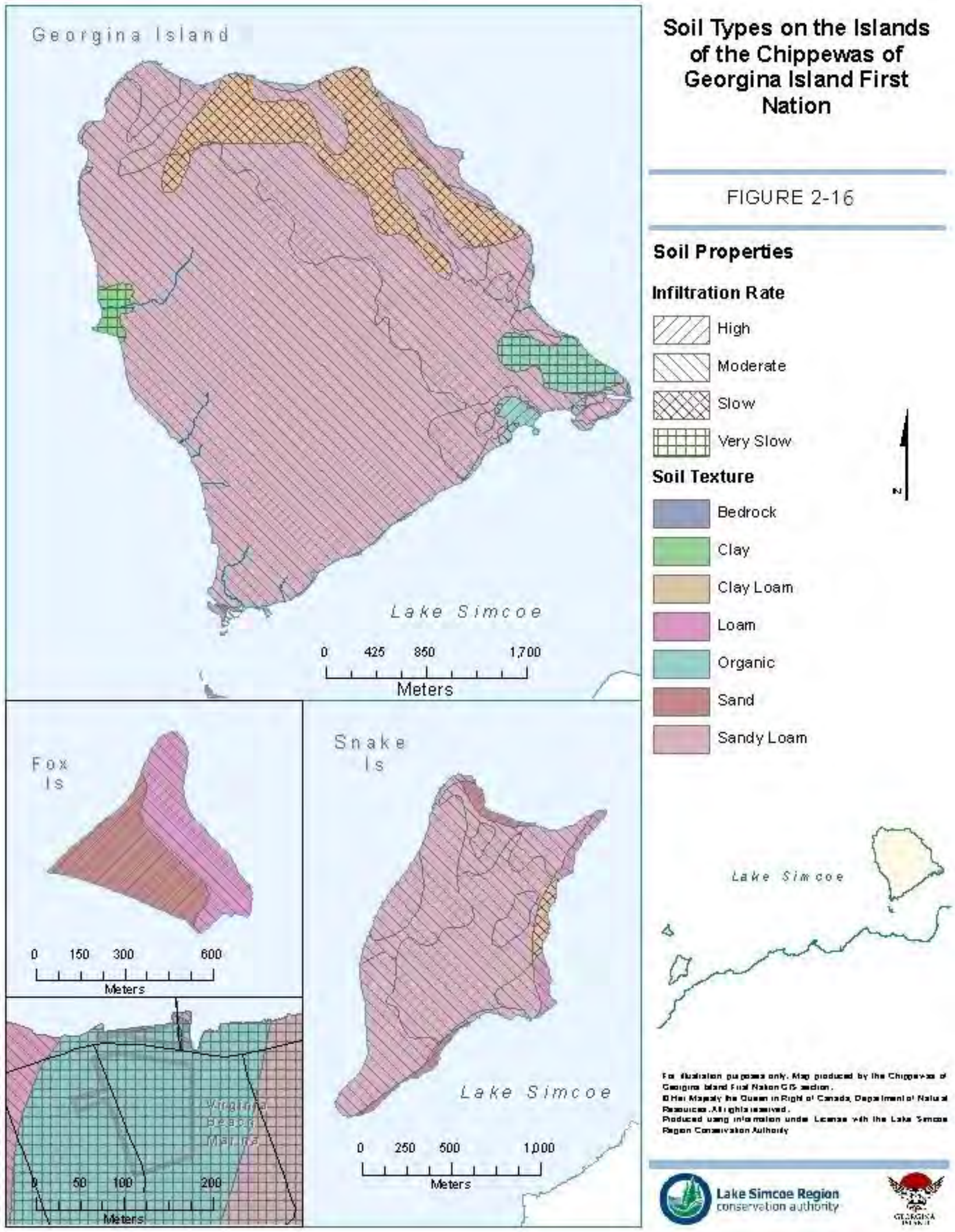


Figure 2-16: Soil types in the Georgina, Fox and Snake Islands subwatershed

2.5.3 Fluvial Geomorphology

2.5.3.1 Introduction and background

Fluvial geomorphology is the study of the processes that influence the shape and form of streams and rivers. It describes the processes whereby sediment and water are transported from the headwaters of a watershed to its mouth. These processes govern and constantly change the form of the river and stream channels, and determine how stable the channels are. Fluvial geomorphology provides a means of identifying and studying these processes, which are dependent on climate, land use, topography, geology, vegetation, and other natural and human influenced changes.

An extensive understanding of geomorphic processes and their influences is required in order to protect, enhance, and restore stream form in a watershed. Changes in land use, and urbanization in particular, can significantly impact the movement of both water and sediment, and can thus cause considerable changes to the geomorphic processes in the watershed. Changes to the morphology of stream channels, such as accelerated erosion, can impact the aquatic community, which has adapted to the natural conditions, and can also threaten human lives, property, and infrastructure.

2.5.3.2 Current Status

Specific fluvial geomorphology studies have not been completed for the Georgina, Fox and Snake Islands subwatershed, but some relevant information was available through other studies. The information and data provided within this section has been collected by LSRCA staff completing studies on the condition of the fisheries in the subwatersheds. While a fisheries study is specific in nature, it also tends to provide a “snap-shot” of the biological, chemical and physical characteristics of the system. It should also be noted that some sections of the watercourses in the subwatershed have been moved, piped, channelized, eliminated or manipulated in some fashion to varying degrees. While specific data on the exact location and the degree to which a stream has been manipulated is not currently available, it is fair to say that the alteration of the watercourses has changed both the shape and functioning ability of them. Information on the impacts of manipulating watercourses is available in **Chapter 6, Aquatic Natural Heritage**.

2.5.3.3 Strahler Stream Order

Stream order is a measure of the magnitude of a stream within a watershed and allows for the comparison of rivers of different sizes or importance within or between systems (Dunne and Leopold, 1978). A first-order stream is an unbranched tributary that typically drains the headwater portion of the watershed. When two or more first order streams converge, the downstream segment is classified as a second order stream. A third-order stream is the downstream segment of the confluence of two or more second order streams, and so on. As the order of a stream increases, the characteristics of the watercourse typically change. Larger order streams are generally characterized by lesser elevation gradients, slower velocities, and an increased stream area to accommodate the flow from additional tributaries. The stream order of a watershed is determined by the stream order of its outlet.

All of the streams on Georgina Island are first order; the stream which outlets at the mainland is a 3rd order stream.

2.5.3.4 Drainage Density

Drainage density is a measure of how well a watershed is drained by its streams and is calculated as the total length of all streams within a watershed divided by the total area of the watershed. Typically, watersheds with high drainage densities are characterized by greater peak flows, high suspended sediments and bed loads, and steep slopes (Dunne and Leopold, 1978). The drainage density of the Georgina, Fox and Snake Islands subwatershed is 0.2, which is below the average for the Lake Simcoe watershed (Table 2-5). This relatively low number is consistent with conditions in the island subwatershed, which has a very small number of short watercourses and characteristically low flows.

Table 2-5: Georgina, Fox and Snake Islands subwatershed stream length, subwatershed area, and drainage density.

Creek	Stream Length (km)	Watershed Area (km^2)	Drainage Density (km/km^2)
Georgina, Fox and Snake Island and mainland	3.45	14.5	0.2
*Lake Simcoe watershed average	3672.3	2515.9	1.5

**The Lake Simcoe watershed average includes the subwatersheds of: Beaver River, Black River, East Holland River, Georgina Creeks, Georgina Island, Hawkestone Creek, Hewitts Creek, Innisfil Creeks, Lovers Creek, Maskinonge River, Oro Creeks North, Oro Creek South, Pefferlaw/Uxbridge Brook, Ramara Creeks, West Holland River, and Whites Creek.*

2.6 Climate and Climate Change

2.6.1 Current climate conditions and trends

As part of the Georgina Island First Nation Climate Change Adaptation Plan, historic climate and weather data for the Georgina, Fox and Snake Islands subwatershed was collected from Environment Canada (Shanty Bay Station 1973-2012) and through a Traditional Ecological Knowledge Survey (Chippewas of Georgina Island First Nation and OCCIAR, 2015). Additionally, the LSRCA analysed data from the Barrie WPCC Meteorological Monitoring Station (1950-2008) (SGBLS, 2015). Also, the LSRCA has been collecting weather data from a meteorological monitoring station located on Georgina Island (Figure 2-19) since November 2015. To date, there is not yet enough data to discern any trends in any of the parameters monitored at this station.

Figure 2-17: Location of the climate station on Georgina Island.

2.6.1.1 Temperature

Historical temperature trends were observed through several sources, including the Shanty Bay weather station, traditional ecological knowledge surveys, and the Barrie WPCC meteorological monitoring station.

The Shanty Bay weather station contains air temperature data from 1973 to 2012, and shows that for all seasons, air temperature increased during this time period. Winter air temperatures warmed more than the other seasons; looking at minimum, maximum and average winter air temperatures over this time scale, there is an overall increase of approximately 2.6°C (Figure 2-18).

Results of the traditional ecological knowledge survey revealed that compared to the historical climate, spring now comes earlier, summers are not as hot, winters are both warmer and shorter and there is less ice formation during the winter time.

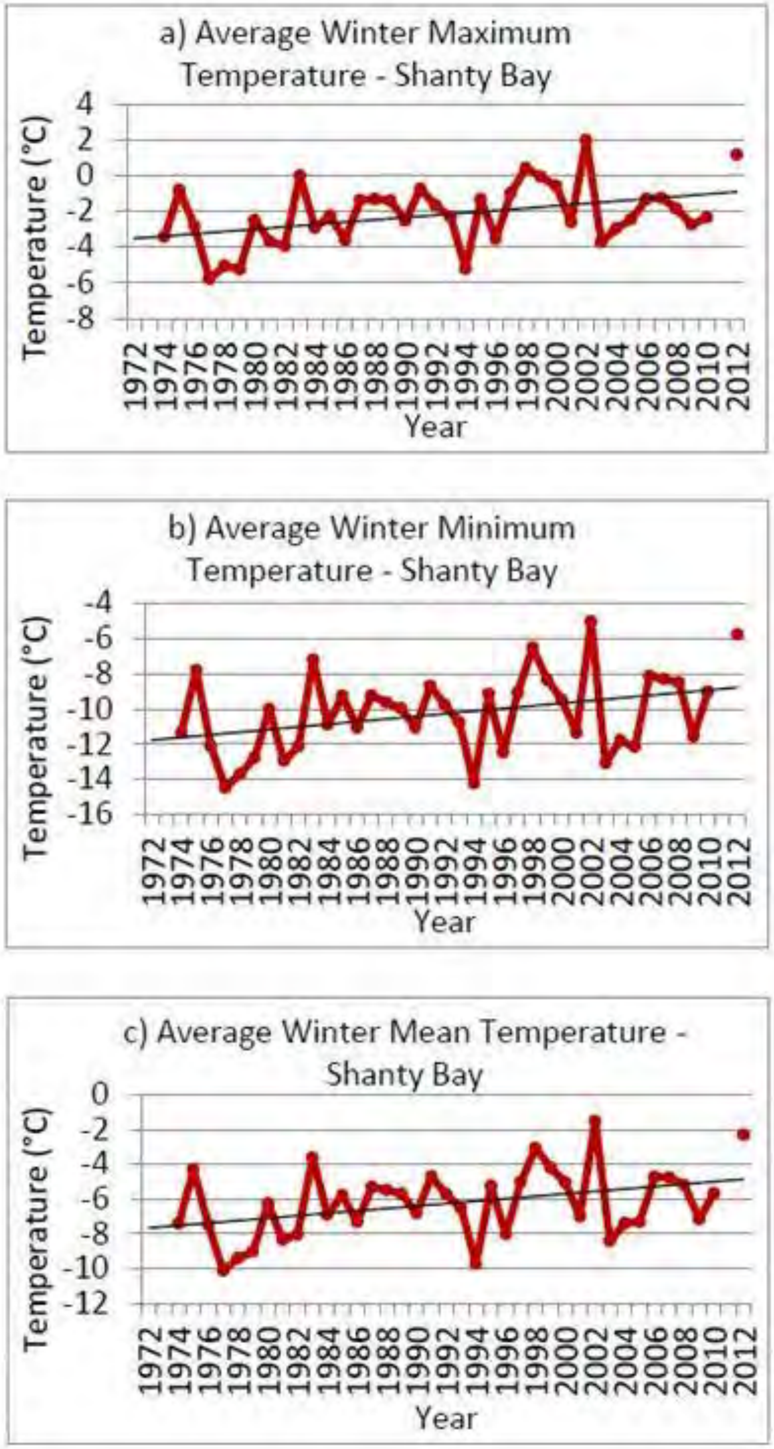


Figure 2-18: Maximum (a), minimum (b) and average (c) winter air temperatures at Shanty Bay between 1973 and 2012. (Source: Chippewas of Georgina Island First Nation and OCCIAR)

Temperature trends for the past 60 years were also observed from the Barrie WPCC meteorological monitoring station. The daily average air temperature was averaged for each year to produce Figure 2-19 to compare the average annual, average maximum annual, and average minimum annual air temperature. Figure 2-19 gives a general overview of the temperature trends at illustrating how all appear to fluctuate in relatively the same manner over the years.

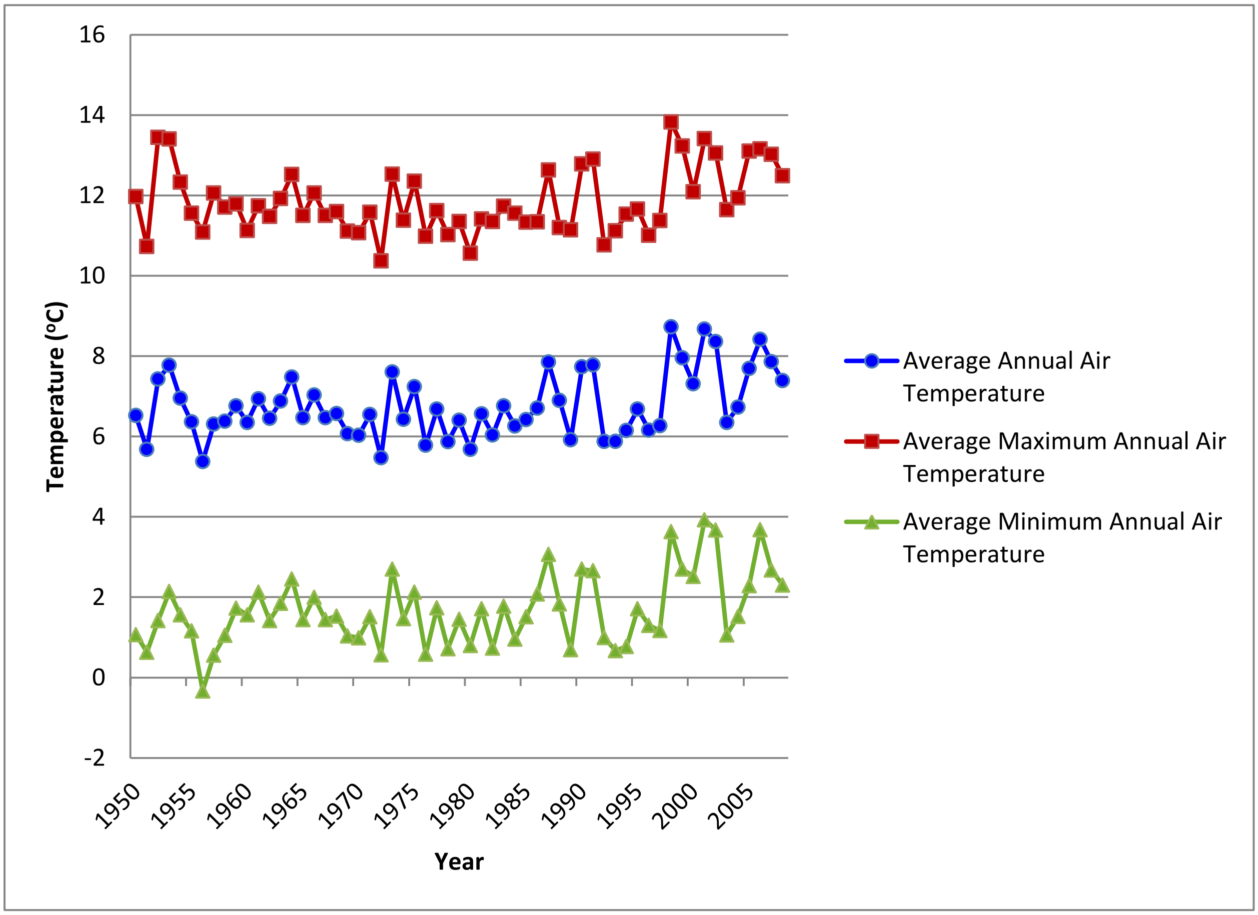


Figure 2-19: Comparison of the average annual, maximum and minimum temperatures at the Barrie WPCC Meteorological Monitoring Station (1950-2008). Source: SGBLS, 2012.

Figure 2-20 displays only the average annual temperature, giving a closer look at the trend for the period of record. From it we can see that there is a gradual increase over the entire period, with this trend becoming more pronounced after 1980. There is a slight decrease at the beginning of the period of record from 1950 through the 1960s, followed by a plateau for the next 20 years or so before starting to increase. Overall, there has been an increase of 0.87°C over the past 60 years.

It should be noted that this is only a broad assessment of temperature trends at the Barrie WPCC meteorological monitoring station.

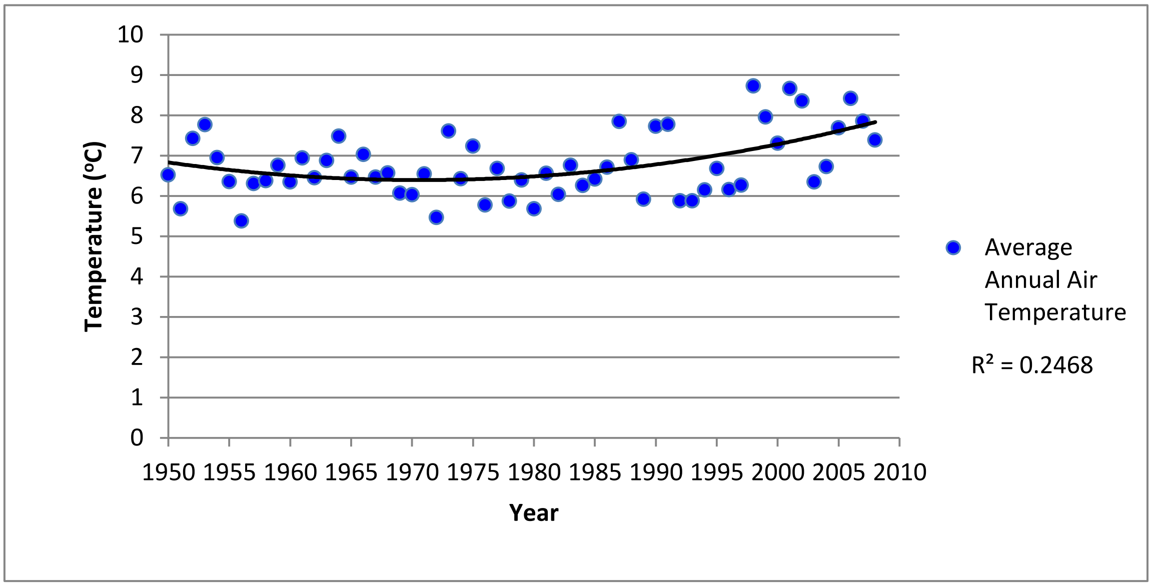


Figure 2-20: Average annual temperature at the Barrie WPCC Meteorological Monitoring Station (1950-2008). Source: SGBLS, 2012.

2.6.1.2 Precipitation

Precipitation data was obtained from the Shanty Bay weather station from 1972 to 2012 and showed an overall increase in precipitation during this period. The winter season showed the largest increase in precipitation (24mm increase in rain and 15cm increase in snow), while spring showed decreases in both rain (-30mm) and snow (-7cm).

Results from the traditional ecological knowledge survey revealed recent changes in climate, including more rain than snow in winter, more severe thunderstorms, snow coming later in the winter, and more thunderstorms in the winter.

2.6.1.3 Thermal Stability of Lake Simcoe

The thermal stability of the lake is important as it can have significant impacts on biological communities, which in turn can impact the lives of those who rely on the lake as a resource. The thermal stability of the lake refers to the amount of energy needed for a water column to mix completely, overcoming the vertical density differences of thermal stratification. In a system where there is low stability, the lake completely mixes, whereas in a system where there is high stability there is little to no mixing (remains stratified). In Lake Simcoe, which is a dimictic lake, the water column is thermally stratified during the ice-free season, and mixes in the spring and fall. Most winters, it completely freezes over.

To determine if the thermal stability of Lake Simcoe was changing in relation to mean air temperatures (collected at Environment Canada's weather station at Shanty Bay), Stainsby *et al.* (2011) compared the water column stability of the lake at three locations (main basin, Kempenfelt Bay, and Cook's Bay), and the timing of stratification in the spring and turnover in the fall occurred over an approximate 30 year time period (1980-2008). For the purpose of this subwatershed plan, the focus will be on Kempenfelt Bay (and to some extent the main basin) as this is the area most closely connected to the subwatersheds within the study area.

Out of the three sampling areas, Kempenfelt Bay generally has higher thermal stability due to its deeper depths (max 42 m; mean 26 m), whereas Cook's Bay tends to have lower thermal stability because of its shallower depths (max 21 m; mean 8 m) and consequently smaller volume of water that needs to mix or stratify (Stainsby *et al.*, 2011).

The first parameter studied was the temperature of Kempenfelt Bay during the ice-free period of the year. Figure 2-21 illustrates the temperature changes in Kempenfelt Bay from 1980 (a) and 2002 (b) as well as the stability of the lake. From it we can see that in comparison to the 1980 graph, in 2002 there is a high degree of red

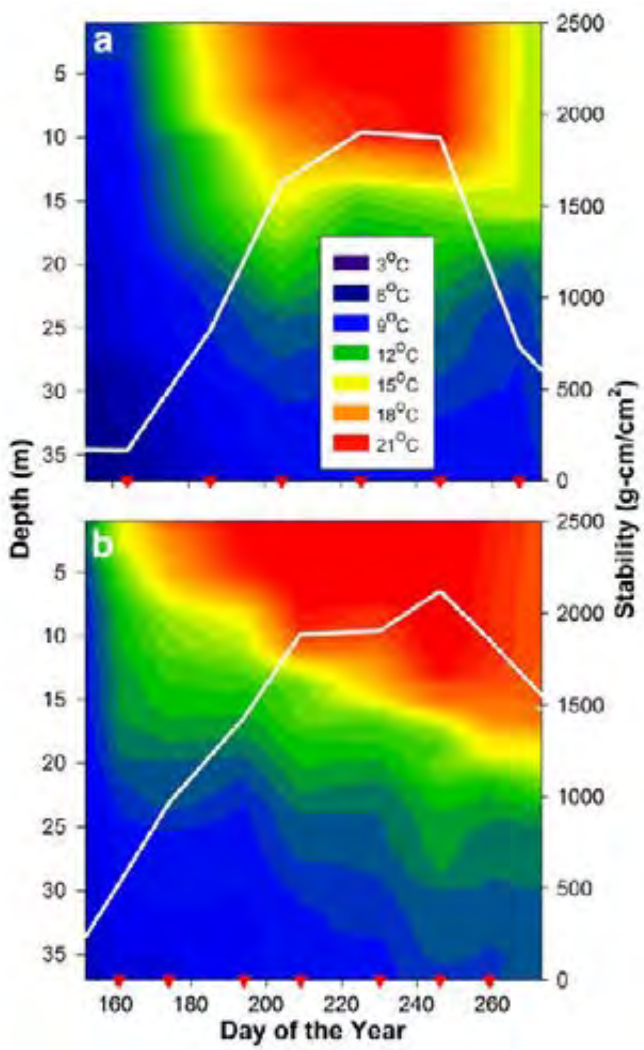


Figure 2-21: Seasonal water column temperature contour in degrees Celsius) and stability (white line) in Kempenfelt Bay in 1980 (a) and 2002 (b). Red triangles show the sampling dates along the x-axis. Source: Stainsby *et al.*, 2011.

(warmer temperatures during the ice-free season) and wider contours (the lake begins to stratify earlier in the year and mixes later in the fall, increasing the overall time the lake remains stratified), all of which correspond with the recorded higher lake stability (white line) (Stainsby *et al.*, 2011).

To further support these findings, Figure 2-22 illustrates the timing of the onset of stratification in Kempenfelt Bay (Figure 2-22a) and the main basin (Figure 2-22b). It can be seen from the data that the lake is stratifying earlier in the year. As of 2002, stratification is occurring approximately 20 days earlier in Kempenfelt Bay (Figure 2-22a) than it was in 1980. In the main basin, stratification is occurring approximately 13 days earlier (Figure 2-22b).

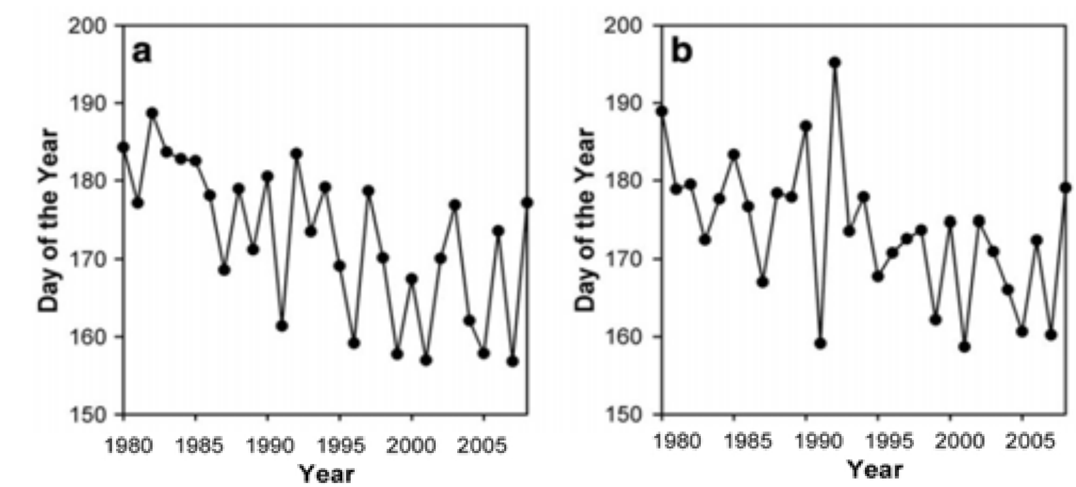


Figure 2-22: The timing of the onset of stratification in (a) Kempenfelt Bay and (b) the main basin. Source: Stainsby *et al.*, 2011.

When looking at the fall turnover, Figure 2-23 shows it to be occurring later and later each year. Between 1980 and 2002, mixing of the water column in the fall is occurring approximately 15 days later in Kempenfelt Bay (Figure 2-23a) and approximately 18 days later in the main basin (Figure 2-23b).

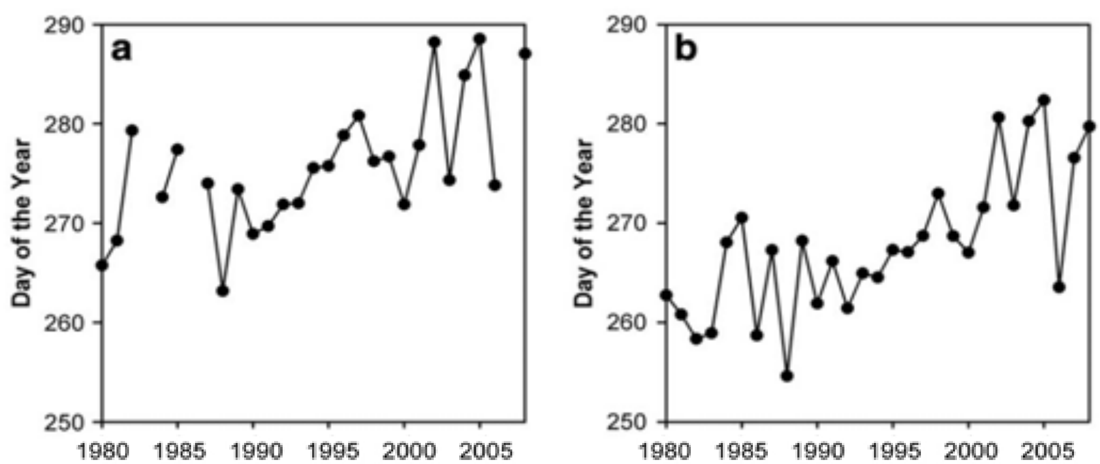


Figure 2-23: The timing of fall turnover in (a) Kempenfelt Bay and (b) the main basin. Source: Stainsby *et al.*, 2011.

Together this means that the lake remains stratified for a longer period of time. A longer stratified period can result in an increase in oxygen depletion in the hypolimnion, which in the deeper zones may create "dead zone" areas where conditions are anoxic. These conditions can also potentially increase the release of nutrients (such as phosphorus) and contaminants from sediments. The impacts of this can include large fish die-offs, changes in the fish communities, algal blooms (which, when dead and decomposing at the bottom further decrease oxygen levels) and can deteriorate drinking water (Kling *et al*., 2003). In Kempenfelt Bay and the main basin of Lake Simcoe, the water column remains stratified approximately 33 days longer in 2008 than in 1980 (Figure 2-24a and b).

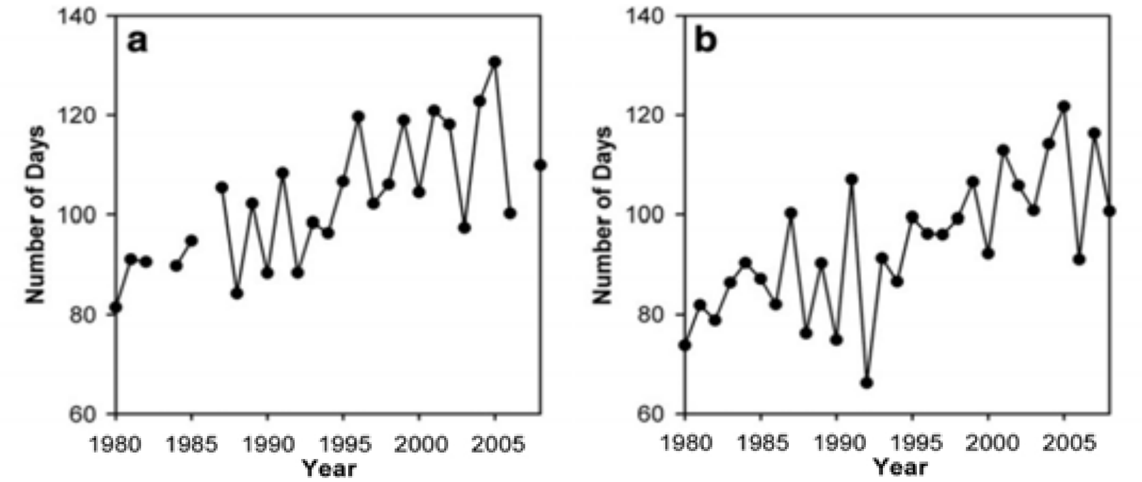


Figure 2-24: The length of the stratified period in (a) Kempenfelt Bay and (b) the main basin. Source: Stainsby *et al.*, 2011.

Many of the impacts already being observed in the Lake Simcoe watershed counteracts much of the work the LSRCA and partner municipalities have done to increase dissolved oxygen concentrations and decrease phosphorus levels in Lake Simcoe. To ensure that efforts are successful, despite the impacts of climate change, projects undertaken on tributaries, particularly those that are managed as coldwater, need to focus on reducing the temperature and the amount of phosphorus input. This can include an increase in riparian habitat, improved stormwater management, and improved practices in construction and agricultural activities. Additionally, municipalities are encouraged to include climate change adaptation policies in the Official Plans, to plan for the future and implement pre-emptive measures.

2.6.2 Climate change and predicted scenarios

Climate change can have numerous impacts on ecological systems and those who depend on them. As mentioned in the previous section, an increase in air temperature can increase the thermal stability of the lake, extending the stratified period, as well as changing the composition of biological communities and creating ideal growing conditions for algae and bacteria. Increased temperatures also affect ice formation on the lake, which has serious implications for the First Nation as a whole and for individual members who depend on the ice cover for their ice fishing businesses. Changes in ice formation also impair transportation to and from the islands, creating unsafe ice conditions resulting in fatalities. An increase in temperature can also cause an increase in evaporation and evapotranspiration, decreasing the amount of water infiltrating into the ground and recharging the groundwater system. Changes in precipitation patterns will also impact the hydrologic cycle, whether these changes show less or more precipitation. Where less precipitation is falling, habitats will experience drought, and be susceptible to fires (terrestrial) and reduction in area (watercourses and wetlands), and less water will be available to replenish aquifers. Where more precipitation falls, it is likely that flows will be altered (potentially changing the stream morphology), and there is an increased risk of flooding and property damage. Further impacts of climate change can be found in the following chapters, where applicable, in the stressors section. An important part of addressing these stressors is to gain an understanding of what the changes will be in the future and act accordingly to minimize the impacts. Climate models, used worldwide, give us an estimate of what these possible changes are.

To obtain more accurate projections for parameters such as seasonal and annual temperature and precipitation, an ensemble of climate models are typically run together. The Georgina Island First Nation Climate Change Adaptation Plan (Chippewas of Georgina Island First Nation and OCCIAR, 2015) has developed projections of future climate scenarios, based on three models: Environment Canada's Canadian Climate Change Scenarios Network (CCCSN), Huang et al (2012) and Gula and Peltier (2012). According to the plan, all three models predict that mean temperature will increase for all seasons into the 2050s, and that the greatest temperature increase will be seen in the winter season. In terms of precipitation changes, the models varied in their future projections, but generally anticipate an increase in winter and spring precipitation, and a decrease in summer precipitation. The predictions from each model are shown in Table 2-6 below.

Table 2-6: Projected changes in mean temperature and precipitation from three models (Source: The Georgina Island First Nation Climate Change Adaptation Plan)

Researcher	Variable	Winter	Spring	Summer	Fall	Annual
CCCSN[4]	Change in mean Temperature (°C)	3.4	2.8	2.9	2.8	3.0
Huang[5]		4.0** (1.6* to 5.1***)	3.3** (1.5* to 4.0***)	4.0** (1.8* to 4.9***)	3.7** (1.6* to 4.2***)	4.0** (1.7* to 4.5***)
Gula and Peltier[6]		2.5 - 3.5		2.0 - 3.0		2.5 – 3.0
CCCSN	Change in Precipitation (%)	10.76	9.65	-0.62	3.85	10.76
Huang		15.3** (3.7* to 32.7***)	9.7** (3.1* to 20.8***)	-5.7** (-6.4* to 24.1***)	-4.0** (-3.8* to 6.9***)	5.6** (-1.2* to 16.6***)
Gula and Peltier		-5.0 to 5		0 to -20		-10 to 10

[4] Canadian Climate Change Scenarios Network (CCCSN) – Ensemble projection of 24 global climate models; projections into the 2050s (2041-2070) based on 1961-1990; High emission scenario based on SRES-A1B
[5] Huang et al, 2012; statistical downscaling technique; probabilistic climate projections into the 2050s (2040-2069) based on 1968 - 1998; projections expressed as cumulative Likelihood levels (*10%, **50%, ***90%)
[6] Gula and Peltier, 2012; dynamic downscaling technique, projections of changes in temperature for the 2050 -2060 period relative to 1979-2001; SRES A2 scenario

Despite the use of a combination of multiple models, it is important to note that there is still a very high level of uncertainty associated with the projections. As scientists continue to understand the smaller interactions (i.e. what role clouds play in climate change) and are able to integrate them into the models, this uncertainty will decrease.

3 Water Quality

3.1 Introduction and background

The Anishnabek have always been caretakers of *Mshkakimekwe* and have a spiritual, ancestral relationship to the sacred elements of *Nibi*, *Noodin*, *Aki*, and *Shkode.*

Nibi plays an important role in our ceremonies. It carries us through the gestation period and it announces our birth into Creation. *Nibi* also provides life to other beings - including *Mshkikiwan*. All these spirits do a lot of work for us.

A priority must be placed on the protection of *Nibi* in all its forms – flowing rivers, streams, lakes, snow and rain - to ensure security for present and future generations. It is a part of all living things.

Gitsijig share the teaching that there is duality to everything - *Nibi* gives life and it can also take it away. We are required to acknowledge this powerful gift. The best way is to offer sacred *Sehmaa*. *Nibi* is tied to *Aki*. They are always linked together.

The chemical, physical and microbiological characteristics of natural water make up an integrated index we define as "water quality". Water quality is a function of both natural processes and anthropogenic impacts. For example, natural processes such as weathering of minerals and various kinds of erosion are two actions that can affect the quality of groundwater and surface water. There are also several types of anthropogenic influences, including point source and non-point sources of pollution. Point sources of pollution are direct inputs of contaminants to the surface water or groundwater system and include municipal and industrial wastewater discharges, ruptured underground storage tanks, and landfills. Non-point sources include, but are not limited to, agricultural drainage, urban runoff, land clearing, construction activity and land application of waste that typically travel to waterways through surface runoff and infiltration. Contaminants delivered by point and non-point sources can travel in suspension and/or solution and are characterized by routine sampling of surface waters in the Lake Simcoe watershed.

The islands of the Georgina Island First Nation are uniquely affected by impacts to water quality, given that the lake surrounding them is subject to the cumulative impacts of all of the tributary streams and rivers draining into it. Given the small size of the islands, and how much the residents depend on the health of the lake, issues in the lake have a disproportionately higher impact on those living on the islands than in most other places in the Lake Simcoe watershed.

The Lake Simcoe Protection Plan (LSPP) identifies a number of targets and indicators related to water quality in Lake Simcoe and its tributaries, which include:

- Reducing phosphorus loadings to achieve a target for *dissolved oxygen* of 7 mg/L in the lake (long-term goal currently estimated at 44 tonnes per year)
- Reducing pathogen loading to eliminate beach closures

- Reducing contaminants to levels that achieve Provincial Water Quality Objectives or better

For the most part, these targets are established to preserve the health of the Lake, rather than its tributaries. As such, the LSPP has also provided indicators to evaluate progress in achieving the water quality targets that can be evaluated in a subwatershed basis. These include:

- Total phosphorus
    - Concentration
    - Loading
- Pathogens
    - Beach closures
- Other water quality parameters, including:
    - Chlorides
    - Other nutrients (e.g. nitrogen)
    - Total suspended solids
    - Heavy metals
    - Organic chemicals

Where information is available, current conditions and trends are provided for the main water quality indicators, as identified by the LSPP.

3.2 Current Status

3.2.1 Measuring Surface Water Quality and Water Quality Standards

3.2.1.1 Tributary Water Quality

Surface water quality is currently sampled at one station on Georgina Island (Figure 3-1); there are no discernable watercourses on Fox or Snake Islands, so tributary water quality could not be assessed. The sampling site has natural features, mainly forest, on the upstream side, with a road and some sparsely spread houses just downstream. Sampling was undertaken twice at this station in 2014; one ‘high flow’ sample, taken after a rain event, and one ‘low flow’ sample, taken during dry conditions. High flow and low flow samples are taken in order to capture any runoff and/or background effects at the site that are affecting the various water quality parameters. The samples were analyzed for a suite of parameters, including phosphorus, various forms of nitrogen, chloride, and a number of metals. The samples were analyzed at Maxxam Laboratories, and assessed against the Provincial Water Quality Objectives (PWQO), where they are available, or other applicable guidelines.

As stated by the Ministry of Environment and Climate Change, the goal of the PWQO is to protect and preserve aquatic life and to protect the recreational potential of surface waters within the province of Ontario. Meeting the PWQO is generally a minimum requirement, as one has to take into account the effects of multiple guideline exceedances, overall ecosystem health, and the protection of site-specific uses. In instances where a chemical parameter is not included in the PWQO, the Canadian Water Quality Guidelines for the Protection of Aquatic Life (CWQG) are applied. The CWQG were developed by the Environmental Quality Branch of Environment Canada to protect aquatic species by establishing acceptable levels for substances that affect water quality and are based on toxicity data for the most sensitive species found in streams and lakes of Canada. Some of the water quality variables of greatest concern in the study area and throughout the Lake Simcoe watershed are summarized in Table 3-1.

Table 3-1: A summary of surface water quality variables and their potential effects and sources

Variable	Effects	Sources	Objective/Guideline
Total Phosphorus	Phosphorus promotes eutrophication of surface waters by stimulating nuisance algal and aquatic plant growth, which results in restrictions on the recreational use of waterways, and the depletion of oxygen levels as they decompose, resulting in adverse impacts to aquatic fauna.	Sources include lawn and garden fertilizers, animal wastes, eroded soil particles and sanitary sewage.	Interim PWQO: 0.03 mg/L to prevent excessive plant growth in rivers and streams.
Chloride	Control of excess chloride levels is important to protect the aesthetics and taste of drinking water. High levels may also have an impact on aquatic life. Background concentrations in natural surface waters are typically below 10 mg/L.	The largest source of chloride is from salt applications during the winter months. Other sources include waste water treatment, industry, and potash used for fertilizers.	CCME (draft June 2010): CWQG for protection of freshwater aquatic life is 120 mg/L for chronic (long-term) exposure and the benchmark concentration is 640 mg/L for acute (short-term) exposure.
Metals	Heavy metals generally have a strong affinity to sediments and can accumulate in benthic organisms, phytoplankton, and fish. Several heavy metals are toxic to human health, fish, and other aquatic organisms at low concentrations.	Most metals in surface runoff are associated with automobile use, wind-blown dusts, roof runoff, and road surface materials.	PWQOs: Copper: 5 μg/L Zinc: 20 μg/L Lead: 5 μg/L Iron: 300 μg/L
Total Suspended Solids (TSS)	Elevated concentrations reduce water clarity which can inhibit the ability of aquatic organisms to find food. Suspended particles may cause abrasion of fish gills and influence the frequency and method of dredging activities in harbours and reservoirs. As solids settle, coarse rock and gravel spawning and nursery areas become coated with fine particles, limiting the ecological function of these important areas. Many pollutants are readily adsorbed and transported by suspended solids, and may become available to benthic fauna.	TSS originate from areas of soil disturbance, including construction sites and farm fields, lawns, gardens, eroding stream channels, and sand and grit accumulated on roads.	CWQG: 25 mg/L + background (approximately 5 mg/L) for short term (<25 hr) exposures. →30 mg/L EPA (1973) and European Inland Fisheries Advisory Commission (1965): no harmful effects on fisheries below 25 mg/L

Figure 3-1: The location of the Georgina Island water quality monitoring site

3.2.1.2 Temperature Collection

The MNRF/DFO protocol, "*A Simple Method to Determine the Thermal Stability of Southern Ontario Trout Streams*" (Stoneman, C.L. and M.L. Jones 1996), Figure 5-1 in **Chapter 4 – Shoreline and Aquatic Natural Heritage** suggests that trout streams are considered to be coldwater if they have an average maximum summer temperature of approximately 14°C. Cool water sites are considered to have average maximum summer temperatures of 18°C. Warm water sites have an average maximum daily water temperature of 23°C.

To monitor these temperatures, electronic data loggers are installed throughout the Lake Simcoe watershed during the hot summer months. They are installed in late May/early June and then retrieved in late September/early October each year. The loggers are used to monitor the daily fluctuations in water temperature of the watercourse over the summer. They are set to take a temperature reading every hour for the entire study period. Periodic checking of the loggers throughout the summer is necessary for quality control purposes. Once the loggers are retrieved in early fall, the data is downloaded and then compared to the air temperature data over the same period of time. Using an Excel spreadsheet, the maximum, minimum, and mean temperatures for each day are graphed. There is some emphasis placed on the daily high temperatures and average maximum temperatures, specifically in cold water stream conditions. The streams can then be classified as cold, cool, or warm (see **Chapter 4 – Shoreline and Aquatic Natural Heritage** for figure displaying temperature of creeks). Daily minimum stream temperatures are used to observe stream recovery from periods of extended warming and the influence of groundwater/baseflow in the individual system.

The LSRCA measured temperature at four sites on Georgina Island in 2014.

3.2.1.3 Beach Monitoring

Public beaches on Georgina Island are monitored annually, from mid-June until Labour Day, to ensure that the water is safe for swimmers (in terms of bacteria). This sampling is completed under Health Canada's Community Based Water Monitoring Program and First Nation Water and Wastewater Program, in partnership with York Region Health. Samples are normally taken once a week at five sites: Northend Bay, Community Centre, Sandy Beach, Simcoe beach, and at Neezh Meegwunun campground on the east side of the island on Bear Road. Samples are sent to be analyzed for *E. coli* bacteria (a key indicator of fecal pollution) at York Region labs. Other parameters are not tested for unless deemed necessary. Additional data that is recorded at the time of sampling include weather conditions, whether there was rain in the previous 24 or 48 hour period, wind direction, degree of wave action, number of bathers, number of waterfowl and/or animals in the area, and clarity of the water.

3.2.1.4 Lake Water Quality

Sampling of water quality is undertaken throughout the lake, through the Lake Simcoe Nearshore Monitoring Program. This sampling has included a site just off of Georgina Island, which was sampled in 2010 and 2011. Sampling also includes a number of sites across the Main Basin of the lake, in which Georgina Island is found, as well as in Cook's and Kempenfelt Bays. Sampling results from locations throughout the Main Basin are generally comparable, since this section of the lake mixes so well, so even though the site off of Georgina Island was only sampled over two years, conditions can be inferred from more current sampling at other Main Basin stations.

Monitoring at these sites is undertaken to track phosphorus reduction efforts, to detect seasonal changes, and to determine the oxygen availability for aquatic life. Samples are analysed for a suite of over 50 limnological variables, including phosphorus, nitrogen, dissolved organic carbon, and metals. Water clarity is also recorded at the time of sampling, using a Secchi disk.

3.2.2 Surface Water Quality Status - Tributaries

Because only two surface water samples have been obtained from the Island's tributaries, we are only able at this point to report on the water quality at that sampling site in 2014. Each sample was tested for 34 parameters, though this included testing for different chemical forms of several parameters. The main parameters of concern that we typically look most closely at are phosphorus, chloride, nitrate, and metals (including copper, iron, lead, and zinc).

3.2.2.1 Phosphorus

Phosphorus is considered to be the main parameter of concern in Lake Simcoe and throughout many of its tributary subwatersheds, and as such is among the most scrutinized parameters. The low flow sample found the total phosphorus concentration at the Georgina Island water quality station to be 0.077 mg/L, more than twice the Provincial Water Quality Objective of 0.03 mg/L. The phosphorus concentration in the event flow sample was 0.20 mg/L, almost seven times the provincial objective. These concentrations of phosphorus could potentially have negative impacts on aquatic health, both within the tributary and then as the stream water discharges to the lake, where it can contribute to the excessive growth of aquatic plants and algae; however, the low volume of water discharging from this tributary means that the actual phosphorus load to the lake from this source is minimal. The likely sources of phosphorus in this area include road runoff (e.g. potentially from the sand used in winter road maintenance), erosion of sediment from some of the trails found throughout the centre of the island, and perhaps some natural release of sediment from the forest and wetland areas upstream.

3.2.2.2 Chloride

The *Canadian Environmental Protection Act* has defined road salts containing chloride as toxic (CCME, 2001). This was based on research that found that the large amount of road salts being used can negatively impact ground and surface water, vegetation and wildlife. While elevated chloride levels are primarily found around urban centres, chloride levels have been found to be steadily increasing across the Lake Simcoe watershed and throughout Ontario, including waters that could be considered pristine northern rivers (LSRCA, 2015) as well as in Lake Simcoe itself (Eimers and Winter, 2005). Another source of chloride in waterways is the discharge of untreated wastewater containing water softening salts from leaking septic systems. While there is minimal salt use on the study area's islands, this parameter was screened in the 2014 monitoring to establish a baseline concentration.

The concentrations of chloride found in the two water quality samples taken on the island in 2014 were both well below the Canadian Water Quality Guideline; however, these samples were both taken during the summer months, when chloride concentrations are typically at their lowest. Some salt is used for winter road maintenance on Georgina Island, which would likely reach local watercourses and result in higher concentrations. These concentrations, however, are likely still well below guideline values due to the small amount being used.

3.2.2.3 Nitrogen

Samples for nitrogen, for both baseflow and event flow samples, fell well within the guidelines.

3.2.2.4 Metals

Concentrations of most metals for both the baseflow and event flow samples were well within guidelines, with most samples being below detection guidelines. The only exception to this was iron, which measured 1300 µg/L in the low flow sample and 2300 µg/L in the event flow sample, both well in excess of the PWQO, which is 300 µg/L. The source of this iron is unknown, although it could be naturally occurring, and found in the soils on the island.

3.2.3 Surface Water Quality Status - Beach Postings

Georgina Island First Nation summer students collect samples at five beaches ion Georgina Island to test *E.coli* levels. Beaches are posted when the geometric mean of the samples taken at each beach exceeds 100 colony forming units. As outlined in Table 3-2, there were several postings for the five-year period between 2009 and 2013. The majority of samples, however, were well within guidelines.

Table 3-2: Beach postings at Georgina Island beaches for the period 2009 to 2013

Year	Location/Postings
2009	0
2010	Band Office/Community Centre - 3 Bay 1 – 2 Sandy Beach – 1 Campground – 1
2011	Band Office – 1
2012	0
2013	Band Office/Community Centre - 1

A posting indicates that bacteria levels in the water are at a concentration that could potentially cause minor skin, eye, ear, nose, and throat infections and stomach disorders. Warning signs are posted at the beach and those who still choose to swim are advised to not put their head under water or swallow the water.

3.2.4 Surface Water Quality Status - Lake Water Quality

The lake monitoring site just off of the southern tip of Georgina Island was monitored in 2010 and 2011. All samples for phosphorus at this site were below the Provincial Water Quality Objective (0.02 mg/L), with the maximum concentration found at the site being 0.016 mg/L in June of 2011. One sample was taken in 2009 at a site slightly north and west of the island, where the phosphorus concentration exceeded the PWQO, at 0.03 mg/L. Other sites in the vicinity of the island show concentrations within guideline levels.

As was discussed above, samples are generally comparable across the main basin, because the lake is so well mixed. More recent samples from elsewhere in the main basin show average concentrations that generally meet the PWQO, with average concentrations for the stations falling in the 0.01 to 0.02 mg/L range (LSRCA, 2013). Concentrations in the sediment, however, tend to be higher. This is likely one of the factors contributing to the high density of plant growth along the southern, eastern, and, to a lesser extent, western shores of the island. This is discussed in more detail in the Shoreline and Aquatic Habitat chapter.

3.2.4.1 Comparison of Nearshore and Offshore Zones of Lake Simcoe

The nearshore and offshore areas of the lake have somewhat different characteristics with respect to water quality. The islands of the study area generally fall into this ‘nearshore’ zone, with the northern and western shores of Georgina Island being found at the edge, with more offshore characteristics just off of the island’s shores. This section looks at the differences between the nearshore and offshore areas of the lake with respect to the concentrations of two commonly observed parameters in the water column, the nutrient phosphorus, and chlorophyll *a*, which is a pigment produced by algae and other plants, and is indicative of their growth in the water column.

Total Phosphorus

With respect to phosphorus, the data shows fluctuations based on annual lake processes, including seasonal changes in the biomass of the algae and plants, which use and release nutrients; and the supply to the lake, generally through precipitation and tributary flows. The nearshore zone of Lake Simcoe generally has a higher total phosphorus concentration than the open-water areas. This is mainly due to terrestrial inputs, as well as the retention by aquatic plants and cycling by zebra mussels. In the nearshore area, phosphorus also shows more variation than in the open-water, or offshore, zone, as this area is more influenced by individual precipitation and snow melt events; whereas the offshore zone is slower to respond and is more influenced by seasonal patterns than individual events. These differences are highlighted below in Figure 3-2.

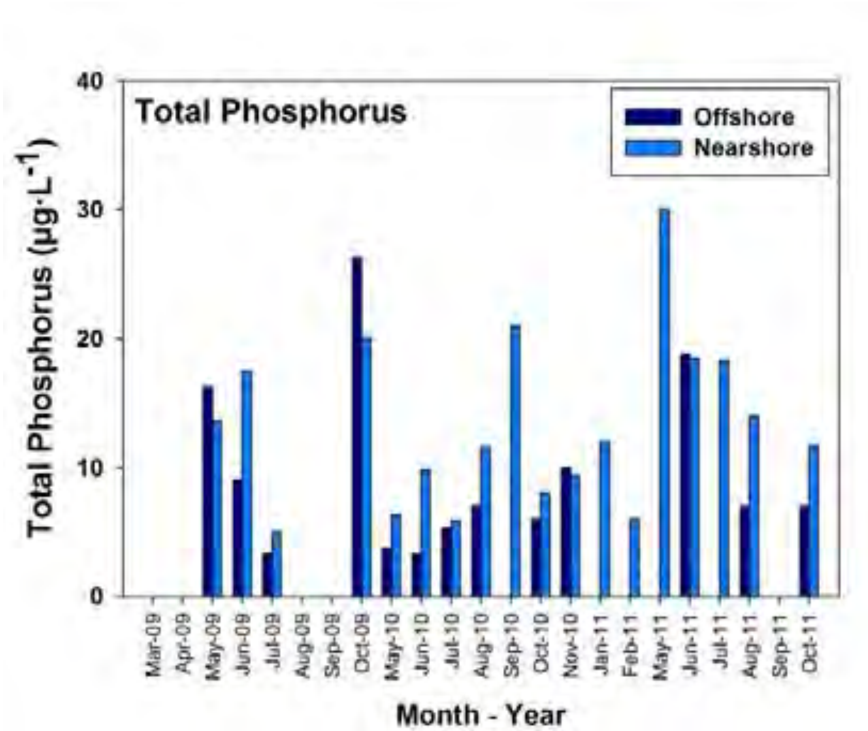


Figure 3-2 Concentrations of total phosphorus in the open water and nearshore zones of Lake Simcoe (LSRCA, 2013)

Chlorophyll a

As noted above, chlorophyll *a* is a pigment produced by algae and other plants, and is a key component of photosynthesis, the process by which sunlight and carbon dioxide are converted to oxygen. The concentration of chlorophyll *a* in the water column is an indicator of the amount of algae that is present. Chlorophyll *a* concentrations in Lake Simcoe are low, particularly in comparison with other lakes with similar phosphorus concentrations. This is due to the consumption of algae by zebra mussels. Due to the relatively higher phosphorus concentrations in the nearshore area, this zone has a relatively higher chlorophyll *a* concentration (and hence, a higher algal biomass) than is found in the open areas.

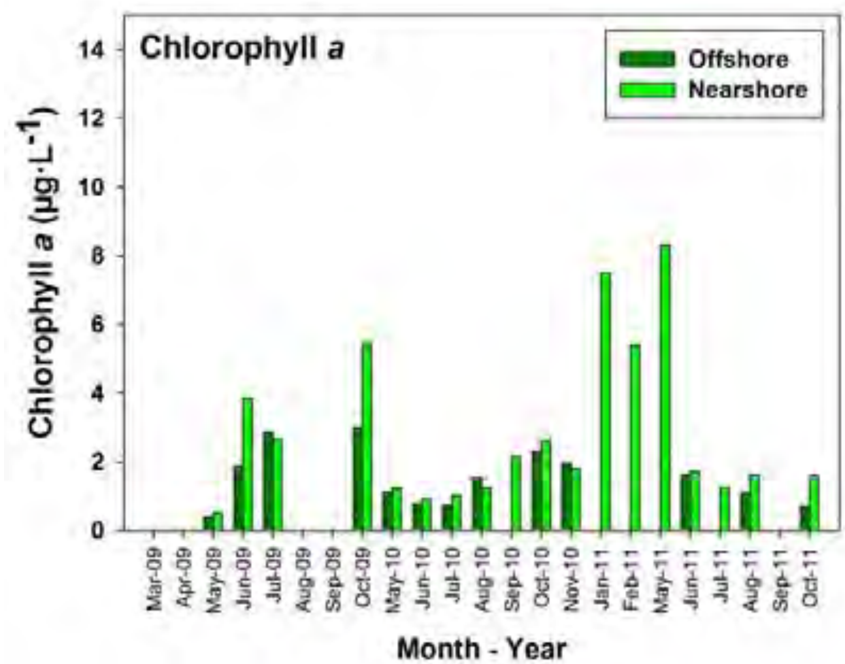


Figure 3-3 Concentrations of chlorophyll *a* in the open water and nearshore zones of Lake Simcoe (LSRCA, 2013)

Key points – Current Water Quality Status:

- Tributary water quality monitoring was undertaken at one site on Georgina Island. This site was sampled twice in 2014, once at low flow, and once following a rain event to capture the range of water quality during varying flow conditions. There are no watercourses to sample on Fox or Snake Islands.
- One station on the lake, just offshore of Georgina Island, was sampled in 2009. This station has not been sampled since, but water quality is consistent throughout the Main Basin of the lake (in which Georgina Island is found), so samples from this area are representative of water quality around the island.
- The water quality samples collected on the Georgina Island tributary showed few issues, with phosphorus being the main parameter of concern. Both samples for phosphorus exceeded the PWQO. Iron concentrations also exceeded guidelines, but the source of this iron is unknown.
- Samples at the water quality monitoring station just off Georgina Island met the Provincial Water Quality Guideline for phosphorus, as do the average concentrations for other stations throughout the main basin of the lake.
- Conditions in the nearshore area of Lake Simcoe, where all three study area islands can be found, are compared with the offshore area, particularly with respect to total phosphorus and chlorophyll *a* concentrations.
- In the five-year period between 2009 and 2013, there were nine beach postings on Georgina Island for *E. coli*. These occurred at the Band Office/Community Centre, Bay 1, Sandy Beach, and the campground
- The nearshore of Lake Simcoe has a higher total phosphorus concentration than the offshore area, and also has higher concentrations of chlorophyll *a*, an indicator of how much algae is present in the water column.

3.3 Factors impacting status - stressors

There are numerous factors that can have an effect on the water quality on and around Georgina, Fox, and Snake Islands. These include:

- Phosphorus,
- Chloride,
- Sediment,
- Thermal degradation,
- Metals,
- Bacteria,
- Emerging contaminants,
- Recreation, and
- Climate change.

Wild Rice

Wild rice is an aquatic grass that grows on the southeast side of Georgina Island. It was drowned out in the 1920s after the Trent Severn Waterway was established and raised the water levels of Lake Simcoe, but it was re-introduced in 2008 in partnership with the MNRF. Wild rice is traditionally harvested as one of the First Nations Staple foods.

These factors are discussed further in the following sections.

3.3.1 Phosphorus

One of the most significant causes of water quality degradation in Lake Simcoe and its tributaries is an excess of phosphorus. Phosphorus promotes the eutrophication of surface waters by stimulating excessive growth of plants and algae. This impairs both the aquatic communities (the decomposition of this extra plant material depletes dissolved oxygen levels, particularly in the deeper parts of the lake where there is critical coldwater species habitat) and recreational opportunities (restricts recreational use of lakes and waterways, washes up on beaches, creates a negative aesthetic view along the shoreline, etc.); these concerns were noted prominently through the surveys conducted for the climate change study on the First Nation. This is discussed further below.

Phosphorus occurs naturally in the environment and is a vital nutrient needed by both plants and animals. However, current land uses have increased the phosphorus loading to Lake Simcoe from an estimated 32 T/yr (prior to settlement and land clearing in the 1800s) to an estimated average load of 86 T/yr for the most recent five-year period (MOECC, 2010; O'Connor *et al.*, 2013).

As discussed above, phosphorus loads have been calculated for the Lake Simcoe watershed by the LSRCA, in partnership with the Ministry of the Environment and Climate Change. This work takes into account water quality data from sampling stations throughout the watershed, flow data, climate information, and atmospheric sources of phosphorus as found through a number of other sampling stations located around the watershed. The sources estimated through this exercise are the tributaries (which measures sources from urban, agricultural, natural, and other areas within the lake's subwatersheds), sewage treatment plants, atmospheric, septic systems (within 100 metres of the Lake Simcoe shoreline), and the watershed's five vegetable polders. The phosphorus load for each subwatershed is displayed in Figure 3-4 below; the loads for all of Lake Simcoe's islands were combined for this analysis, including the islands of the study area as well as Thorah and Strawberry Islands. Even with all the islands combined, the load is still the lowest of all of the subwatersheds draining into Lake Simcoe, at only 0.28 tonnes per year (O'Connor *et al.*, 2013). This low load is due in part to the relatively low volume of water flowing off of the islands, the low levels of land use change on the islands in comparison with the lake's other tributaries.

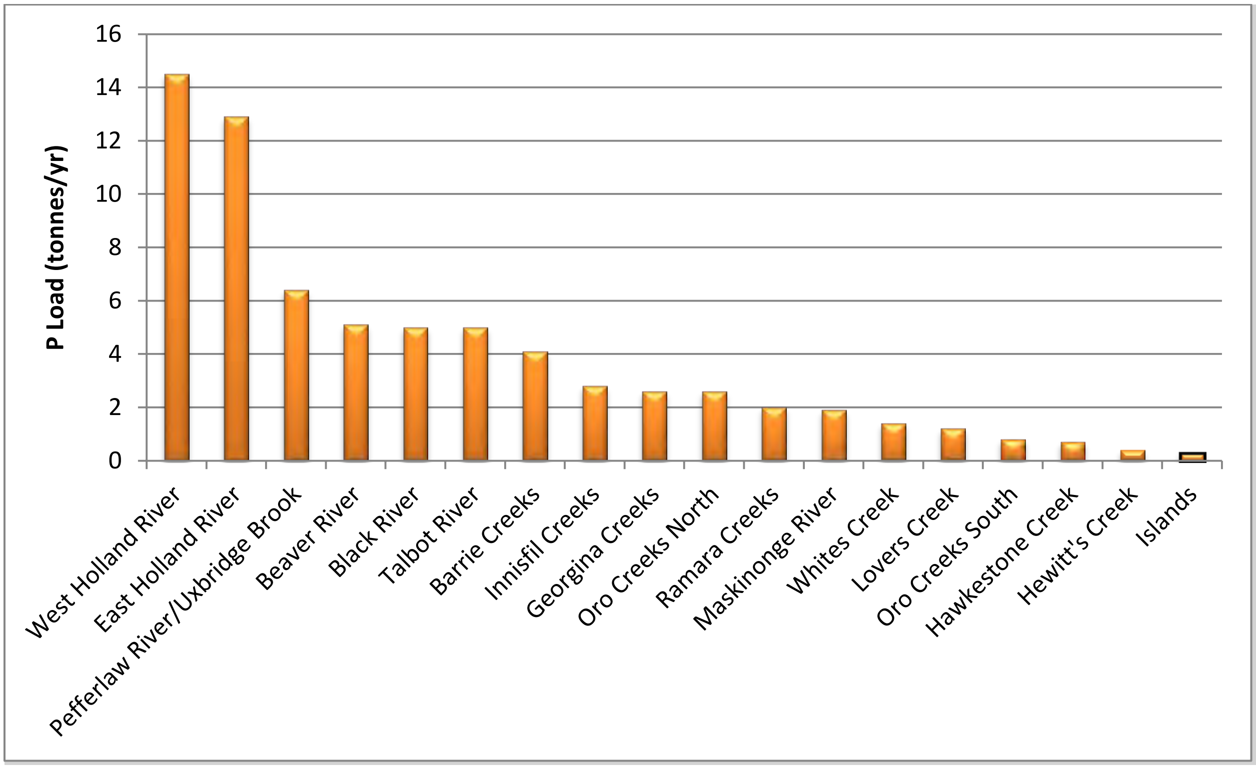


Figure 3-4: Average phosphorus loads (tonnes/year) contributed by each Lake Simcoe subwatershed (data: O'Connor *et al.*, 2013). The combined load for Lake Simcoe's islands is denoted by a bold outline.

Another way to look at the phosphorus loading of each subwatershed is the amount per year per hectare, or export rate. Figure 3-5 illustrates this, using the loads calculated by LSRCA and MOECC, showing that although the total phosphorus loads to Lake Simcoe from a number of other subwatersheds are much higher than that of the islands (Figure 3-4); they actually contribute the 10th highest amount of phosphorus per hectare in the Lake Simcoe watershed. If the flow volumes from the island were higher, then their contribution to the annual load would likely also be much higher.

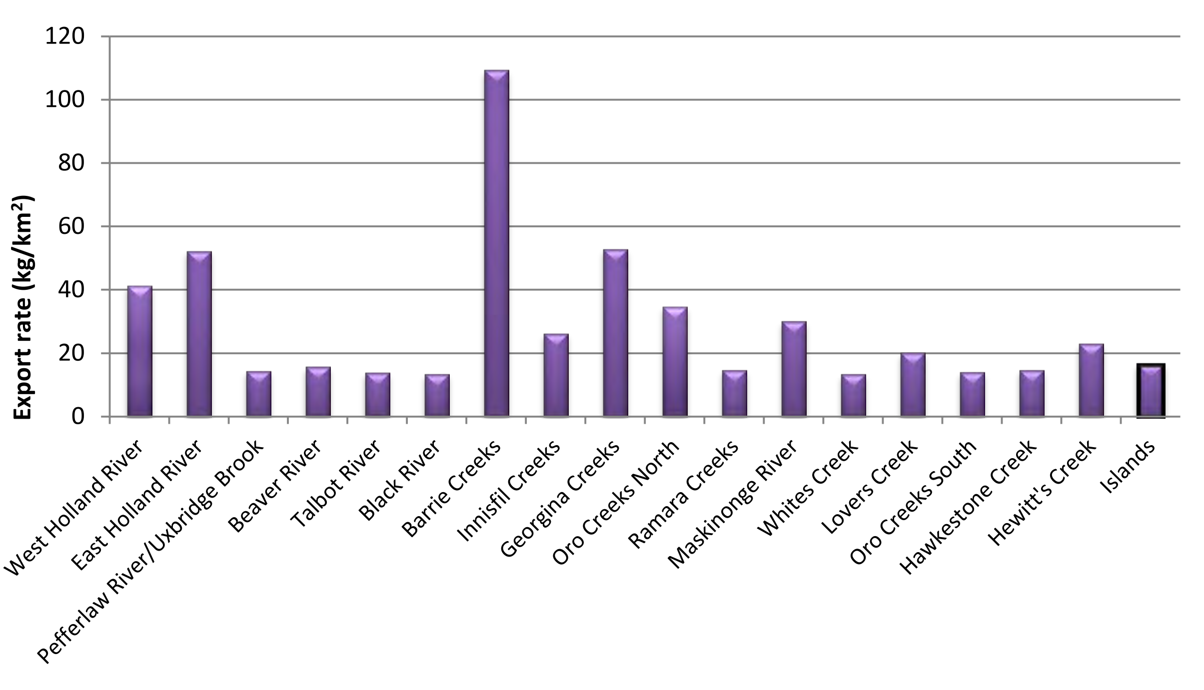


Figure 3-5: Phosphorus loading (kg/yr) per hectare under current conditions for each Lake Simcoe subwatershed (data: O'Connor *et al.*, 2013).

3.3.2 Chloride

The main source of chloride, in its various compounds, in the environment is from road salt (Environment Canada, 2001). It enters the environment through runoff from roadways as well as through losses from salt storage and snow disposal sites. Due to its high solubility, chloride very easily contaminates both surface and groundwater.

High levels of chloride, such as those that can be found in runoff water draining from roads and salt storage yards, can damage the roots and leaves of aquatic and terrestrial plants, and can also have behavioural and toxicological impacts to animals. Continued exposure to high chloride levels can cause a shift from sensitive communities to those more tolerant of degraded conditions (including a number of invasive species that are able to thrive).

Because chloride is used in limited quantities on Georgina Island, as part of a sand-salt mixture, concentrations are unlikely to reach the levels seen in some of the watershed's more urban areas, though its use should be monitored and perhaps limited if impacts are observed. Its use on the mainland roads near the access to the ice road may be more of a concern, as some deterioration of the ice road at this point has been observed. At this point it cannot be determined whether this deterioration is the result of salt residue from vehicles at the launch point, or other factors.

3.3.3 Sediment

While a certain amount of sediment input is normal in a natural system, in larger amounts it can cause a number of problems. Many contaminants, including phosphorus, bind themselves to soil particles, and eroding soil acts as a vector for introducing these particles to an aquatic system. There are also impacts to aquatic biota, which are discussed in greater detail in **Chapter 4 – Shoreline and Aquatic Natural Heritage**.

There are a number of sources of sediment in the Lake Simcoe watershed, some of which can be found in the study area, while others contribute sediment to the lake which may impact the quality of the water surrounding the islands:

Shoreline properties: Many shoreline property owners undertake shoreline works, including the removal of shoreline vegetation, installing docks and hardened shorewalls, creating paths and walkways, and undertaking landscaping work. These works are done for a number of reasons: to 'improve' the owner's view of the lake, to address shoreline erosion issues, and to improve shoreline access.

Cranberries

Cranberries historically grew on the shores of the southeast side of Georgina Island and were drowned out in the 1920s when the Trent Severn Waterway was opened. Traditionally, the First Nation harvested cranberries as a staple food and there are still a few small areas within the First Nation where they grow and a few members of the First Nation that continue to harvest them.

Many of these practices, however, can have impacts on water quality in the shoreline area. The removal of natural shoreline vegetation removes the stabilization function that this vegetation naturally serves, and can lead to soil loss and shoreline erosion, causing increased turbidity and sediment deposit on the substrate in the nearshore area. The installation of docks and hardened shorewalls can actually displace wave energy, transferring it to other areas on the shore and leading to erosion in those areas. Depending on their orientation, paths and walkways along the shore can also be subject to erosion, and again can be a source of sediment in the nearshore. Finally, if there are large patches of bare soil with plants interspersed, landscaping work can cause the input of sediment, and fertilizer use in landscaped areas can be a source of phosphorus and other nutrients. The implementation of best management practices such as planting native vegetation, bioengineering, using rounded rocks instead of hardened shorewalls, and proper trail design can help to resolve some of these issues.

Agricultural areas: There are a number of ways by which agricultural areas can be a source of sediment in the watershed. Fields are particularly vulnerable to erosion whenever they are bare (e.g. after tilling and in the spring prior to the establishment of crops); the flow of melt waters and precipitation over the fields during these periods can result in a huge influx of sediment. The removal of treed windbreaks and riparian vegetation eliminate the soil removal functions of these features. Livestock, where they have direct access to watercourses, can erode streambanks, resulting in significant sediment inputs. The implementation of appropriate best management practices throughout the watershed can help to prevent some of this sediment input.

Urban areas: The use of sand and salt for maintaining safe road conditions during the winter is commonplace. However, large quantities of sand remain on the roadsides after all of the snow has melted in the spring, and if it is not removed (e.g. by street sweeping) in a timely manner, much of it will be washed away by surface runoff during rain events. These impacts from winter maintenance, as well as warming of runoff waters during the summer months, are likely observed in the vicinity of the road that runs around Georgina Island.

Development sites: Sites are often stripped of vegetation to prepare for construction. These bare soils are then subject to erosion by both wind and water. The proper installation of sediment and erosion controls can prevent some of the soil from reaching watercourses, but it is imperative that these measures are inspected and maintained regularly.

In the lake, the sediment can be deposited on the lake bed, where the substances attached to the soil particles can be released under certain conditions in the lake, or it can cause the lake water to become more turbid, or less clear, as it floats in the water column. High turbidity can impact fish, plants, and other aquatic life, although the filtering action of zebra and quagga mussels in the lake have reduced this impact in recent years.

3.3.4 Thermal degradation

Surface water tends to warm when it is detained (e.g. in a pond or by a control structure) or flowing slowly through a watercourse, particularly when the vegetation along the stream or shoreline has been removed, or when it flows over impervious surfaces, such as roads or parking lots. During the summer, impervious surfaces such as parking lots and rooftops can become extremely warm. As water flows over these surfaces before discharging to a watercourse, its temperature increases as well. The detention of water in a pond increases the surface area of the water that is exposed to sunlight, and keeps it there for a prolonged period of time, leading to warming. The use of practices such as planting vegetation along ponds and watercourses can help to reduce the heating effect, but ponds and slowly flowing watercourses will still have an impact on the thermal regime of a watercourse, and eventually the lake into which it drains. The climate change study undertaken on Georgina Island also noted the shrinking and drying up of swamps and ponds along the roads; changing flow patterns due to road and cottage development may be contributing to this, as could changing precipitation and weather patterns. If these features contribute flow to local watercourses, they could potentially contribute to the warming of the watercourses. Temperature monitoring on the island has indicated that the watercourses surveyed are all considered to be ‘cool water’ with respect to aquatic habitat (this is discussed in detail in **Chapter 4 – Shoreline and Aquatic Natural Heritage**); meaning that the watercourses measured are able to support some of the more sensitive fish, but it is important in these systems to ensure that the temperature does not increase, otherwise the system’s ability to support these species may be lost.

3.3.5 Metals

Metals are found almost everywhere and are persistent within the environment. While some are naturally occurring, elevated amounts in settled areas are typically associated with agricultural waste, industrial wastes (e.g. metal finishing, tanneries, plastic fabrication), residential sewage, and urban runoff (Adriano, 2001). These elevated levels of metals in the environment can have significant impacts on wildlife communities, as metals can bioaccumulate within organisms, cause chronic toxicity, and adversely affect organisms' behaviour, growth, metabolism, and reproduction (Wright and Welbourne, 2002).

In 2008, Landre *et al*. took sediment samples from Lake Simcoe, at the same 22 locations of an earlier study (Johnson and Nicolls, 1988). Sampling sites were located in the main basin, at the outlet to Lake Couchiching, and in Kempenfelt Bay and Cook's Bay. Each of the samples was tested for 17 metals: aluminum, arsenic, barium, cadmium, cobalt, chromium, copper, iron, mercury, manganese, nickel, lead, rubidium, antimony, strontium, vanadium, and zinc. This study found high concentrations of cadmium, chromium, copper, mercury, nickel, lead, and zinc near the shore in Cook's Bay, with concentrations decreasing farther away from shore and into the main basin, and declining further still toward the outlet basin (Landre et al., 2011).

Higher concentrations close to shorelines are not unexpected as these are the areas of the subwatersheds experiencing urban growth, both in the residential and commercial sectors, and is where streams running through agricultural and urban lands discharge loads into the lake. In addition, historically, metal pollution was not regulated from metal finishing facilities and tanneries that were operating in and around areas such as Kempenfelt Bay and in the East Holland River, in the past.

When comparing current results to the results of the earlier study (Johnson and Nicolls, 1988), metal concentrations had remained the same or decreased, with the exception of copper and zinc in Kempenfelt Bay. The concentrations of these two metals were on par with the peak levels seen in the 1950s, 60s, and 70s (both decreased slightly in 1980s). Additionally, cadmium, mercury, lead and antimony were found at concentrations that were three to seven times higher than pre-1900s conditions (Landre *et al*., 2011). Of all the metals studied, chromium was the greatest concern, as it exceeded the Ontario Sediment Quality Guidelines severe effect level at three sample sites. This makes it one of the metals of most concern to ecological systems. Depending on the chemical form of chromium, the type of organism and the life stage of the organism, contamination that exceeds the guideline can impact the growth, activities, reproduction and survival, as well as causing changes to chromosomes and physical formation, due to its carcinogenic, mutagenic, and teratogenic properties (U.S Environmental Protection Agency, 2011).

Overall though, because of a decrease in industrial activity, better wastewater treatment and an increase in urban area, there has been a shift in the source of metals from industrial discharge to urban runoff (Landre et al., 2011). Hence, to manage the concentration of metal contaminants in Lake Simcoe, it is important to install and maintain sufficient stormwater treatment facilities and to decrease metal inputs into stormwater.

3.3.6 Bacteria

The presence of bacteria in surface waters has become a significant concern in recent years. Municipal health units monitor the health of local beaches at regular intervals throughout the summer to ensure that they are safe for human contact. The Provincial Water Quality Objective (PWQO) for body-contact recreation has been defined by the Ministry of the Environment and Climate Change by using the relative numbers of *Escherichia coli* (*E. coli*) bacteria as an indicator to assess the risk to human health. When the *E. coli* population exceeds the PWQO, the beach is designated unsafe for bathing activities. *E. coli* is a fecal bacteria found in the intestines of mammals that can cause serious illness and even death.

The presence of high levels of *E. coli* in the lake's waters is an indication of contamination by human sewage or animal wastes. While there are other reasons for beach postings, including water turbidity, the presence of blue-green algae, or poor aesthetics, closures in Lake Simcoe are generally due to high levels of *E. coli*. The number of beach closures due to high concentrations of *E. coli* varies from year to year, as they are heavily influenced by precipitation levels. Storm water carries with it animal waste (e.g. from farms with livestock, as well as from pet and waterfowl waste), which can contaminate beaches when it reaches them, either through direct runoff from adjacent areas, or being carried to tributaries and discharged when it reaches the lake.

There were several beach postings on Georgina Island during the five-year period from 2009-2013 (Table 3-2).

Water Lily (*Kundamoo*)

Water lily is an aquatic medicinal plant traditionally used to help with infections. It can be used to treat such things as ulcers, boils and other skin irritations. It is also known to have cancer fighting properties.

3.3.7 Emerging contaminants

As anthropogenic activities increasingly impact our natural areas, the potential for introduction of harmful substances becomes more of a concern. It is for this reason that a Toxic Pollutant Screening Program was initiated by the Lake Simcoe Region Conservation Authority in 2004. The goal of this project was to develop a better understanding of the location and prevalence of certain elements, chemicals, and chemical compounds that have the potential to negatively impact either human or aquatic life in the watershed. Sampling through this program revealed that there are currently some substances with levels exceeding regulatory guidelines in some Lake Simcoe tributaries. In addition, there were some substances, such as pharmaceutical products, that were not included in this monitoring work. Many of these substances have the potential to impact humans and affect aquatic life, although their impact may be less on the islands of the study area than on the mainland. Further research would be needed to determine how many of these substances are found in the lake water in the vicinity of the islands.

3.3.7.1 Endocrine Disrupting Chemicals

Endocrine disrupting chemicals (EDCs) are chemicals which adversely affect the endocrine system, which is a set of glands and the hormones which guide development, growth, reproduction, and behaviour. Harmful effects have been observed on wildlife and humans including reproductive disorders, impacts on growth and development, as well as the incidence of some cancers. EDCs can come from both natural and man-made sources including pesticides and hormones (both natural and synthetic which are used in oral contraceptives and in livestock farming), and can be the product of industrial processes such as incineration. In nature, EDCs including polychlorinated biphenyls (PCBs) and other man-made chemicals have caused, among other issues, severe reproductive problems in fish and birds, swelling of the thyroid glands in numerous animal species, reduction in frog populations, and, in birds, the thinning of eggshells.

3.3.7.2 Pharmaceuticals and Personal Care Products

The presence of pharmaceuticals and personal care products (PPCPs) in the natural environment has been a growing concern over the past two decades, and will become more prevalent with the growing population and increasing use of these products. While the effects of pharmaceuticals on humans during the course of treatment are very well studied, the impacts of their by-products after use are not. Although some of the products and their by-products can be broken down incidentally at Waste Pollution Control Plants, the plants are generally not equipped to remove PPCPs from waste water. Studies have shown hormones, antibiotics, anti-inflammatory drugs, fragrances, antiseptics, sunscreen agents, and a host of other PPCPs in varying amounts in the environment, though they are mostly seen within 100 metres of a waste water treatment plant discharge. In general, the levels in the environment are quite low; however, the effects of prolonged exposure to low levels are not well known. Some studies have shown that PPCPs have the potential to alter physiology, behaviour, and reproductive capacity. Concerns in the environment related to PPCPs include endocrine disruption in aquatic life and antibiotic resistance. Further understanding of these and other concerns is required in order to determine potential steps.

3.3.7.3 Polybrominated Diphenyl Ethers

Polybrominated Diphenyl Ethers (PBDEs) are emerging as a chemical of concern to both human and environmental health due to their persistence and ability to bioaccumulate in the environment. PBDEs are a group of chemicals used as flame retardants in a number of manufactured products, particularly in plastics. They are found in most homes and businesses in products such as electronics, TVs, textiles, cars, aircrafts, construction products, adhesives, sealants, and rubber products. They have become an increasingly common pollutant and have been found in samples taken in air, water, and land. PBDEs have also been detected in a number of species (including humans) worldwide, and studies are finding that levels of PBDEs have been increasing steadily and substantially over time. In the Canadian environment the greatest potential risk from PBDEs is secondary contamination in wildlife from the consumption of prey with elevated PBDE levels as well as effects on benthic organisms through exposure to PBDEs in sediments.

Due to the environmental persistence and bioaccumulation of PBDEs they are considered toxic to the environment as defined under the Canadian Environmental Protection Act (CEPA). Currently, Canada has prohibited the manufacture of PBDEs, and has banned many forms of PBDEs. This ban, however, does not include the decaBDE form, the most commonly used form. Through the federal government, environmental objectives are also being proposed for virtual elimination of a number of forms of PBDEs detectable in the environment. The production of most forms of PBDEs has been significantly reduced due to voluntary measures by producers and restrictions by government agencies in Canada and other countries.

3.3.8 Recreation

Natural areas such as lakes, streams, and rivers are popular locations for recreational activities such as hiking, boating, and snowmobiling. These activities, if not managed correctly and undertaken in a responsible manner, can negatively impact the surface water quality in the area.

Hiking trails near watercourses and waterbodies can cause increased bank erosion and instability, and the loss of riparian areas, which could result in an increase in total suspended solids (and any associated contaminants) into the waterbody. There is also a network of ATV trails running through the centre of Georgina Island, which could contribute to sediment erosion, as well as potential inputs of petrochemicals.

Boating can have impacts, particularly in the areas near shore. Many of these impacts are caused by excessive speed, which can result in shoreline erosion and increased inputs of sediment, and can also cause the suspension of bottom sediments, resulting in increased turbidity in the water. Higher turbidity can impact the ability of some fish to feed, and can also blanket nests and eggs (at certain times of year) and habitat for the benthic invertebrates that support the fish community. In addition, spills of gas and oil, even if they are small, can impact the health of the aquatic community. Black and grey water from boats, if not disposed of correctly, can input nutrients, bacteria, and a host of other chemicals into the lake.

Concerns around snowmobiling, a very popular activity on Lake Simcoe in the winter months, include the impacts of petrochemical spills on water quality, as well as inputs of garbage.

3.3.9 Climate Change

While it is difficult to predict direct impacts of climate change to water quality within the Lake Simcoe watershed, it is likely that it will exacerbate the many of the previously mentioned water quality stressors, creating cumulative, long-term impacts.

Warmer temperatures will lead to further thermal degradation of watercourses and create ideal habitat for bacteria and pathogens. An increase in the frequency and intensity of weather events can also have an impact on contaminants, including:

- Causing the release of contaminants through the mobilization of surface contaminants that are normally immobile;

- Transporting contaminants greater distances; and
- Increasing the quantity of contaminants (such as road salt) that are required to deal with weather events (such as snowfall).

A number of impacts on water quality associated with climate change were identified by the community of the Georgina Island First Nation through a climate change study being undertaken by the GIFN, in partnership with the Ontario Centre for Climate Impacts and Adaptation Resources (OCCIAR). Through this study, residents were asked a number of questions about changes they had observed; and a number of the responses pertained to issues of water quality. These included:

- Increased phosphorus in the lake
- Algae growth
- An odour in the water
- Concerns around swimming in the lake (e.g. skin rashes and irritation)
- Increased nutrient and contaminant loads due to more intense rainfall (e.g. from agricultural activities and septic systems)
- Changes to swamps and ponds along road ways
- Concerns with the quality of the ice road. While the majority of the issues with the ice road are likely due to changing winter conditions caused by climate change, these issues are potentially being exacerbated by the transport of winter salt from the roads and parking lots on both the island and the mainland, particularly along the shorelines

***Key points – Factors Impacting Water Quality - Stressors*:**

- The combined phosphorus load of all of Lake Simcoe's islands (including the study area islands as well as Thorah and Strawberry Islands) is 0.28 tonnes/year, the lowest of all Lake Simcoe subwatersheds
- When comparing the phosphorus loads (kg/yr) per hectare of the subwatersheds in the Lake Simcoe watershed, the watershed's islands are the tenth highest contributor per hectare.
- While chloride levels were low in the samples taken in support of this plan, they may be higher during the winter months with the highest salt use. It is possible that winter salt use in the vicinity of the ice road could impact its quality, though further research would be needed to verify this.
- Increasing surface water temperatures can be attributed to overland flow across impervious surfaces and discharge from ponds. The change in flow patterns of ponds and wetlands along roadways on the island may be another source of warming, depending on where these features discharge.
- The emerging threat of climate change will interact with all of these stressors, creating additive long-term impacts that, based on climate change scenarios, may impact water quality in the study area. This could include increased phosphorus loading, more beach postings, and warming of the lake and watercourses.

3.4 Current Management Framework

The Georgina Island First Nation has undertaken a number of initiatives on their lands to protect environmental health. Several of these initiatives will, either directly or indirectly, help to protect and improve water quality on the islands and in Lake Simcoe. These initiatives, and their potential benefits, include:

- Undertaking a Climate Change/Traditional Ecological Knowledge initiative, in partnership with the Ontario Centre for Climate Impacts and Adaptation. This initiative utilizes the vast amount of knowledge found within the community to identify existing and potential issues, many of which pertain to water quality, and identifies numerous solutions to address these issues. Several of these solutions are addressed below in the Recommended Actions
- Undertaking wetland evaluations through the Adopt-A-Pond Wetland Conservation Programme. The survey and delineation of 735 ha of wetlands on the island, and the measures that will subsequently be undertaken to protect them, will protect the important filtering functions that these areas naturally perform. The preservation of these areas will promote healthy water quality in the island's watercourses, and will also help to ensure that the waters draining off of the island are of high quality.
- The completion of a forest management plan. Similar to the wetland inventory work, identifying and preparing a plan to manage the island's forests will help to ensure that water quality is protected. The study area's forested lands help to hold soils in place, preventing erosion, and help to take up nutrients and prevent them from reaching watercourses and/or draining into the lake.
- The development of by-laws and a Community Land Use Plan, which contain stipulations around property development that would limit the impacts to the environment, including to water quality

3.5 Management Gaps and Recommendations

The Georgina Island First Nation have been proactive in their approach to improving conditions with respect to a number of environmental parameters within their lands. Despite this strong foundation, there are gaps in the management framework and water quality issues that need to be considered. This section identifies some of the gaps in existing protection and restoration of the water quality within islands of the study area, and outlines recommendations to help fill these gaps.

It is recognized that many of the undertakings in the following set of recommendations are dependent on funding from all levels of government. Should there be financial constraints, it may affect the ability of the partners to achieve these recommendations. These constraints will be addressed in the implementation phase

3.5.1 Construction practices

While the rate is not as high as in many areas of the Lake Simcoe watershed, there is some development planned for the Georgina Island First Nation. Significant deterioration to water quality can occur during construction, as exposed soils are very susceptible to run-off and wind erosion if appropriate measures are not undertaken. While policies in the LSPP (e.g. 4.20-DP) aim to minimize construction phase impacts, further improvements could be made through the use of best management practices.

> **Recommendation 3-1 -** That the Georgina Island First Nation amend the Building By-law and Land Use Plan to include erosion and sediment control requirements, and ensure enforcement of the requirements through the addition of enforcement staff.

> **Recommendation 3-2 -** That the Georgina Island First Nation promote and encourage the adoption of best management practices to address sedimentation and erosion controls during construction and road development. This may include, but will not be limited to, explicit wording in permits detailing what is required in this regard.

3.5.2 Stewardship Implementation

The high concentrations of phosphorus in water quality samples taken on Georgina Island, as well as the issues observed during the BMP inventory undertaken on all three islands, indicate that there are practices being used throughout the study area that may be impacting water quality. In order to improve water quality on Georgina Island, and in the lake, there are a number of best management practices and tools that can be used to undertake projects that will mitigate some of these impacts.

> **Recommendation 3-3 -** That the recently developed spatially-explicit prioritization tool be used to properly allocate stewardship resources, so that projects are undertaken in locations where maximum phosphorus reduction can be achieved. The undertaking of stewardship projects should be a priority in the study area, as they present some of the best opportunities to improve water quality and aquatic health. Further, that these tools

should be updated continually to reflect updated information and the completion of projects.

Recommendation 3-4 - Implement Traditional ceremonies as a Community celebration to mark the changing of the seasons, giving thanks to the Creator for all She provides

Recommendation 3-5 - Develop an aquatic plant booklet identifying filter plants that could be planted in wetland areas and shorelines, such as the water lily and identify the traditional medicinal uses building on our cultural connection.

Recommendation 3-6 - Develop maps that identify natural water flow and connectivity that Community Members could utilize in determining locations for developmental purposes as well as stewardship efforts; ensuring those pathways are healthy and stay connected so that there is the proper flow and filtering before the water hits the lake. Also to ensure that maps are continually updated to reflect any development or stewardship projects that has occurred.

Recommendation 3-7 - Development of a traditional guide in regards to natural products to replace chemical products for use as weed control, cleaning products etc.

Recommendation 3-8 - Educate and encourage people to maintain or recreate the vegetated buffer zones along the shoreline and any other waterway on their properties.

Recommendation 3-9 - Incorporate traditional teachings into stewardship projects (ie. water teaching, teachings on the different plants that are being planted and their cultural and medicinal purpose).

3.5.3 Monitoring and Assessment

Currently there are no regular, long-term surface or groundwater monitoring stations located in the Georgina, Fox and Snake Islands subwatershed to assess changes and track trends. To this point, monitoring has been limited to the samples taken in support of the development of this plan. Additional sampling would help to determine the success of projects undertaken in the vicinity of tributaries and groundwater resources, advise of any emerging issues, and enable adaptation of management options.

Recommendation 3-10 - That the Georgina Island First Nation undertake regular monitoring of the water quality in island tributaries, potentially through the development of a Citizen Science program, and/or as a Water Treatment Plant Operator responsibility.

Recommendation 3-11 - That the Georgina Island First Nation develop a groundwater monitoring program to include the installation of monitoring wells and regular monitoring of groundwater quality, levels and flow.

Recommendation 3-12 - That the Georgina Island First Nation implement regular monitoring and maintenance of the First Nations Landfill site to ensure that there is no groundwater or surface water contamination.

Recommendation 3-13 - That the Georgina Island First Nation continue with the septic system repair and replacement program until all systems are up to date and functioning properly. Develop and implement a septic system monitoring and maintenance program; create full-time position for the enforcement of this program.

Recommendation 3-14 - Monitor the salt use (both road salt and water softeners) at the mainland access points as well as on the First Nation, and their effect on water quality.

Recommendation 3-15 - That the Georgina Island First Nation access and utilize partnerships with other organizations such as the LSRCA, MOE, York Region Health, etc.

Recommendation 3-16 - That the Georgina Island First Nation mandate that consultants share information with the First Nation in regards to changes they may have noticed within the First Nation lands.

Recommendation 3-17 - Identify specific species to be monitored that have a correlation to water quality such as the frog and turtles and monitor them. Species identified could also have traditional teachings about them to the community.

Recommendation 3-18 - That the Georgina Island First Nation initiate a research study on the effects of personal care products and pharmaceuticals on water quality.

Recommendation 3-19 - That the Georgina Island First Nation develop a source water protection plan.

Recommendation 3-20 - That the Georgina Island First Nation complete a comparison of historical trails and existing trails to identify areas which may be causing water quality issues and may need to be closed and / or require restoration work.

3.5.4 Recreation

Although recreational activities (eg. ATVs, hiking) promote the appreciation of natural areas, excessive or incorrect use of trails can cause soil erosion and sedimentation which can negatively affect water quality. The management and maintenance of trail systems and education of users is important for the protection of natural heritage features.

Recommendation 3-21 - That the Chippewas of Georgina Island First Nation update the existing trail maps within the First Nation on Georgina, Fox and Snake Islands.

Recommendation 3-22 - That the Chippewas of Georgina Island First educate landowners on the importance of maintaining recreational trails and effects of sediment runoff on water quality when trails are not used appropriately or maintained.

Recommendation 3-23 - That the Chippewas of Georgina Island First Nation develop a trails guide outlining rules, regulations and restrictions for both community members and cottagers.

Recommendation 3-24 - That the Chippewas of Georgina Island First Nation develop and post signage in designated areas outlining rules, regulations and restrictions of trail use.

3.5.5 Climate Change

The Georgina Island First Nation Climate Change Adaptation Plan identifies several adaptation measures to address the risks associated with climate change. They fall under four broad categories: Engage People, Reduce Threats, Enhance Adaptive Capacity, and Improve Knowledge. Relevant recommendations found under each of these headings are included below:

Engage People

Recommendation 3-25 - Develop a communication plan to coordinate efforts to notify the community of beach closures. This could include such measures as signage at beaches and specified areas around the island, a communications board at the mainland access points, and/or the development of an e-mail distribution list.

Recommendation 3-26 - Create a full time position for the regular monitoring and update of information on the Community web page, which would include opportunities for community members - as well as cottage residents - to access information and funding opportunities, and participate in stewardship projects

Reduce Threats

Adaptation measures in this section include a number of measures to reduce nutrient and contaminant loads into tributaries and the lake.

Recommendation 3-27 - Develop programs to reduce the nutrient load into the lake and tributaries, and to reduce the amount of contaminants entering the lake from agricultural practices and septic systems. Measures under such programs could include promoting the use of phosphorus free fertilizers, implementing a septic system inspection program and encouraging the regular maintenance of septic systems, and stewardship efforts to enhance vegetation along streams and shorelines.

Recommendation 3-28 - Undertake remediation projects that address water quality issues that might arise during and/or after an extreme rain event.

Recommendation 3-29 - Develop remediation or restoration measures to address water quality issues that might arise as a result of warmer water temperatures to ensure the safety of the community.

Recommendation 3-30 - Develop shoreline protection program or initiatives

Recommendation 3-31 - Develop a shoreline protection program or stewardship initiatives that reduce the risk to drinking water associated with climate change

Recommendation 3-32 - Develop public and private stewardship initiatives to restore water quality

Recommendation 3-33 - Develop water conservation programs

Recommendation 3-34 - That the Georgina Island First Nation upgrade the water treatment plant and water distribution infrastructure; ensure regular maintenance of infrastructure

Recommendation 3-35 - Encourage the strategic placement of snow fencing in the winter to reduce drifting snow over roads and in ditches to reduce overland run off during the spring thaw.

Recommendation 3-36 - Bridge gaps between those who conduct agricultural activities with organizations like OMAFRA and educate them on best management practices and encourage them to implement them.

Recommendation 3-37 - Regulate and reduce traffic on the ice road to minimize the amount of salt and other pollutants from vehicles reaching the lake and the landings (ie. through the implementation of tolls for non-member use).

Improve Knowledge

Recommendation 3-38 - Develop program(s) to monitor algal blooms around the island.

Recommendation 3-39 - Enhance communication with community members in regards to outreach and education for monitoring programs.

Enhance Adaptive Capacity

Recommendation 3-40 - Develop best management program to educate home and cottage owners on how to protect the quality of water in their well.

Recommendation 3-41 - Encourage and promote community members and cottagers alike to get involved and participate in water quality improvement projects.

4 Aquatic Natural Heritage

4.1 Introduction

The Georgina Island First Nation, as Anishnabe People have a deep connection with Mother Earth and her Aquatic Natural Heritage features, including the aquatic life that create their habitat within those features. We appreciate and respect that every living thing from the two legged, the four legged, the winged one's, plant life, insects and most importantly the aquatic life depends on those features for survival.

Our Elders have been explaining for generations the important roles certain aquatic natural heritage areas such as the wetlands play in keeping waterways clean and healthy, acting like giant sponges, holding water and purifying that water before it is released slowly back out onto the land and waterways. Our people have always acknowledged that the streams and rivers flowing like veins in a human body provide sustenance, nutrition and oxygen to every living thing, carrying the life giving and healing powers of the abundance of traditional medicines that can be found within these areas throughout to the rest of the land.

We have always recognized that healthy, sustainable aquatic natural features ensure that species such as fish, which are a resource that is highly valued by the Chippewas of Georgina Island, being a source of food, trade and important cultural significance, are in abundance for future generations. That the waterfowl such as the ducks and geese whom have been important messengers historically in informing our people of such things as when winter was beginning and when it was ending have a place to thrive.

We understand that it is our inherent responsibility to love, care and safeguard these features that we have been gifted and will do everything in our power to do just that in whatever capacity we can.

Habitat can be described as a place where an animal or plant normally lives, often characterized by a dominant plant form or physical characteristic. All living things have a number of basic requirements in their habitats including space, shelter, food, and reproduction. In an aquatic system, good water quality is an additional requirement. In an island ecosystem, water within the lake as well as inland tributaries affects all of these habitat features; its movement and quantity affects the usability of the space in the channels and nearshore areas, it can provide shelter and refuge by creating an area of calm in a deep pool, and it carries small organisms, organic debris, and sediments downstream and towards the shore. This can provide food for many organisms and the water currents incorporate air into the water column; providing oxygen for both living creatures and chemical processes in the water and sediments. Habitat features also frequently affect and are affected by other features and functions in a system. For instance, the natural state of a shoreline, with riparian vegetation and natural substrates, can affect the amount of erosion that will take place over time; this in turn affects the shoreline health and ability to provide food and habitat. Shoreline development and hardening alters this natural state and removes important shoreline features including riparian vegetation and substrate, which provides shade, refuge, spawning habitat, allochotonous nutrients and filters stormwater flowing into the lake.

All habitat features are impacted by changes in the system, both natural and anthropogenic. There are numerous causes of stress in an aquatic environment. Any type of land use change from the natural condition will place a strain on the system, and can cause significant changes to the aquatic community. For example, the creation of natural and anthropogenic barriers, such as perched culverts or weirs, impairs the ability of aquatic species to move between tributary and lake habitats in order to complete all of their life cycle processes, including spawning and feeding. Restriction of this critical factor of ecosystem health can lead to shifts in aquatic communities, decreased abundance and diversity, degraded water quality, and isolated populations.

The following sections in this chapter highlight the current status (Section 4.2) of the Georgina, Fox, and Snake Islands subwatershed, as well as the stressors impacting them (Section 4.3), and the current community initiatives in place to protect and restore them (Section 4.4). This is followed by a series of recommendations, developed to address the specific issues and management gaps seen within the study area.

Of the three islands in the subwatershed, Georgina Island is the only one containing stream habitat, and therefore the sections relating to streams are only based on data from that Island.

4.2 Current Status

To assess the environmental quality and the overall health of the aquatic system, the Lake Simcoe Protection Plan has provided indicators to determine how well the aquatic ecosystem is functioning. The indicators relevant to the Georgina, Fox, and Snake Islands subwatershed and its tributaries are:

- Natural reproduction and survival of native aquatic communities;
- Presence and abundance of key sensitive species;
- Shifts in fish community composition, and;
- The integrity of natural shoreline, i.e. the amount of shoreline that is either undeveloped or maintained in a naturalized state

To address these indicators, a number of analyses have been undertaken on the stream, shoreline, and nearshore systems. The following sections summarize these results.

4.2.1 Overview of aquatic communities – Tributaries

There are four tributaries located on Georgina Island, while Fox and Snake Island do not have any flowing watercourses. Therefore this section related only to aquatic habitats found on Georgina Island. The streams on Georgina Island are all located in naturalized areas with some riparian buffer, however all are intersected by paved roads, and are adjacent to residential properties. There is low baseflow in these watercourses and at least one dries up completely during the summer.

4.2.1.1 Fish Community

Studying the health of the tributary fish community of Georgina Island provides an important window into the health of the aquatic system as a whole. Fish are sensitive to a great number of stresses including water quality, temperature, flow regimes, and the removal of habitat. While they are able to move quickly in response to a sudden change in conditions (e.g. a release of a chemical into the system) and are therefore not a good indicator of these types of issues, prolonged stresses will eventually cause a shift in the fish community from one that is sensitive and requires clean, cool water to survive to one that is more tolerant of degraded conditions. Long term monitoring will identify changes and trends occurring in the fish community, and will help to identify and guide restoration works.

In order to characterize the fish community on Georgina Island, stream sampling has been completed by LSRCA within the four tributaries in 2014 and 2015. Streams were sampled in July 2014 and May 2015 by one LSRCA electrofishing crew. In 2014, one stream (GI-02) was dry and could not be sampled.

A total of six species have been captured on Georgina Island since LSRCA began sampling in 2014 (Table 4-1). In July 2014, only two individuals were caught at two sites; in 2015, 22 individuals were caught. The fish community in the tributaries on Georgina Island is characteristic of a cool water system containing species such as central mudminnow (*Umbra limi*), brook stickleback (*Culea inconstans*), and emerald shiner (*Notropis atherinoides*).

The water temperature of a system can dictate the composition of the fish community, as well as determine how the systems are managed. Figure 4-1 below illustrates the combination of maximum air temperatures versus water temperature at 4 pm (when water temperatures tend to reach their maximum) that determines whether a stream is classified as warm, cool, or cold water. Typically, the average maximum summer water temperature for a cold water system is 14°C; this is generally due to inputs of cool groundwater, which ensure that air temperatures have little effect on the water temperature. The average maximum daily water temperature for cool water systems is approximately 18°C; this temperature is and approximately 23°C in warm water systems (Stoneman and Jones, 1996). This temperature rating system has been used to classify the tributaries in the Lake Simcoe watershed.

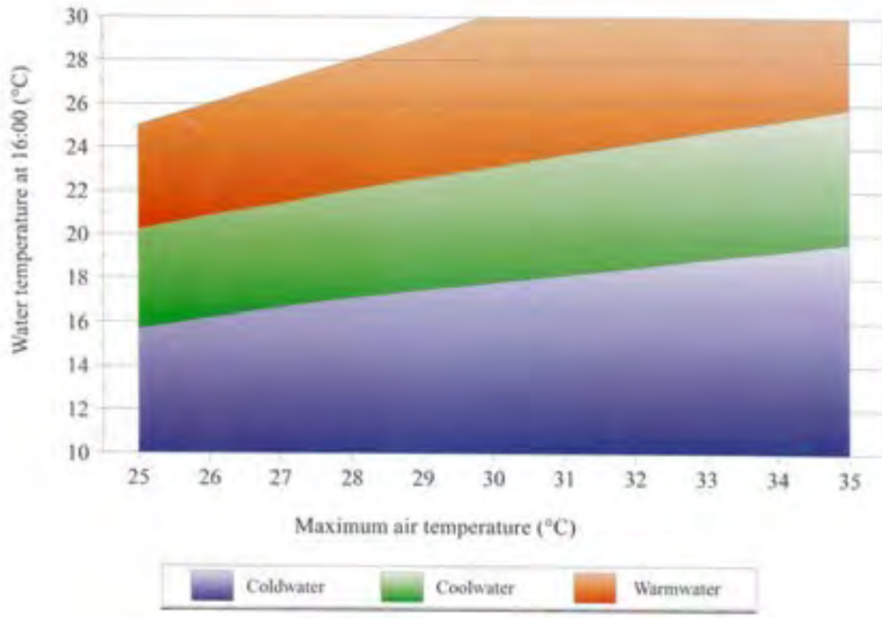


Figure 4-1: Cold, cool and warm water stream temperature ranges (Source: Stoneman and Jones, 1996)

Table 4-1: Fish species captured in the Georgina Island tributaries 2014-2015 (Source: LSRCA data from 2014 to present)

Common Name	Scientific Name
Central mudminnow	*Umbra limi*
Northern redbelly dace	*Phoxinus eos*
Emerald shiner	*Notropis atherinoides*
Creek chub	*Semotilus atromaculatus*
Brassy minnow	*Hybognathus hankinsoni*
Brook stickleback	*Culaea inconstans*

The first step in analyzing the condition of a subwatershed's aquatic community is to undertake a general overview of the current fish communities to see what type of fish are at a site (cold water species[1], cool water species, warm water species[2], or no fish) and what the temperature of the creek is at the site (cold, cool, or warm water), as well locating any barriers to the

[1] Cold water species are indicators of cold water habitat. There are no coldwater species found in the study area. All species listed in Table 4-1 are cool water species.

[2] Warm water species are considered to be generalist species that are not coldwater indicators and can exist in warm, cool and coldwater sections of a stream.

movement of some or all fish species (Figure 4-2). Over time, this broad overview can show the general shifts in the fish communities; for example, as water temperatures rise, a coldwater fish community may shift to a warm water community, and where dams are present fish may eventually disappear from an area.

Figure 4-2 shows the variation in temperature among the watercourses. Due in part to the absence of cold water groundwater discharge areas, there are no cold water systems in the Georgina, Fox, and Snake Islands subwatershed. As such, cold water species such as brook trout and mottled sculpin are absent. The temperatures of the streams on Georgina Island range from cool to warm, and in 2015, all of the streams except GI-05 dried up during the sampling season.

LSRCA field crew - electrofishing

An Index of Biotic Integrity (IBI) was used to assess the ecological integrity of the creeks through an analysis of the composition of fish communities within the system (Figure 4-3). Fish population and community composition surveys are valuable tools for examining the health and stability of streams and rivers. Over time, shifts in composition, along with the presence or absence of key species, not only provides an indication of system health but can be used to help identify which ecosystem stressors, such as climate change and urbanization, are influencing aquatic habitats.

With this method there are five rankings that can be assigned to a site:

- Very good: Excellent diversity, top predators, trout present and high fish abundance
- Good: Average diversity, top predators present, trout present, average abundance

- Fair: Low/average diversity, some top predators, no trout, low/average abundance of fish
- Poor: Low diversity, no top predators, no trout, low abundance of fish
- No Fish: No fish were captured at these sites

Overall, Figure 4-3 shows that the ecological integrity of the systems varies spatially across Georgina Island, with the sites assessed as Poor, Fair or having No Fish. The main influence on these systems is likely the ephemeral nature of these small streams, with any other factors, such as barriers, potentially influencing their habitat quality during the spring months when they have flow. The streams on the island likely play an important role for the spawning of fish that typically reside in the lake – given that they have flow and appropriate habitat during spring spawning, and some of the species caught are those who prefer spawning in the smaller systems that drain into the lake, this is a safe assumption. Further monitoring would confirm this. Given the likeliness of this important function, barriers such as perched culverts, and other disruptions to the function of these stream systems may have a significant impact on the spawning success, and hence the populations, of some of these species.

Due to the limited number of streams and short sampling period, no general trends related to land use and fish community are apparent on Georgina Island. Continued monitoring will help to identify any potential trends occurring spatially or temporally within the island's tributaries as well as the species using these tributaries to spawn, and may help to identify stressors on the aquatic systems.

Figure 4-2: Occurrence of fish community in relation to measured water temperature in stream

Figure 4-3: Ecological integrity of stream sites based on fish community conditions assessed using the Index of Biotic Integrity (IBI)

4.2.1.2 Benthic community

Aquatic insects, or benthic invertebrates, are an ideal indicator of water quality as different species have different tolerances to factors such as nutrient enrichment, dissolved solids, oxygen, and temperature. The presence or absence of certain species is used to determine water quality at a given site. Of the indices developed to assess water quality in relation to benthic invertebrate communities, the Hilsenhoff Biotic Index (HBI) was selected as it provides a full spectrum of the different levels of organic pollution within a watercourse, which enables watershed managers to document declining watershed conditions by comparing years of data; whereas other indices (such as BioMAP) only provide an 'impaired' or 'unimpaired' rating.

Figure 4-4 is an assessment of the ecological integrity of the creeks on Georgina Island determined through the composition of the benthic invertebrate communities within the system. This composition is dependent on the quality of the water and the degree of organic pollution. With this method there are seven rankings that can be assigned to a site:

- Excellent: No apparent organic pollution
- Very good: Slight organic pollution
- Good: Some organic pollution
- Fair: Fairly significant organic pollution
- Fairly poor: Significant organic pollution
- Poor: Very significant organic pollution
- Very poor: Severe organic pollution

Figure 4-4 shows the ecological integrity of the watercourses, based on 2014 and 2015 benthic analysis, on Georgina Island. High levels of diversity in the benthic community may not be expected due to the small and ephemeral nature of these streams, which is likely limiting the index score received in these systems. Further, the island is characterized by significant residential development along the shoreline and low summer flows, which would also contribute to lower benthic invertebrate scores. The sites vary from Fair to Fairly Poor, with the majority of sites rated Fairly Poor.

LSRCA staff collecting benthic invertebrates

Half of the sampling sites, which are all located adjacent to main roads, are in streams that are intersected by barriers (perched culverts). Of the four sites sampled, two (GI-01 and GI-05) are not restricted by a barrier, and site GI-05 contained the highest fish species diversity and abundance. In addition, while all of the sites are located in fairly natural areas, sites GI-02 and GI-03 are in streams that have been altered and have less natural cover, which could contribute to the low Hilsenhoff biotic index (HBI) scores.

The dominant soil type also plays a role in the benthic invertebrate scores. Although the watercourses flow through significant areas of natural heritage before reaching the sampling sites, they are also located in swampy areas, which is likely the most important contributing factor to the low HBI scores as mucky soils do not support the more sensitive benthic invertebrate species that would contribute to a higher rating.

When using fish and benthic indices to evaluate the ecological integrity of a system, it is likely that there will be some discrepancies between the data. For example, there may be a poor rating of a site by the IBI and a good rating by the HBI. This may be explained by the absence of cold water indicator fish species on Georgina Island, which would result in a lower IBI score, while some highly sensitive insects are not affected by warmer water temperatures. There may also be the opposite scenario where the IBI gives a good rating and HBI a poor rating. A likely explanation for this is that fish are more mobile than benthic invertebrates, and in times where habitat conditions have deteriorated (low oxygen, low water levels, high temperatures, or poor water quality), benthic invertebrates are unable to move as quickly to better conditions and whole populations can be eliminated. If this occurs, benthic invertebrate communities will likely not return the following year, whereas fish will return if habitat conditions have improved. The last scenario is at sites where no fish have been caught. Conditions at a site could include low flow, high gradient, or have barriers to fish passage. While these conditions are not favourable to fish, benthic invertebrates can still have healthy populations at these sites, which will be reflected in a higher HBI rating. These types of occurrences happen at two of the sites; at Site GI-01, no fish were found; however, the benthic HBI gives scores of Fairly Poor, and at Site GI-03, the IBI score was poor while the HBI score was fair.

Figure 4-4: Ecological integrity of stream sites based on benthic community conditions assessed using the Hilsenhoff Biotic Index (HBI)

4.2.2 Overview of aquatic communities – Lake Nearshore

In addition to assessing the tributaries within the subwatershed, the nearshore lake communities were also analyzed, as the nearshore zones are critical areas that are linked to both the terrestrial riparian area and to the tributaries and the aquatic communities within them. The nearshore zone for Lake Simcoe is from the shoreline to when the depth reaches 15-20 m. This is an important fish feeding, migration, and nursery area; and is also an area that has undergone significant environmental change, including the introduction of a number of invasive species (including zebra and quagga mussels, round gobies, plants, and zooplankton), changes in the aquatic plant communities, and the impacts of shoreline development and hardening. Five lake health indicators were analyzed in the nearshore areas of the Georgina, Fox, and Snake Island subwatershed: aquatic plants, water quality, sediment phosphorus, benthic invertebrates, and fish community. Part of the mandate of the LSRCA Lake Science Research and Monitoring Program is to assess the environmental status of Lake Simcoe and track any ecological changes; the collected data is being used to set public policy, advise lake managers, and verify environmental guidelines.

4.2.2.1 Aquatic Plants

Submerged aquatic plants are an important biological component of a lake ecosystem and have an important role in stabilizing sediments, buffering shorelines from wave action, and providing important habitat (living, feeding, and nursery space) for warmwater fish species such as perch, pike, bass, and sunfish. Aquatic plants also have an important role in cycling nutrients (particularly phosphorus) in the lake, uptaking as much as 97% of their phosphorus requirement from lake sediments and re-distributing it through the lake through plant decomposition and movement of plant material following plant die-back in autumn. Decomposition of this plant material provides an important food source for benthic invertebrates that are, in turn, food for recreationally important warmwater and coldwater fish species. Despite these important roles of aquatic plants in the lake ecosystem, under conditions of increased nutrient inputs to a lake, particularly when combined with increased water clarity from filter-feeding invasive species such as zebra and quagga mussels (such as in Lake Simcoe), aquatic plants can achieve dense growths that are considered a nuisance by lake users, impairing recreational uses such as swimming, boating, and fishing, or forming unaesthetic wash-ups of dead / decomposing plant material on shorelines located downwind of areas with high growths of plants.

The LSRCA has carried out two comprehensive, lake-wide, surveys of the Lake Simcoe aquatic plant community in 2008 and 2013. In 2008, a total of 16 species were recorded. In 2013, 22 species were recorded. Three submerged aquatic plant species in Lake Simcoe are invasive: Eurasian watermilfoil (*Myriophyllum spicatum*), first reported in 1984; curly-leafed pondweed (*Potamogeton crispus*), also reported in 1984, and starry stonewort (*Nitellopsis obtusa*), first recorded in 2009.

Based on the analyses, there were five areas of high aquatic plant growth in Lake Simcoe, one of which is the channel between Georgina Island and the mainland (Figure 4-5). These areas of high plant growth are related to four, closely related, environmental factors: (1) water depth and clarity, the maximum depth of plant growth is 10 m and has increased from 6.5 m before invasion by zebra and quagga mussels; (2) presence of soft (mud and silt, or sand) lake bottom that provides stable attachment for rooted plants and have higher nutrient (phosphorus) concentrations; (3) higher phosphorus concentrations in water and sediment that provide nutrients for plant growth; and (4) proximity to larger subwatersheds that provide higher amounts of phosphorus to Lake Simcoe.

Locations of dense plant growths coincide with sand or mud substrates in the channels between Snake and Georgina islands and the mainland, off Bald Point to the east of Georgina Island, and along Fox Island Shoal. No significant amounts of aquatic plants were recorded on rocky substrates with relatively high wind and wave exposure to the north of Blackbird Point, on Georgina Island, or east of Snake Island.

The southern shore of Georgina Island had a high biomass of 1078 g/m^2 (wet weight) of plants in 2008, dominated by the invasive species Eurasian watermilfoil (*Myriophyllum spicatum*) along the shoreline, and muskgrass (*Chara* spp.) toward the mainland. In 2013, the average biomass had doubled to a wet weight of 2173 g/m^2, dominated by Eurasian watermilfoil as well as coontail (*Ceratophyllum demersum*) and pondweeds (*Potamogeton* spp.). Other sample sites near Georgina Island had a lower biomass of plants, with muskgrass, water stargrass (*Zosterella dubia*), and tapegrass (*Vallisneria americana*) being prominent off Bald Point, and no plants being recorded at sites on the exposed northern shoreline near Blackbird Point.

While fewer plants were recorded off Fox and Snake islands, there was still an increasing trend in biomass in 2013 compared to 2008. Fox Island had the lowest biomass with an average of 17 g/m^2 of Eurasian watermilfoil recorded in 2008, which increased to 705 g/m^2 in the 2013 survey. The highest biomass of plants near Snake Island were recorded in the shallow channel between the island and the mainland with 1367 g/m^2 recorded in 2008 and a much higher 3055 g/m^2 in 2013. In 2008 this location was dominated by Eurasian watermilfoil, however by 2013 the sites consisted mostly of muskgrass with small amounts of watermilfoil. This trend has been seen in other locations of the lake, with invasive Eurasian watermilfoil being reduced between the 2008 and 2013 surveys and replaced by native muskgrass. Other samples sites in more exposed locations of Snake Island had fewer plants, although there was still an increasing trend between 2008 and 2013 (541 g/m^2 compared to 1320 g/m^2, respectively).

While a trend toward a plant community comprised of native flora is an encouraging trend, it should be noted that some species, particularly muskgrass, is prone to washing up on shorelines and being the cause of complaints from shoreline property owners and lake users. With nutrient concentrations continuing to be elevated in Lake Simcoe, and less competition from larger plants such as watermilfoil, an increased amount of muskgrass may lead to more wash-ups of plant material on shorelines. In addition, the plant community, and ecological benefits to the warmwater fish community, may threatened by the spread of more resilient invasive species, such as starry stonewort.

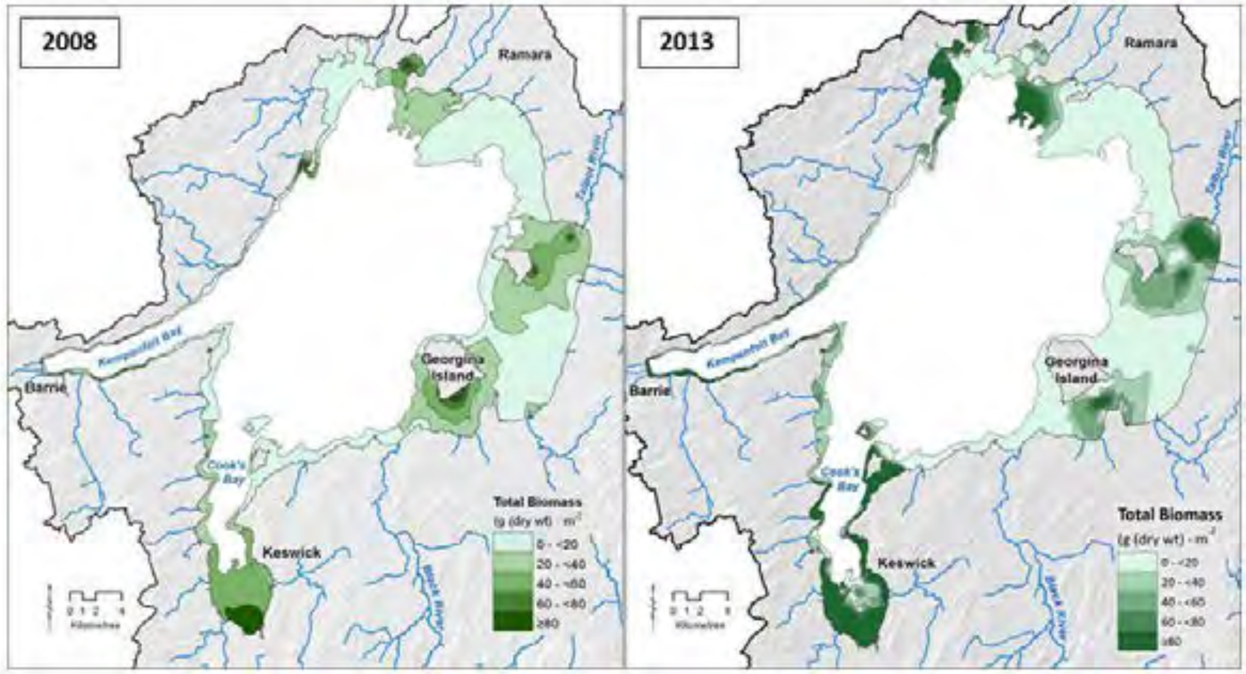


Figure 4-5: Changes in Lake Simcoe plant biomass from between 2008 (left) and 2013 (right)

4.2.2.2 Water Quality

Water quality is generally good in Lake Simcoe, although concentrations of the nutrient phosphorus are elevated above the sustainable state set by the Lake Simcoe Protection Plan (LSPP) of 8 µg/L. While offshore monitoring stations record water column total phosphorus (TP) concentrations ~15-18 µg/L, nearshore concentrations are typically slightly higher (TP ~17-30 µg/L) due to run-off from the land, inputs from tributaries, and the process commonly referred to as the “nearshore shunt” where zebra mussels “pull” offshore water and nutrients into shallower water depths.

In terms of water clarity, Lake Simcoe has very clear waters with an average Secchi Disk depth of 7-9 m. This depth increased from an average of approximately 2-5 m, following phosphorus abatement strategies in the 1980-90s and due to removal of algae and suspended particles by zebra mussels that are thought to have become established in 1995.

Secchi Disk Depth

A Secchi disk is a black and white disk used to measure water clarity. The disk is mounted onto a pole or line, and lowered slowly into the water. The depth at which the disk is no longer visible is taken as a measure of the transparency of the water. This measure is known as the Secchi depth and is related to water clarity. The clearer the water, the greater the Secchi depth.

4.2.2.3 Sediment Phosphorous

Another lake health component analyzed in the LSRCA Lake Science Research and Monitoring Program is the amount of phosphorus contained in lake sediments, which was poorly understood prior to the initiation of the program. Monitoring of sediment phosphorus is undertaken because of the potential for phosphorus release under low dissolved oxygen concentrations in the water (less than 2 mg/L) and this is, thus far, an undetermined source of phosphorus loading.

Near the Georgina, Fox, and Snake Island shorelines, mean sediment nutrient concentrations are relatively high with total phosphorus (TP) ranging from 0.8 to 1.0 mg/g, likely due to soft, muddy substrates which hold more nutrients than coarser grained sediments (Figure 4-7c). For comparison, concentrations range across the lake from TP ~0.35 mg/g in Cook's Bay to ~1.4 mg/g near Beaverton. (For details on the total phosphorus within the tributaries please refer to **Chapter 3 - Water Quality**).

4.2.2.4 Benthic Invertebrates

The benthic invertebrate community in the nearshore zone is dominated by two species of invasive mussels: zebra mussels (*Dreissena polymorpha*), which were first detected in Lake Simcoe in 1992 and were well established by 1995; and quagga mussels (*Dreissena rostriformis bugensis*), which were first recorded in 2004. Since their arrival, these filter feeders have increased the water clarity by removing suspended particles, altered phosphorus cycling in the lake by increasing the proportion deposited on the bottom, and changed the abundance and biomass of benthic (or bottom-dwelling) species by providing more food and more living space. Benthic groups that have increased as a result have included scavengers and deposit feeders such as amphipods (scuds), chironomids (non-biting midges), and oligochaetes (aquatic earthworms). Other groups of filter feeders (in particular native unionid mussels) have experienced large declines following the dreissenid mussel invasion due to competition for suspended food particles.

Since 2008, LSRCA has been monitoring trends in the benthic community of Lake Simcoe, in particular the portion in nearshore habitats (Figure 4-7b). In this time, a large decline in zebra mussels has been recorded along with a corresponding increase in quagga mussels. In 2009, a lake-wide survey of 747 sites recorded an invasive mussel community composed of 75% zebra mussels and 25% quagga mussels. Since then, zebra mussels have declined to the point where they are currently (2014) only 5% of the community, while quagga mussels increased to 95% (Figure 4-6). In 2009, the distribution of mussels was limited to water depths shallower than 20 m (except in Kempenfelt Bay where the limit was 31 m depth), likely due to a change in bottom-type to potentially filter-clogging silt and mud substrates. In 2014, quagga mussels have been recorded at all depths and on all substrates as they have a greater ability to survive on soft-substrates by forming aggregations known as druses. This change in a dominant, ecosystem-engineering species appears to be quite common in lakes that have been invaded by both zebra and quagga mussels and has already been reported in Lake Erie and Lake Ontario, and is currently taking place in Lake Michigan. What is unknown are the potential ecological consequences of this change and how they will impact the Lake Simcoe ecosystem, environmental management plans, and the ability to use Lake Simcoe as a resource for commerce and recreation. LSRCA is continuing to monitor this and other ecological changes, and in 2015 will re-survey the 747 sites from 2009 to more fully quantify the changes recorded by the annual monitoring program.

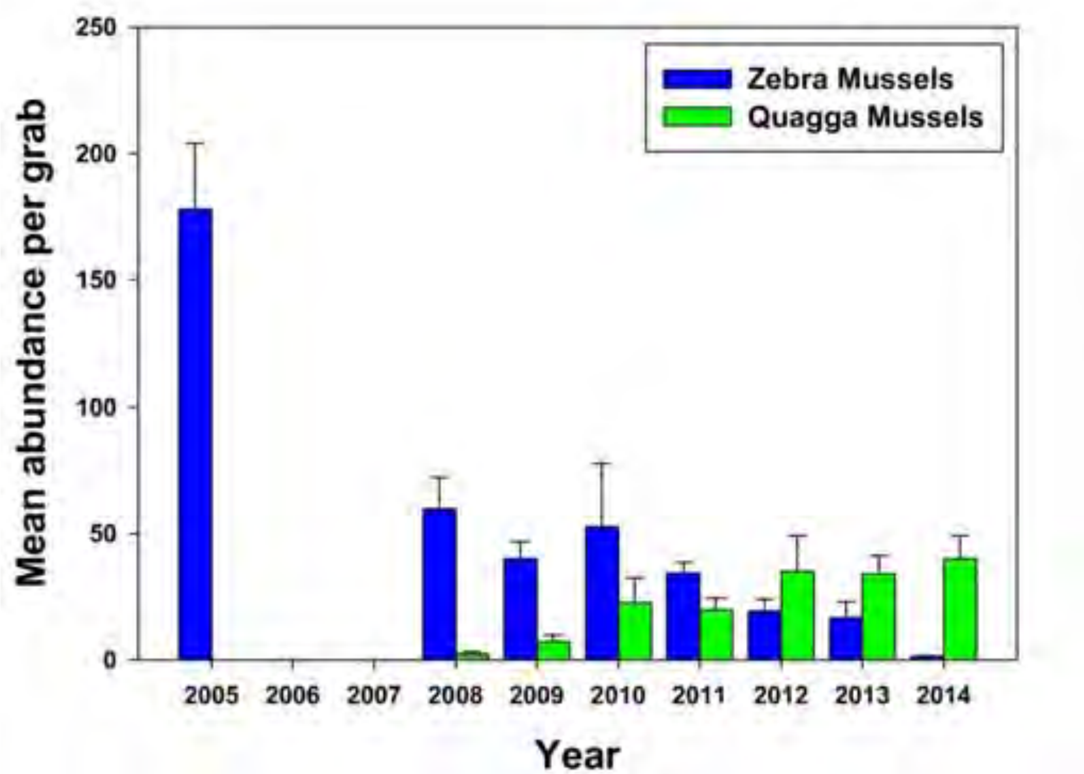


Figure 4-6: Changes in zebra and quagga mussel abundance in Lake Simcoe from 2005-2014 (Source: LSRCA data from 2005 to 2014)

4.2.2.5 Fish Community

In addition to the LSRCA nearshore data, the Chippewas of Georgina Island First Nation, in partnership with the Anishinabek/Ontario Fisheries Resource Centre, completed a nearshore small fish biodiversity study in 2014. This study examined changes in fish biodiversity around

Georgina, Fox, and Snake Islands since previous studies conducted in 1996 and 2008. In 2014, a total of over 1,400 individuals of 16 fish species were captured at sites around the three islands (Table 4-2). The most commonly encountered fish species were round goby (*Neogobius melanostomus*) (74%), emerald shiner (*Notropis atherinoides*) (13%) and yellow perch (*Perca flavescens*) (5%). Biodiversity trends over the 18-year period showed a decrease in mean species richness at all three islands and a corresponding increase in the Shannon-Weiner Evenness Index at Georgina and Snake Islands. The Shannon-Weiner Evenness Index provides an indication of how equal the numbers of individuals of each species present are in a sample – a value of zero denotes an uneven distribution and a value of one indicates an even distribution of species. This provides an estimate of species dominance, and in this case the increase in evenness is likely driven by the increased abundance of one species, namely the invasive round goby (*Neogobius melanostomus*).

This shift in nearshore fish community coincides with other changes to the Lake Simcoe ecosystem including increased shoreline development and hardening, as well as decreased shoreline riparian cover on all three islands; the introduction of invasive zebra and quagga mussels and the resulting increase in water clarity and macrophyte abundance; increased phosphorous loads to Lake Simcoe; the introduction of invasive Eurasian watermilfoil and round goby; and an increased abundance of two piscivorous fish species (bluegill and rock bass) (Table 4-2).

Table 4-2: Fish species captured in the nearshore areas of Georgina, Fox and Snake Islands in 2014[+]

Common Name	Scientific Name	Location		
		Snake Island	Fox Island	Georgina Island
Banded Killifish	*Fundulus diaphanous*	3		17
Black Crappie	*Pomoxis nigromaculatus*	1		
Blackchin Shiner	*Notropis heterodon*			1
Blacknose Shiner	*Notropis heterolepis*	2		
Bluegill	*Lepomis macrochirus*	25		1
Emerald Shiner	*Notropis atherinoides*		1	177
Largemouth Bass	*Micropterus salmoides*			6
Longnose Dace	*Rhinichthys cataractae*			1
Mimic Shiner	*Notropis volucellus*			6
Pumpkinseed	*Lepomis gibbosus*	1		
Rock Bass	*Ambloplites rupestris*	12		1
Round Goby	*Neogobius melanostomus*	69	90	888
Sand Shiner	*Notropis stramineus*	1		5
Smallmouth Bass	*Micropterus dolomieu*			3
Spottail Shiner	*Notropis hudsonius*			27
Yellow Perch	*Perca flavescens*	32		36
Total		**146**	**91**	**1169**

+= The source of data used for this table was Anishinabek/Ontario Fisheries Resource Centre data from 1996, 2008 and 2014.

Fish as a Food Source

Fish are a staple food for our First Nation Members, specifically the whitefish which is to this day still harvested by some of our community members and distributed to the elders and other community members. Sturgeon is another fish that was harvested but no longer exists in Lake Simcoe.

4.2.2.6 Substrate

Additionally, a 2012 study conducted by the Chippewas of Georgina Island First Nation, in partnership with the Anishinabek/Ontario Fisheries Resource Centre, assessed the littoral substrate and vegetation on Fox and Snake Islands. Similar to the lake nearshore area, the littoral zone is located from the shoreline and extends to where sunlight reaches all the way to the substrate. This is an important area because it allows aquatic vegetation to grow which provides extra habitat and food for aquatic species. The study found that the entire littoral zone around both islands contained sand, and cobble and gravel were present in the southern littoral zones. The islands have a large littoral zone and shallow depths, with a deep channel separating the two islands. There was only sparse littoral vegetation around Fox and Snake Islands, however detritus is present around the entire littoral zones. These results indicate that the littoral zones of Fox and Snake Island may not be suitable habitat for fish species such as Northern Pike and Muskellunge, which require vegetated habitat for their various life stages.

4.2.2.7 Conclusion

Overall, the goal of the Chippewas of Georgina Island First Nation research as well as the LSRCA Lake Science Research and Monitoring Program is to monitor for environmental changes in Lake Simcoe, fill existing data gaps, target emerging environmental issues, and understand linkages between current ecological stressors. Monitoring of benthic invertebrate, aquatic plant and fish communities not only allows the evaluation of ecosystem health in these habitats, but also their development as biological indicators for oxygen levels, contaminants, and nutrients. Nutrient movement from the land to the tributaries to Lake Simcoe is reflected in both the plant biomass and sediment phosphorus levels (higher nutrient supply from tributaries equals more phosphorus in sediments and more plant biomass). In addition, the work with zebra and quagga mussels not only provides monitoring of these invasive species but suggests how they are impacting Lake Simcoe (high amounts of zebra mussels corresponds to increased filtering of particles from the water column, allowing greater light penetration and in turn more plant biomass and more offshore nutrients pulled to shallow water habitats).

In terms of rating the condition of the nearshore habitats, based on the components above, the shoreline along the Georgina, Fox, and Snake Island subwatershed is considered to be in fair condition.

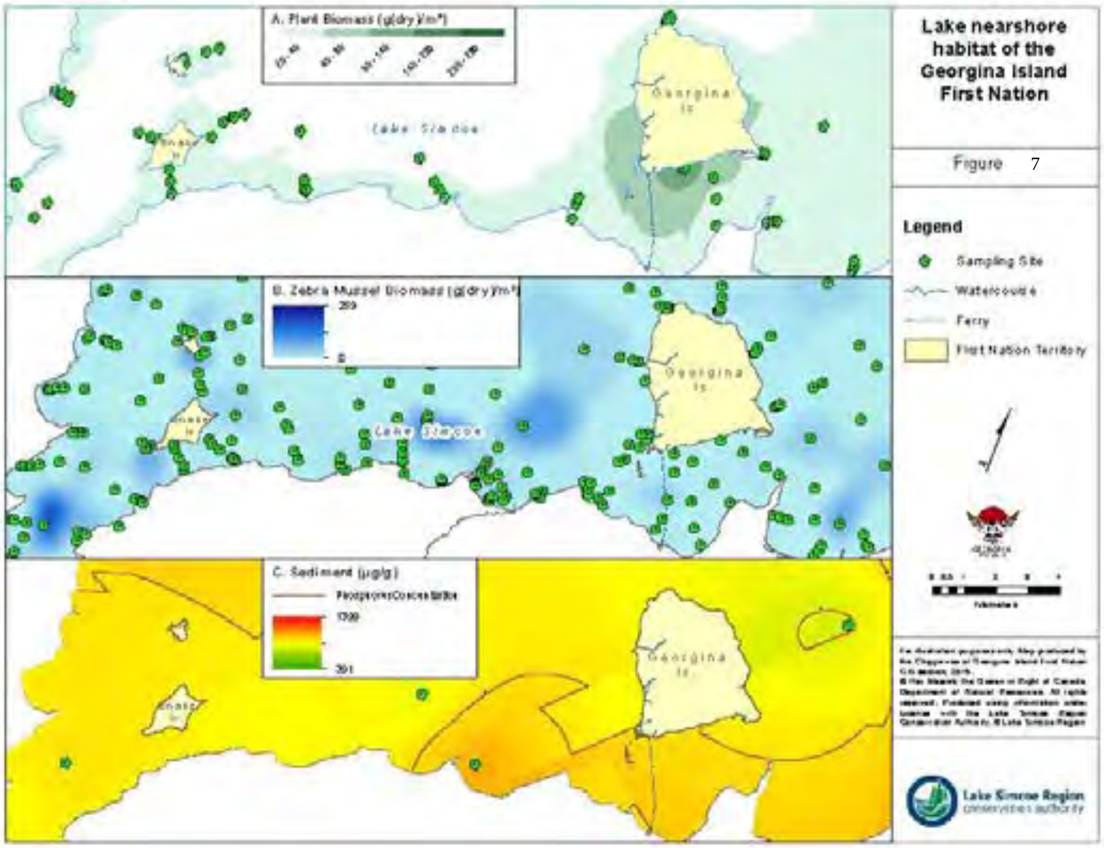


Figure 4-7: Lake nearshore habitat: plant biomass (top), zebra mussel biomass (middle), sediment phosphorous concentrations (bottom)

4.2.3 Overview of aquatic communities – Shoreline Health

The shoreline, also known as riparian zone, is the area where the land meets the water and is characterized by terrestrial plants. This area is important for aquatic habitats because the vegetation on the shoreline provides stability for the banks as well as shade, food, and shelter for aquatic and semi-aquatic animals, and also filters nutrients, chemicals and sediment from stormwater runoff before it enters the lake. Another important aspect of shoreline habitat is the substrate, which can be comprised of various materials including bedrock, cobble, and sand. The type of substrate on a shoreline determines the likelihood of erosion, the types of vegetation that will grow, and the amount of habitat available. The shoreline extends to the littoral zone, and provides an important link between terrestrial and aquatic ecosystems.

Several studies examining the health of the shorelines of Georgina, Fox, and Snake Islands have been completed since 2012. These include a Shoreline Habitat Assessment of Fox and Snake Islands, conducted by the Chippewas of Georgina Island First Nation and Anishinabek/Ontario Fisheries Resource Centre, as well as a Best Management Practices Opportunities Inventory completed for the shorelines of all three islands by LSRCA in 2014.

The shoreline habitat assessment was completed in order to characterize the shoreline ecosystem of Fox and Snake Island, and to create a baseline record for comparison with future studies as well as for comparison with similar lakes and watersheds. The study found that shoreline substrate on the islands was comprised of boulders, cobble, gravel, sand, and muck. The substrate of the north and east shorelines of Fox Island and the east shoreline of Snake Island were entirely boulder. The remaining shoreline of both islands was almost entirely comprised of large substrate (boulder/ cobble/gravel) except for smaller sections comprised of sand, where erosion from wave action has altered the shoreline. The vegetation along both shorelines was comprised of hardwood and softwood tree species, herbs and grass, shrubs, and lawns, and was dominated by hardwood species (e.g. maple). The study also found that the shoreline slope on the north sides of both islands was significantly steeper than the other sides. The assessment also identified stresses on the habitat, including development and shoreline alteration, and identified areas requiring protection and/or restoration.

In 2014, the LSRCA completed a Best Management Practices (BMP) Opportunities Inventory along the shorelines of Georgina, Fox, and Snake Islands, as well as on the band's mainland property, with the goal of identifying all alterations of the natural shoreline in order to create an inventory of potential stewardship projects, as well as a baseline of development conditions. The inventory was completed on Georgina Island by crews walking along the entire length of shoreline, on the mainland by crews walking along watercourses, and on Fox and Snake Islands from a boat. The inventory catalogued all altered shoreline features including built structures (e.g. docks, boathouses), erosion, insufficient riparian vegetation, runoff from lawns and impervious surfaces, shoreline hardening, wells, and fish migration barriers. In total, 1,964 BMP opportunities were identified on the GIFN lands, with 937 on Georgina Island, 235 on Fox Island, 792 on Snake Island, and 20 on the mainland. These are discussed in further detail in **Section 4.3 – Stressors**.

4.2.4 Rare and Endangered Species

There are no known aquatic Species at Risk in the Georgina, Fox, and Snake Islands subwatershed.

Key Points - Current Aquatic Natural Heritage Status:

- Unlike other subwatersheds in Lake Simcoe, there are no cold water fish communities on Georgina Island; the fish community is characteristic of a cool water system containing species such as brook stickleback, emerald shiners and creek chub. The likely reason for the lack of cold water species is that there are few or no groundwater inputs into the streams on the island, which are necessary to sustain these communities. There are no inland tributaries located on Fox or Snake Island.
- The ecological integrity of tributary system on Georgina Island is poor, as indicated in the low fish IBI and benthic invertebrate HBI scores. IBI scores ranged from 'Poor' to 'No Fish'. The HBI scores ranged from 'Fair' to 'Fairly Poor'. The poor scores are likely due to tributary barriers, streams drying up in the summer, alterations of the watercourses, and stormwater runoff from adjacent roads and lawns.
- The lake nearshore community around the Georgina, Fox and Snake Islands subwatershed is in relatively fair condition, being identified as an area with some of the highest plant biomass in Lake Simcoe. There are also some areas in the nearshore with high concentrations of zebra and quagga mussels, and sediment phosphorus concentrations are approximately 0.9 mg/g, with the highest concentrations being found southwest of Georgina Island.
- There are some invasive species in the subwatershed. Rusty crayfish have invaded the tributaries of Georgina Island, while zebra mussels, quagga mussels, Eurasian watermilfoil, curly-leaf pondweed and round gobies have established in the lake nearshore habitat of all three islands.
- Aquatic plant surveys undertaken by LSRCA in 2008 and 2013 showed a doubling in plant biomass off of Georgina Island between the two study years to an average (wet weight) biomass of over 2 kg/m^2. The same study found lower plant biomass around Fox and Snake Islands, but an increasing trend between the two study years.
- The littoral substrate around Fox and Snake islands contain sand, and cobble and gravel were present in the southern littoral zones; very little vegetation other than detritus was found in the littoral zones. The shorelines are dominated by large substrate (boulder/ cobble/gravel) and hardwood vegetation.
- A 2014 study of small fish biodiversity, which looked at changes in biodiversity since 1996 and 2008, found a decrease in mean species richness over the 18-year period at all three islands.
- The Lake Simcoe Basin Best Management Practice Inventory (LSRCA, 2014) served to identify all alterations of the natural shoreline in order to create an inventory of potential stewardship projects, as well as a baseline of development conditions. Features inventoried included barriers to fish movement, sections of banks and shorelines that have been hardened, runoff from lawns and impervious surfaces, and insufficient riparian vegetation. The inventory identified a total of 1,984 BMP opportunities.

4.3 Factors impacting status - stressors

There are a number of land uses, activities and other factors that can have an effect on the health of the aquatic community in the Georgina, Fox, and Snake Islands subwatershed. These include:

- Shoreline development;
- Loss of riparian vegetation;
- Barriers to fish migration;
- Shoreline hardening;
- Stormwater runoff from lawns and impervious surfaces;
- Water quality, quantity and thermal degradation;
- Invasive species; and,
- Climate change.

These factors are discussed in detail in the following sections.

4.3.1 Shoreline Development

There is extensive development along the shorelines of Georgina, Fox, and Snake Islands, relative to the interior of the islands. This includes residential properties (houses and cottages), beaches, parks, marinas, a ferry dock, and a campground. Approximately 70% of the Georgina Island shoreline, 65% of Fox Island and 85% of Snake Island is currently developed.

The majority of developed shoreline also coincides with other stressors, including removal of riparian vegetation, shoreline alteration, built structures (eg. docks and boathouses), septic tanks, and runoff from lawns and impervious surfaces. The cumulative effects of these stressors along the majority of the shoreline can have negative effects on shoreline health, including the availability of resources and habitat, stability, morphology and hydrological processes.

Figure 4-8: An example of shoreline development on Georgina Island

4.3.2 Loss of riparian vegetation

In many instances, vegetation in the riparian areas of the subwatershed's watercourses and the shoreline of Lake Simcoe has been removed to accommodate residential development and recreational activities, leaving the bank or shoreline vulnerable to erosion due to the removal of the stabilizing influence of the roots of the vegetation. This can result in inputs of sediment into the waterbody, which can settle and smother the substrate, thus eliminating important habitat used by fish for spawning and inhabited by benthic invertebrates. Sediment suspended in the water can also interfere with the feeding of those fish species that are visual feeders.

Riparian vegetation is also an important source of allochthonous material such as leaves and branches that serve as a food source for benthic invertebrates, and can also provide cover for fish.

Removal of native riparian vegetation can also facilitate the spread of invasive plant species including buckthorn (*Rhamnus cathartica*), European common reed (*Phragmites australis*), and dog-strangling vine (*Vincetoxicum rossicum*). Clearing native vegetation along shorelines provides space for invasive plants to become established, from which they can outcompete and further displace native species. For more information on invasive plant species, please refer to **Chapter 5: Terrestrial Natural Heritage.**

In addition, riparian vegetation serves to enhance water quality – it filters the water flowing overland, causing sediment and other contaminants to settle out or be taken up prior to reaching the waterbodies; and also helps to moderate water temperatures through the shade it provides. Removal of this vegetation can have an influence on the type of aquatic community able to inhabit watercourses – a reach that may have been able to support a healthy coolwater community may no longer be able to do so, and the community may shift to a warm water community containing less sensitive species.

The majority of the watercourses on Georgina Island are in areas of natural cover, except where roads intercept the streams, so there tends to be healthy levels of riparian vegetation. With respect to the shoreline, however, the level of natural cover generally decreases closer to the shoreline where the extent of development is greater, and the majority of the shoreline along all three islands has an insufficient amount of riparian vegetation (i.e. less than 30 m).

The BMP Opportunities Inventory identified a total of 369 areas of insufficient riparian buffer on the islands; 45 on Fox Island, 135 on Snake Island, 189 on Georgina Island, and one on the mainland (Figure 4-10).

Figure 4-9: An example of loss of shoreline riparian buffer on Georgina Island

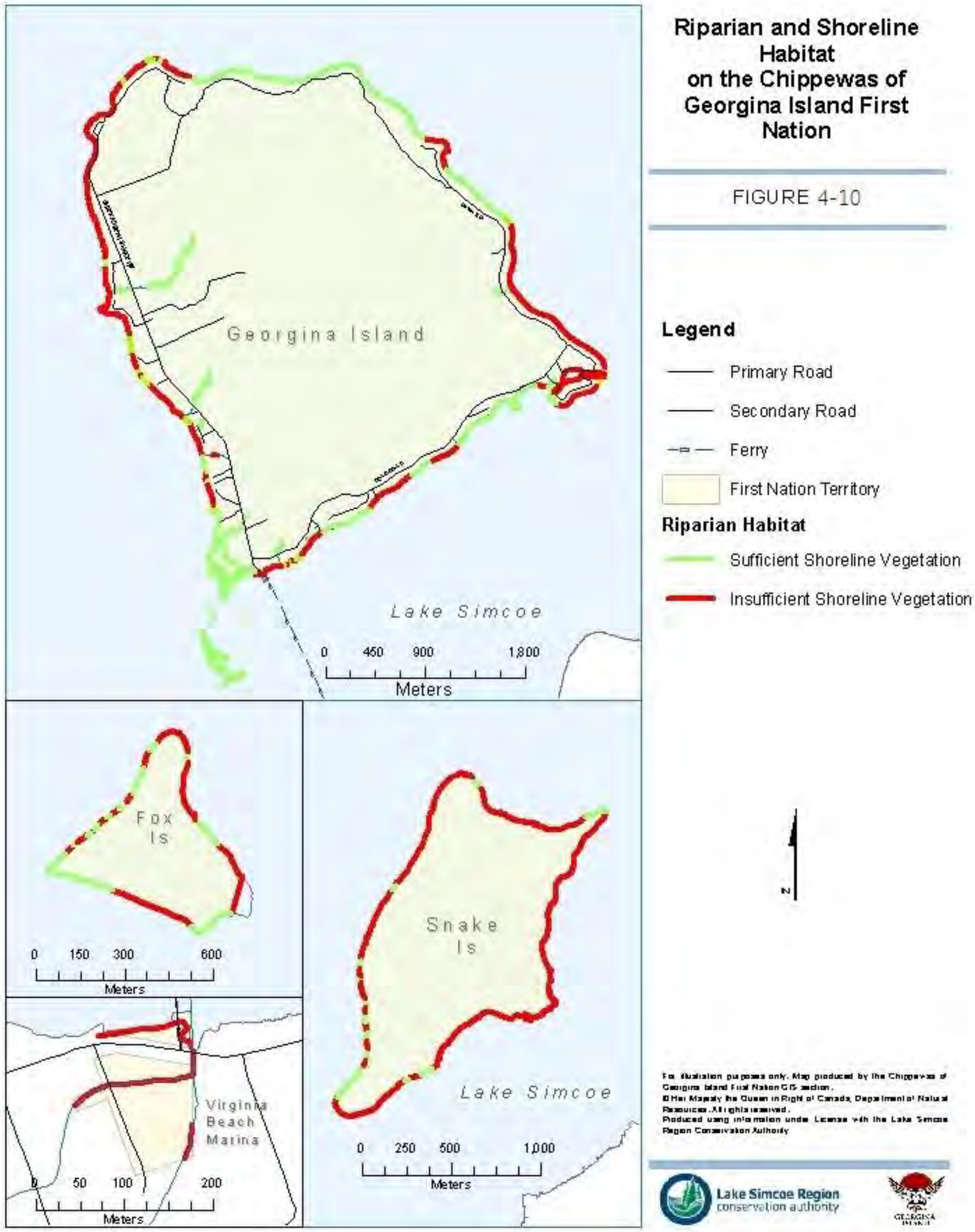


Figure 4-10: Insufficient shoreline riparian vegetation

4.3.3 Barriers to Fish Migration

Barriers to fish movement in the form of dams, perched culverts, and enclosed watercourses serve to fragment the fish community by preventing fish from accessing important parts of their habitat. The impoundments created by dams serve to increase water temperatures, raise bacteria levels, and disrupt the natural movement of fish, benthic invertebrates, sediment and nutrients. The natural movement of each is imperative for a healthy aquatic system.

The Lake Simcoe Basin Best Management Practice Inventory (LSRCA, 2014) looked at barriers to fish movement, which included dams, perched culverts, weirs, and other barriers. The BMP Opportunities Inventory covered all of the watercourses on Georgina Island but did not assess Fox or Snake Island as they do not have any known tributaries.

The BMP Opportunities Inventory has identified two barriers to fish movement in the subwatershed - both perched culverts located on Georgina Island (Figure 4-11). Given the likelihood that the tributaries on the island are used as spawning grounds for some of the lake's fish species, the mitigation of these barriers should be a priority.

Figure 4-11: An example of a perched culvert on Georgina Island

Figure 4-12: Barriers to fish movement on Georgina Island

4.3.4 Shoreline hardening

In the past it has been common practice to harden or armour stream banks and shorelines as a way to prevent erosion and increase 'developable' area. While we now know that this practice is harmful to the environment and can cause more issues than it resolves, there are several areas in the subwatershed where these practices have been utilized.

The armouring of shorelines can have the following negative effects:

- Alteration or destruction of critical shoreline and littoral habitat for fish;
- Removal of riparian buffer, which decreases the stormwater filtering capacity of the shoreline and may allow for invasive plant species to thrive;
- Interruption of natural shoreline processes; and,
- Increased erosion at the base of the hardening structure, and erosion around failing or un-maintained structures.

There were 233 instances of hardened sections of shoreline or stream banks identified on Georgina, Fox and Snake Islands through the BMP Opportunities Inventory. Of these, 38 were in a failed condition. On the mainland, there were four sites with hardened channels; all of these were considered to be failing. An example of shoreline hardening is depicted in 4-13 below, and the locations of shoreline or stream bank hardening are depicted in Figure 4-14.

Figure 4-13: An example of shoreline hardening on Georgina Island

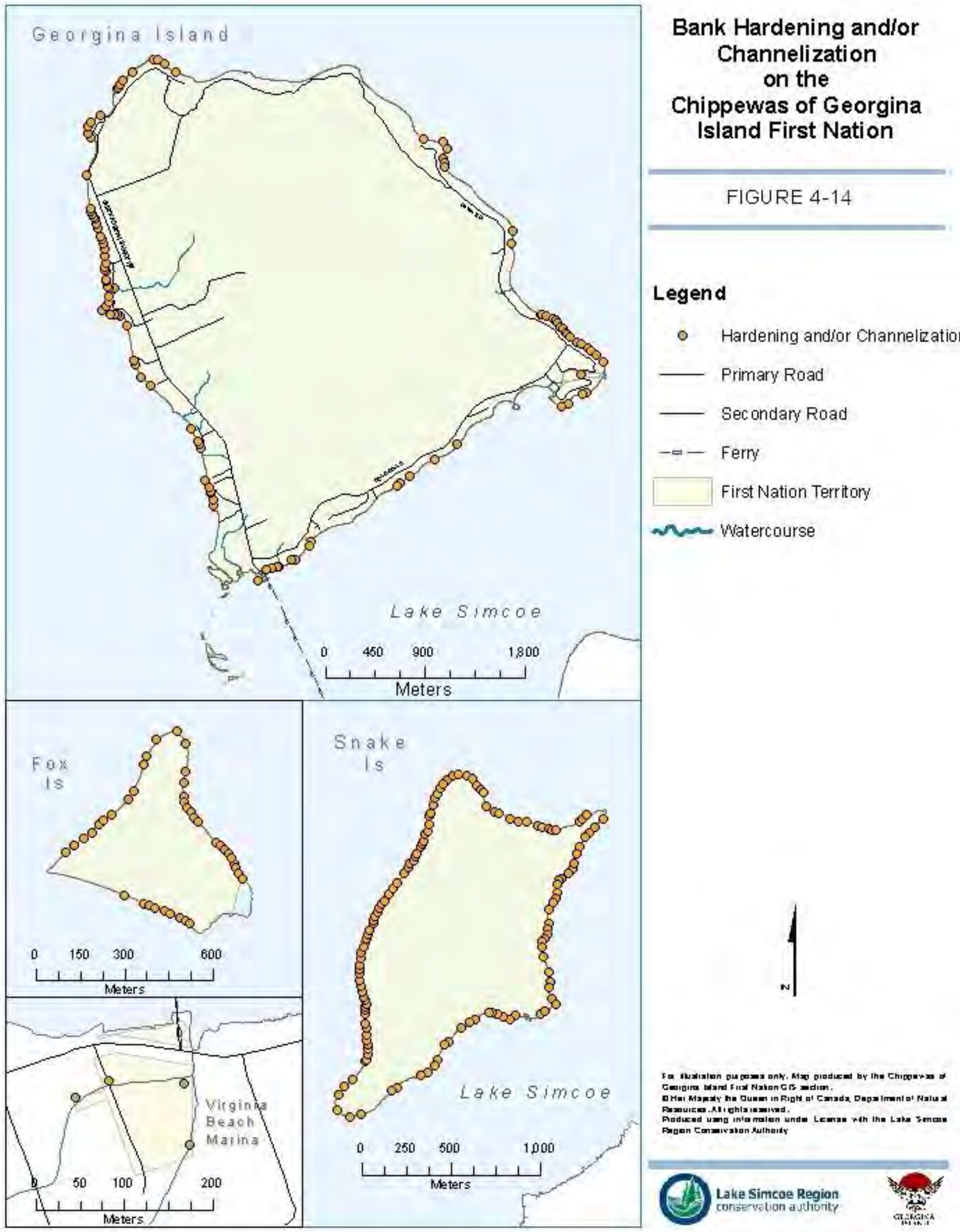


Figure 4-14: Shoreline hardening in the Fox, Snake and Georgina Islands subwatershed

4.3.5 Stormwater runoff from lawns and impervious surfaces

Stormwater runoff occurs as rain or melting snow washes off dirt and debris, minor spills, landscaping chemicals and fertilizers off streets, driveways and lawns, which flow directly into receiving waterbodies. In the past it was common practice to route stormwater directly to streams, rivers, or lakes in the most efficient manner possible, primarily through ditches. This practice typically has negative impacts on the receiving waterbody since the stormwater is not treated prior to its release. As the amount of impervious area and manicured lawns increases, the natural water balance is disrupted. Evapotranspiration is decreased as there is less natural vegetation and the permeable soil surface is hardened or paved over; infiltration to groundwater is significantly reduced; and thus the runoff characteristics change. This results in increases in the frequency and magnitude of runoff events, a decrease in baseflow, and an increase in flow velocities and energy. These changes further affect the form of the morphology of streams, including channel widening, undercutting, sedimentation, and channel braiding.

One of the most significant impacts of stormwater runoff though, is to water quality (discussed in more depth in **Chapter 3 – Water Quality**). Problems with degraded water quality directly affect the aquatic ecosystem. This occurs as pollutants are washed off of streets, driveways, rooftops and lawns into ditches which discharge to watercourses and to the lake. Generally, concentrations of pollutants such as bacteria (e.g. *Escherichia coli*, faecal coliform, *Pseudomonas aeruginosa,* and faecal streptococci), nutrients (e.g. phosphorus, nitrogen), phenolics, metals, and organic compounds are higher in stormwater runoff. Other associated impacts include increased water temperature and the collection of trash and debris. There were

All of these changes can cause considerable stress to aquatic biota, and can cause a shift from a community containing more sensitive species to one containing species more tolerant of degraded conditions.

In the study area, there were a number of sites with runoff, both from lawns and impervious surfaces (Figure 4-15). On the mainland, there were three sites with runoff from impervious surfaces, and two from manicured lawns. On the islands, Georgina had 41 sites with runoff from impervious surfaces and 153 with runoff from manicured lawns; on Snake Island there was one site with runoff from impervious surfaces, and 102 sites with runoff from manicured lawns; and finally, Fox Island had 26 sites with runoff from manicured lawns (Figure 4-16).

Figure 4-15: Examples of runoff from impervious surfaces (top) and lawns (bottom)

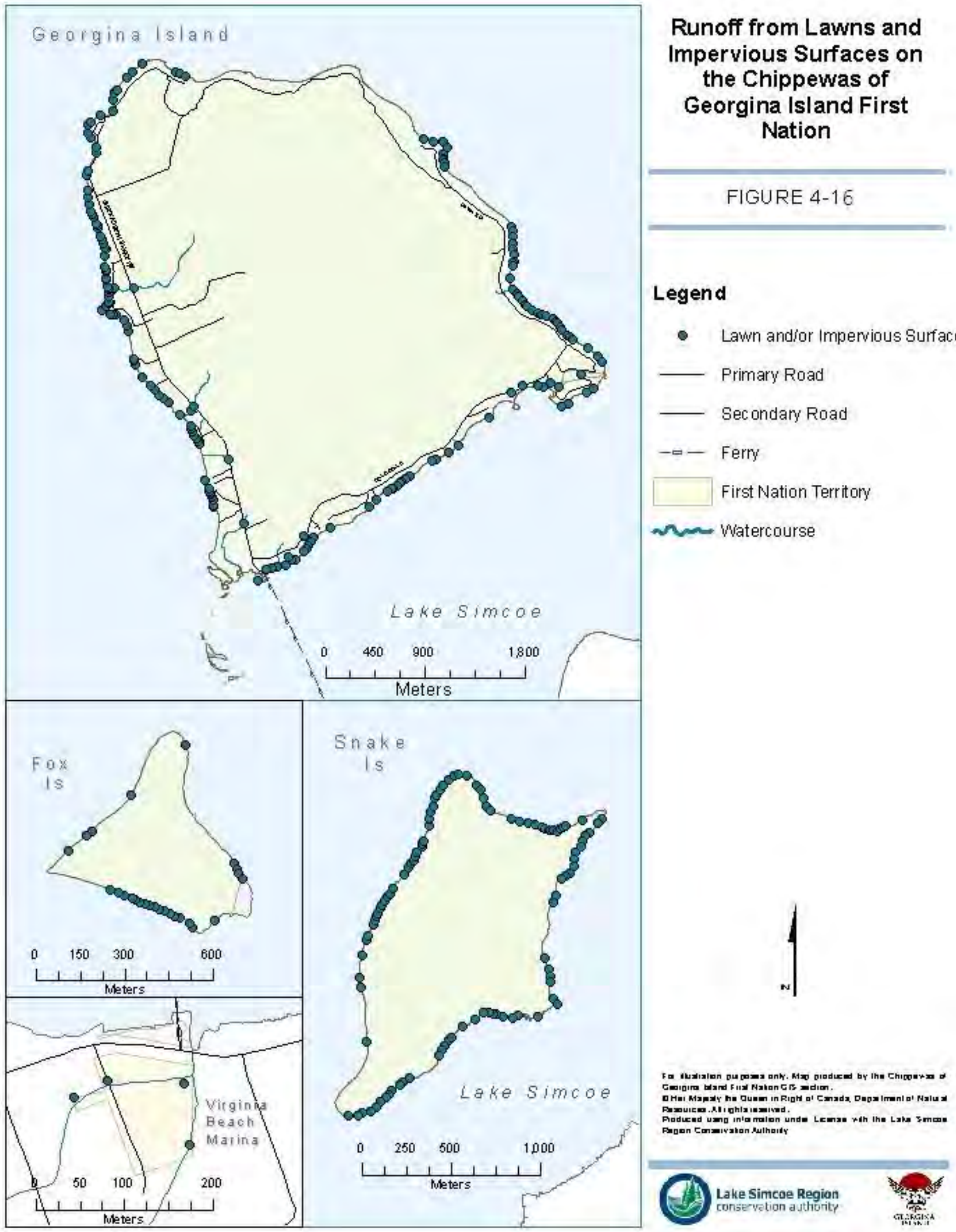
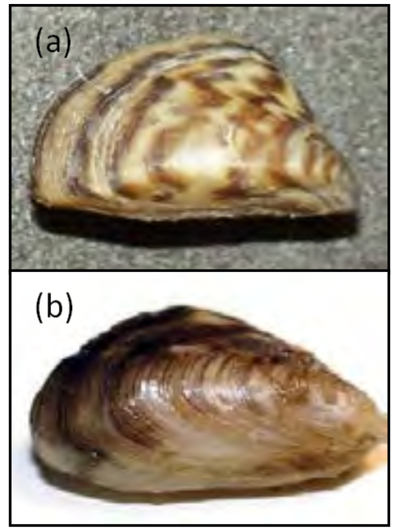


Figure 4-16: Runoff from lawns and impervious surfaces

4.3.6 Invasive species



Two invasive mussel species in Lake Simcoe: (a) zebra mussel; (b) quagga mussel.

The traits possessed by non-native invasive species, including aggressive feeding, rapid growth, prolific reproduction, and the ability to tolerate and adapt to a wide range of habitat conditions enable them to outcompete native species for food, water, sunlight, nutrients, and space. This may result in the eventual reduction in the number and abundance of native species. The replacement of native species with invasive species affects the balance of the ecosystem, as species that relied on the native species for food, shelter and other functions now either have to move to another area with these species, or must utilize another source that is perhaps less desirable. This cycle reverberates throughout the ecosystem, and can be exacerbated by the introduction of additional invasive species. Ecosystems that are already under stress are particularly vulnerable to invasion by non-native species, as the existing ecosystem is not robust enough to maintain viable populations of native species as the invasive species become established. The process may happen more quickly in already disturbed systems than it would in a healthy community.

As of 2014, the only invasive fish species found in the Georgina, Fox, and Snake Islands subwatershed was the round goby (*Neogobius melanostomus*). Round gobies made up the majority (75%) of fish identified in the 2014 nearshore small fish biodiversity study. Round gobies have a number of characteristics that make them detrimental to areas they are introduced to: they feed aggressively on insects, mussels, small fish and fish eggs; they prey on and compete with native fish and mussels, including some species at risk; and they are prolific breeders, so their numbers can quickly shift the balance from native species.

The only invasive benthic invertebrate species that has been caught is the rusty crayfish (*Orconectes rusticus*), a species native to the Ohio, Kentucky, and Tennessee regions. It is thought to have been introduced in the 1960s by non-resident fishermen who used it as bait. Rusty crayfish have a number of characteristics that are cause for concern: they feed heavily on aquatic plants and other benthic invertebrates, thus disturbing the dynamics of the ecosystem; they are competition for native crayfish as well as juvenile fish; they aggressively chase native species from the best daytime hiding spots, leaving the native crayfish more vulnerable to predation; and they are also more aggressive when under attack by fish and are thus less likely to be preyed upon. In addition, they are able to mate with native species of crayfish, a process that may hasten the local extinction of the native species.

There have also been a number of invasive species identified in the nearshore areas of Lake Simcoe around Georgina, Fox, and Snake Islands, that can impact the littoral environments and the tributaries in the subwatershed. These include:

- Eurasion watermilfoil (*Myriophyllum spicatum*);
- Curly-leaf pondweed (*Potomogeton crispus*);

- Zebra mussel (*Dreissena polymorpha*); and,
- Quagga mussel (*Dreissena rostriformis bugensis*).

Additionally, several other invasive species have been found in other areas of Lake Simcoe, which have the potential to affect the Georgina, Fox, and Snake Islands subwatershed include:

- Common carp (*Cyprinus carpio*);
- Rainbow smelt (*Osmerus mordax*); and,
- Spiny waterflea (*Bythotrephes longimanus*).

The LSPP includes a number of polices (7.1-SA to 7.10SA) to prevent the introduction of invasive species into the Lake Simcoe watershed. Of most importance is Policy 7.4-SA that requires that a "watch list" be developed and that response plans for those species on the list be prepared. These response plans will detail the actions that should be taken if the species are detected within the watershed. The following organisms are on the aquatic watch list:

- Fanwort (*Cabomba caroliniana):* A submersed freshwater perennial plant that is extremely persistent and competitive. Under suitable environmental conditions, it can form dense stands, crowding out previously well-established plants.
- European water chestnut *(Trapa natans):* Native to Europe, Asia, and Africa, *T. natans* is an invasive aquatic plant that can form dense mats of floating vegetation.
- Water soldier (*Stratiotes aloides):* An aquatic plant commonly sold in the aquarium and water garden industry. The plant is native to Europe and Central Asia, but has been identified in the Trent Severn Waterway near the hamlet of Trent River. Water soldier forms dense large masses of plants which crowd other aquatic plants.
- Asian carp: The term "Asian carp" refers to four invasive species (bighead, silver, grass, and black carp) that were brought to North America in the 1960s and 70s. Since then they have migrated north through U.S. waterways towards the Great Lakes, replacing native species in their path.
- Viral hemorrhagic septicaemia: A deadly infectious fish disease caused by the viral hemorrhagic septicemia virus. The virus can be spread from fish to fish through water transfer, as well as through contaminated eggs and bait fish from infected waters.

Figure 4-17: Invasive plant species on aquatic 'watch list': (A) Fanwort, (B) European water chestnut, and (C) Water soldier. (Photo Credits: Ontario's Invading Species Program)

Round Goby (*Neogobius melanostomus*)

The round goby (*Neogobius melanostomus*) is among the species currently of greatest concern in the Lake Simcoe watershed. Round gobies are native to Europe and were released into Canadian waters via ballast from international ships. They are an aggressive and fertile sculpin-like species that can out-compete native species for space and food. The round goby was first discovered in the Pefferlaw River in 2004 by an astute angler, and their presence was confirmed in June 2005 by the LSRCA and OMNR. In October 2005, efforts were made to eradicate the gobies by application of the pesticide Rotenone by licensed applicators and dead fish were removed from the system.

Round goby
Photo Credit: Gary Blight

4.3.7 Climate Change

Recent work from an MOECC Vulnerability Report for Lake Simcoe watershed wetlands, streams and rivers (Chu, 2011) suggests that climate change over the next 90 years will reduce suitable thermal habitat for lake-dwelling, cold-water species such as lake trout by as much as 26%, and 89% of the wetlands within the watershed will be vulnerable to drying and shrinkage. This prediction essentially threatens most wetlands on Georgina, Fox and Snake Islands. The report also estimates that stream temperatures will increase by 1.3°C by 2100, which may alter the temperature regime within Georgina Island streams and affect the physiology, behaviour and distribution of fish and benthic invertebrates in these aquatic systems.

This study highlights the importance of protecting and building more resilience to respond to climate change through activities such as shoreline and instream rehabilitation, barrier removal, planting of riparian vegetation, the use of natural subratates for streambank and shoreline hardening, water quality protection, and wetland protection. Long-term monitoring will be needed to assess the impacts of climate change to aquatic communities, where the key shifts are taking place and how they might be mitigated.

Climate change is also anticipated to have effects on the processes in Lake Simcoe itself. The most obvious impact, which is already being observed and is expected to continue in the coming years, is that the lake is freezing later in the year and thawing earlier. This has obvious impacts on the ice road, as well as activities such as ice fishing and snowmobiling. Less obvious, but related to the longer ice-free period, is that the lake is stratifying earlier in the spring (approximately 13 days earlier in the main basin of the lake), due to the earlier melt, and is remaining stratified later into the year (fall turnover is occurring an average of 18 days later in the main basin) (Stainsby *et al.*, 2011). This longer period of stratification can have significant impacts on the lake ecology, resulting in increasing depletion of oxygen in the hypolimnion, or bottom layer of water, which may create “dead zones” with extremely low oxygen levels in the deepest parts of the lake. Low oxygen, or anoxic, conditions may cause the release of nutrients (including phosphorus) and other contaminants from the sediments; the impacts of this could include further growth of plants and algae, decreases in fish populations, and can have impacts on drinking water (Stainsby *et al.*, 2011).

An ongoing study being undertaken by the Ontario Centre for Climate Impacts and Adaptation Resources (OCCIAR) and the Georgina Island First Nation (GIFN) included a survey of band members, consisting of a series of questions around what changes they felt have occurred on the islands due to climate change. While there was a wide range of questions and responses to them, there were several related to shorelines and aquatic habitat. These included:

- A decline in water quality, including increased nutrients (phosphorus); more algal and plant growth, as well as a change in the species of plants found; an odour to the water; an increase in zebra and quagga mussels
- An increase in the plants and algae growing around the island are causing impacts, including clogging boat motors, which impacts their ability to undertake activities such as fishing
- Fluctuating water levels – a rise in water levels was noted, as well as increased fluctuations
- The disappearance of wild rice
- A decrease in flow/disappearance of creeks was noted – some attributed this to road development
- A number of changes in the lake’s fish were also noted. These included changes in the flesh of the fish (softer); a decrease in carp in the 8-10 years prior to the survey; a decrease in the trout population, and a decrease in the size of trout being caught; a drop in the whitefish population, with stocked fish being bigger and behaving differently than resident fish; a decrease/loss of smelt; changes in where fish, particularly perch and bass, are being found
- Changes in the timing and location of fish spawning were also noted
- Concerns around the proliferation of double crested cormorants: their droppings are killing trees and polluting the water, the amount of fish that they consume, causing

changes in movement of some fish (e.g. perch and bass avoiding the shallow areas they would normally inhabit to avoid predation)

- Changes in winter and spring precipitation, including a decrease in the amount of water in spring runoff (due to a decrease in snow cover in winter), a faster spring runoff
- The length of time that the lake is frozen has decreased, as has the quality of the ice. In general, it is freezing later and melting earlier, is thinner than in the past, and there are more pressure cracks. This ice road is noted to deteriorate faster now than in the past, making it difficult for residents to travel to and from the island.
- More damage is being reported during the spring thaw – more spring flooding and an increase in the severity of the pile-up of ice along the shore have both resulted in increasing incidents of property damage
- An increasing number of dead fish have been noted along the shoreline, and some residents no longer eat the fish from the lake, in spite of it being one of their traditional food sources

Key Points – Factors Impacting Aquatic Natural Heritage – stressors:

- There are several stressors to the aquatic natural heritage systems in the Georgina, Fox, and Snake Islands subwatershed, the cumulative impacts of which can be seen in the and the poor tributary habitat conditions and water quality as indicated by the benthic invertebrate data and the absence of fish in some of the watercourses.
- Some of the most significant stressors include physical changes such as shoreline development and hardening, the removal of riparian vegetation, and barriers such as perched culverts.
- Habitat quality and quantity are also impacted by changes in flow regime resulting from land use changes, stream and shoreline alterations, and uncontrolled stormwater runoff. Increased flow degrades habitat through processes such as bank erosion, while decreased flow can lead to a temporary or permanent reduction in the amount of aquatic habitat present. One of the four streams on Georgina Island is dry for more than two consecutive months of the year, the IBI for all streams ranges from fairly poor to very poor.
- Zebra mussels, quagga mussels, Eurasian watermilfoil, curly-leaf pondweed and round gobies have invaded the lake nearshore habitat of the Georgina, Fox and Snake Islands subwatershed. In the tributaries of the subwatershed, there are populations of rusty crayfish. If populations of these invasive species increase, it is likely they will negatively affect native communities by occupying and/or destroying the habitat of native species and by out-competing them for resources.
- The introduction of zebra and quagga mussels and excess nutrient runoff have contributed to changes in the aquatic plant communities in the lake nearshore; some of the highest plant biomass in Lake Simcoe is found in the nearshore off of Georgina and Snake Islands.
- The emerging threat of climate change will interact with all of these threats, creating additional long-term stresses on the aquatic systems. Although research in this area is still emerging, initial predictions suggest that over the next 90 years stream temperatures will increase by 1.3°C above current conditions and 89% of the wetlands in the Lake Simcoe watershed will be vulnerable to drying and shrinkage. Further, nearshore fisheries may be affected by the increasing water temperature of Lake Simcoe.

4.4 Current Management Framework

The Georgina Island First Nation has undertaken numerous studies and has put policies in place to help improve shoreline and aquatic health within the study area, and in Lake Simcoe. These activities, and their potential benefits, are highlighted below:

- Conducting a habitat assessment on Fox and Snake Islands, in partnership with the Anishinabek/Ontario Fisheries Resource Centre. This study helps to identify stresses on nearshore habitat, and to better understand the ecosystem, which can help guide management actions into the future. This could include identifying areas for protection and/or rehabilitation
- Again in partnership with the Anishinabek/Ontario Fisheries Resource Centre, completing a nearshore small fish biodiversity assessment around all three islands (in 2014, to build upon previous studies completed in 1996 and 2008), in order to examine changes in fish biodiversity over time. Understanding the changes in the fish community can help to identify some of the stressors on it, and can also help to guide management actions.
- Undertaking the Traditional Ecological Knowledge/Climate Change study, in partnership with the Ontario Centre for Climate Impacts and Adaptation Resources. This study drew upon the extensive knowledge of the island's residents to identify changes that have occurred over time. This 'on-the-ground' knowledge and identification of changes and issues, has led to the identification of a number of management actions.

4.5 Management Gaps and Recommendations

4.5.1 Stewardship implementation

Stewardship programs play an important role in meeting the goals and objectives of the subwatershed plans. However, in order to ensure that they are both effective and efficient, stewardship projects should be selected in the context of the priority needs of the system, with those that will have the greatest benefit to watershed health given highest priority.

Recommendation 4-1 - That traditional ceremonies be implemented as a community celebration as each season changes to the next in order to give thanks to the creator for all that She provides for us.

Recommendation 4-2 - That the Georgina Island First Nation develop a medicinal plant booklet that the community members can use as a reference in determining which plants to plant during restoration projects, as well as their traditional uses, in order to build a cultural connection.

Recommendation 4-3 - That the Georgina Island First Nation develop maps to identify natural water flow and connectivity that community members could use to determine locations for development purposes as well as stewardship efforts. Ensuring that those waterways are available for the movement that is necessary for species survival and sustainability.

Recommendation 4-4 - That the Georgina Island First Nation develop an aquatic species booklet to identify existing and past species as well as invasive species, including the BMPs for removal and control of invasive species.

Recommendation 4-5 - That the Georgina Island First Nation develop a traditional guide in regards to natural products which can be used to replace chemical products currently used for weed control, cleaning products etc.

Recommendation 4-6 - Create and/or publicize link to a website that provides information and contact information on available funding programs for stewardship works, and ensure that this site is kept current.

Recommendation 4-7 – That prioritized restoration areas identified through the recently developed tool be integrated into a stewardship plan that ensures prioritized restoration opportunities are undertaken as soon as feasible. If needed the parameters for the tool should be refined to reflect the unique nature of the study area, and specific priorities for the study area should be identified.

4.5.2 Water Quality and Water Temperature

Based on the fairly poor to very poor benthic invertebrate community scores, water quality on Georgina Island is considered to be degraded in most areas. Similarly, the assessment of the fish Index of Biotic Integrity and water temperature indicate that the thermal regime of the watercourses is being affected by factors such as loss of riparian cover and barriers. Recommendations specifically addressing water quality are presented in **Chapter 3 – Water Quality**.

Recommendation 4-8 – Implement traditional ceremonies to honour the water and give thanks to the creator and Mother earth and to bring awareness to the community members and others of the importance of water.

Recommendation 4-9 – In conjunction with the LSRCA, utilize programs and train public work staff as well as staff hired for the mainland access points in the Smart about salt program.

Recommendation 4-10 – That measures be taken to mitigate increases in water temperature and barriers to fish and benthic invertebrate movement, including planting riparian vegetation and removing perched culverts.

4.5.3 Invasive Species

Invasive species can have significant impacts on native ecosystems, in a number of ways, as described in the above sections. To limit these impacts, it is extremely important to limit their introduction and spread, with education being among the most important tools.

Recommendation 4-11 - Identify invasive species within the First Nation territories and develop a Management and removal plan.

Recommendation 4-12 - Identify non-native that have similar characteristics and uses as replacement for native species that may not survive with the changing climate.

Recommendation 4-13 - That the Georgina Island First Nation put a protocol and/ or policy in place for checking and cleaning vehicles on the ferry boat and ensue that they are being implemented. Put protocols and/or policies in place for Snake and Fox Islands as well.

Recommendation 4-14 - That the Georgina Island First Nation post information at marinas, on the ferry, in the band office, and in other public areas about invasive species of concern, and what individuals can do to prevent their introduction and spread in the Lake Simcoe watershed.

4.5.4 Monitoring and Assessment

Long-term monitoring is required to identify changes and trends occurring in the aquatic community. These on-going annual surveys of fish, invertebrates, stream temperatures, water quality, baseflow and channel morphology are also intended to provide information that will direct future rehabilitation efforts. Additional environmental characteristics such as fish community surveys, field confirmation of groundwater inputs, algae/diatom sampling, lake/tributary interface assessment, as well as an expanded water quality and quantity network will need to be considered to provide the information to look at the system in an integrated and holistic way. A renewed need for regular reporting of the results and a systematic re-evaluation of the program is also required.

Recommendation 4-15 – That Traditional Ecological Knowledge be collected 1-4 times per year from the community members through a survey or summer student or other program to collect the qualitative information on the health of the systems and species.

Recommendation 4-16 – Develop a protocol to direct and ensure that the First Nations administration departments have up to date information in a centralized location.

Recommendation 4-17 – That LSRCA, with support from the Chippewas of Georgina Island First Nation, aim for improved spatial and temporal resolution in annual monitoring of aquatic habitat, including water quality, fish, and benthic indicators.

Recommendation 4-18 – That LSRCA and its partners work to create a centralized location for reports and resources pertaining to Lake Simcoe and its watershed such that information can be accessed by all interested stakeholders.

Recommendation 4-19 - Initiate research into factors affecting aquatic natural heritage features, including the impacts of interior wetlands and water softeners.

4.5.5 Climate Change

The adaptation plan, developed through the Georgina Island First Nation and Ontario Centre for Climate Impacts and Adaptation Resources three-year climate change study, identified a number of recommended adaptation actions to address and/or mitigate some of the changes that have been observed on the island by its residents and are thought to be due to climate change. They have been placed into four categories: Engage People, Reduce Threats, Improve

Knowledge, and Enhance Adaptive Capacity. Relevant adaptations are included below under these four categories.

Engage People

Recommendation 4-20 - That GIFN develop communication plans to notify community members of

- Extreme weather events
- Ice conditions (ice road, ice road landings, presence of pressure cracks, and overall ice conditions for recreation purposes)
- Dry conditions (including fire bans and precautions)
- Wind conditions

This could include such measures as signage at beaches and specified areas around the island, a communications board at the mainland access points, the development of an e-mail distribution list, and the posting and/or distribution of Environment Canada's automated weather notices, among other actions.

Recommendation 4-21 - Create a full time position for the regular monitoring and update of information on the Community web page, which would include opportunities for community members - as well as cottage residents - to access information and funding opportunities, and participate in stewardship projects.

Reduce Threats

Recommendation 4-22 - That GIFN and its partners undertake projects to establish healthy buffer zones around the lake and tributaries to reduce the amount of contaminants and nutrients entering the lake and tributaries, including during and after extreme rainfall events.

Recommendation 4-23 - That the GIFN develop a shoreline protection program or initiatives. Possible mechanisms for this program might include:

- The development and distribution of educational materials for landowners, such as fact sheets and public workshops/presentations
- The requirement, through permits required for shoreline works, to stipulate that a natural buffer be left along the shoreline, or that the shoreline should be managed in such a way that it enhances conditions for fish and wildlife, or that mimics its natural condition
- Discouraging shoreline hardening using materials such as concrete and armourstone, and giving preference to more natural shoreline stabilization solutions such as bioengineering and rock revetments (as referenced in http://www.ourlakesimcoe.com/documents/pdf/shorelinemanagement_landowner.pdf)

- Working with landowners to replace hardened shore walls with more natural features (http://www.ourlakesimcoe.com/documents/pdf/shorelinemanagement_landowner.pdf)
- Ensuring that docks are designed and built such that they do not negatively impact fish habitat (http://www.ourlakesimcoe.com/documents/pdf/shorelinemanagement_landowner.pdf)

Recommendation 4-24 - Develop ecosystem restoration, creation, or enhancement projects to restore and protect creeks and wetlands/swamps on the island (see section 5.5.1 above for more detail around stewardship recommendations

Recommendation 4-25 - That the GIFN develop and enforce bylaws to limit clearing of sites and maintain existing vegetative cover and buffer zones to the maximum extent practicable

Improve Knowledge

Recommendation 4-26 - That the GIFN, in partnership with LSRCA, develop a long-term monitoring program to monitor the change in water plants around Georgina Island with changing climate

Enhance Adaptive Capacity

Recommendation 4-27 - That the GIFN develop a program to educate the community on the importance of keeping drainage ways (e.g. creeks and culverts) clear of debris. This should be balanced with the need to ensure that any ecological function in these ditches is maintained (e.g. if drainage ways are dredged, ensure that any fish using the ditch for habitat and/or spawning will not be affected. This could include the identification of timing windows for these types of works). This could include printed brochures and/or fact sheets, and presentations and displays at community events

5 Terrestrial Natural Heritage

5.1 Introduction

Getsidjig have taught us that *Aki* is a sacred gift from *G'zhimnidoo* that provides for our continued way of life.

Through our customary knowledge and land stewardship traditions, we have maintained our relationship to *Aki* and *Nibi*.

When we refer to *Aki*, we mean not only what is on or above the earth – lakes, rivers, wetlands, grasslands, sky, but also what is under the ground – aquifers, minerals, medicinal roots, and miniscule creatures.

It is this relationship to *Aki* and *Nibi* which is at the heart of our culture and *Naadziwin*.

Caring for Aki and *Nibi* is not only a matter of physical survival for the Chippewas of Georgina Island First Nation but also one of cultural and spiritual continuity, reaffirming the sacred trust between us, *Aki*, *Mshkakimekwe* and Creation.

Terrestrial natural heritage features are extremely important components of subwatershed health, as they not only provide habitat for many of the species residing in the subwatershed, but also influence subwatershed hydrology and water quality. They are among the most important parts of the ecosystem, and are the most likely to be directly impacted by human activities.

A terrestrial natural heritage system is composed of natural cover (features), natural processes (functions), and the linkages between them. The matrix of rural, agricultural and natural areas within the Georgina, Fox and Snake Islands subwatershed's terrestrial system interacts with other hydrological and human systems, and serves as habitat for flora and fauna throughout the subwatershed. The system includes not only large tracts of natural features, but also the small features that can be found within rural and agricultural areas. Measuring the quantity, quality, and distribution of natural heritage features within the subwatershed can tell us a great deal about its health. Figure 5-1 details the distribution of natural features in the subwatershed.

Currently, natural heritage features account for 88% of the Georgina, Fox and Snake Islands subwatershed (including 22% wetland, 48% upland forest, and 9% grassland).

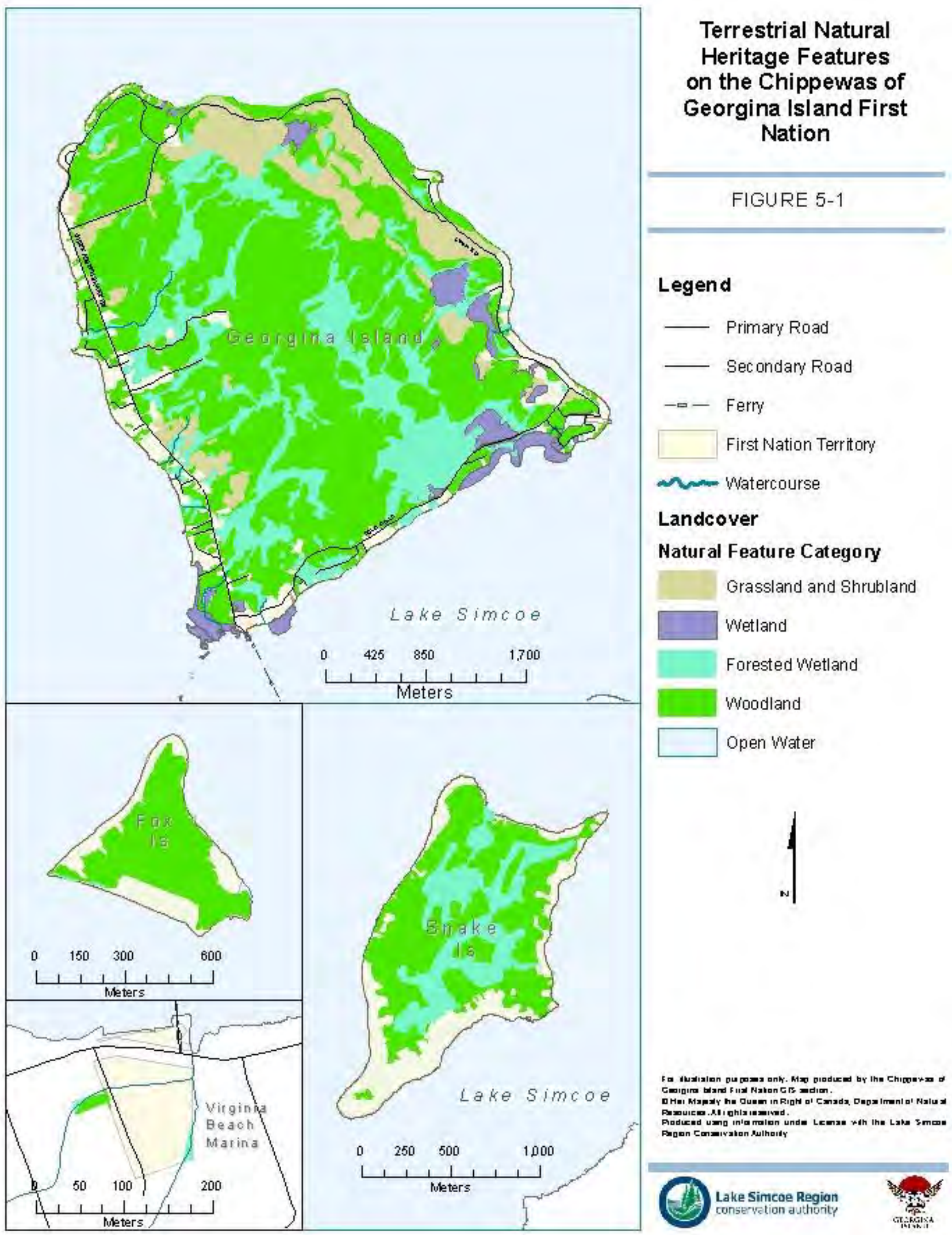


Figure 5-1 Terrestrial natural heritage features in the Georgina, Fox and Snake Islands subwatershed

5.2 Current Status

Terrestrial natural heritage features, as described by the Provincial Policy Statement, include woodlands, wetlands, valleylands, Areas of Natural and Scientific Interest, habitat for endangered species, and wildlife habitat. The Provincial Policy Statement provides direction for the protection of *significant* natural heritage features throughout the Province.

The Lake Simcoe Protection Plan (LSPP) provides further targets for the Lake Simcoe watershed:

- Ensure no further loss of natural shorelines on Lake Simcoe;
- Achieve a greater proportion of natural vegetative cover in large high quality patches;
- Achieve a minimum 40 percent high quality natural vegetative cover in the watershed;
- Achieve protection of wetlands;
- Achieve naturalized riparian areas on Lake Simcoe and along streams;
- Restore natural areas or features, and;
- Achieve increased ecological health based on the status of indicator species and maintenance of natural biodiversity

The current state of natural heritage features in the Georgina, Fox and Snake Islands subwatershed can be described, relative to these targets, where data permits.

At 88.8%, the total natural cover in the Georgina, Fox and Snake Islands subwatershed is above average with respect to other Lake Simcoe subwatersheds, with the majority of the subwatersheds having less natural cover. The subwatershed does exceed the target of 40% natural areas for the entire Lake Simcoe watershed set by the Lake Simcoe Protection Plan, although it has not yet been determined if all of these natural areas would be considered 'high quality' as is the goal of the LSPP. Other, less prevalent land uses include rural development, estate residential, as well as agricultural and aggregate extraction operations (Figure 2-3).

5.2.1 Woodlands

The *Natural Heritage Reference Manual* (OMNR, 2010) lists a variety of important functions associated with woodlands and Larson *et al*. (1999) summarize the importance of woodlots. These important functions can generally be described as follows:

- **Economic Services and Values:** oxygen production, carbon sequestration, climate moderation, water quality and quantity improvements, woodland products, economic activity associated with cultural values
- **Cultural/Social Values:** education, recreation, tourism, research, spiritual and aesthetic worth
- **Ecological Values:** diversity of species, structural heterogeneity, nutrient and energy cycling.
- **Hydrological Values:** interception of precipitation, reduction of intensity of rainfall runoff, slower release of melt water from snowpack, shade to water courses

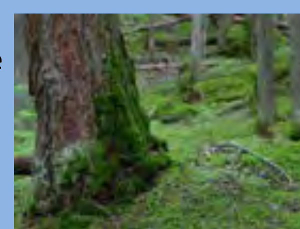
Woodlands include all treed communities, whether upland or wetland. The Ecological Land Classification (ELC) communities that were considered to represent woodlands are forest, swamp, plantation, and cultural woodland (the breakdown of these woodland types is displayed in Table 5-1 and Figure 5-2). Some woodlands in this section are also counted as wetlands later in the chapter (e.g. wooded swamp), as the two terms are not mutually exclusive.

The ecological function of woodlands tends to be influenced by factors relating to fragmentation (the splitting of larger woodlands into ever smaller pieces), patch size (the requirement of woodland pieces to be of a certain area for the maintenance of some functions), woodland quality (such as shape, interior habitat, age, composition, structure and the presence of invasive species), and total woodland cover (i.e., the woodland area within a jurisdiction or watershed).

Of these factors there is increasing scientific evidence to show that the total woodland cover of a landscape may exert the most important influence on biodiversity. Obviously, the loss of woodland cover results in a direct loss of habitat of that type. This reduction in habitat can result in proportionally smaller population sizes, and animals in habitat remnants may experience altered dispersal rates, decreased rates of survival, decreased productivity, altered foraging behaviours, and decreased mating opportunities (Fahrig, 2003). Research that has examined the independent effects of habitat loss and habitatfragmentation suggests that habitat loss has a greater effect than habitat fragmentation on the distribution and abundance of birds (Fahrig, 2002) and there is now substantive evidence that total woodland cover is a critical metric (e.g., Austen *et al.* 2001; Golet 2001; Fahrig 2002; Lindenmayer *et al.* 2002; Trzcinski *et al.* 1999; Friesen *et al.* 1998, 1999; Rosenburg *et al.* 1999; Radford *et al*. 2005).

Moss

There are many traditional uses for moss in the First Nation culture. Such uses included lining of cradle boards to comfortably carry infants and keep them warm, and it was also used as a diaper. Moss was also used as a natural compass as it typically only grows on the north side of a tree. Moss plays a very important role within the forest and it is like the coral reef of the ocean to the forest.



Prior to European settlement the dominant land cover type of Southern Ontario was woodland, and estimates of total cover were in the range of 80%. In 1978, woodland cover in York Region was estimated to be 18.5% (Larson *et al*., 1999). Woodland cover in the Georgina, Fox and Snake Islands subwatershed is 74% (Table 5-1); well above the average for the Region.

The Lake Simcoe Protection Plan sets a target of the retention of a minimum of 40% high quality natural vegetative cover in the entire Lake Simcoe watershed, which would include forest, native grassland, and non-forest wetland ecosystems. Clearly, this amount of natural cover cannot be achieved uniformly throughout the watershed, as development pressures are distributed unevenly throughout the islands and are concentrated on the shorelines. At 88% natural cover, the Georgina, Fox and Snake Islands subwatershed exceeds this target, although it is unknown what proportion of this 88 % is considered to be 'high quality', as this definition has yet to be finalized.

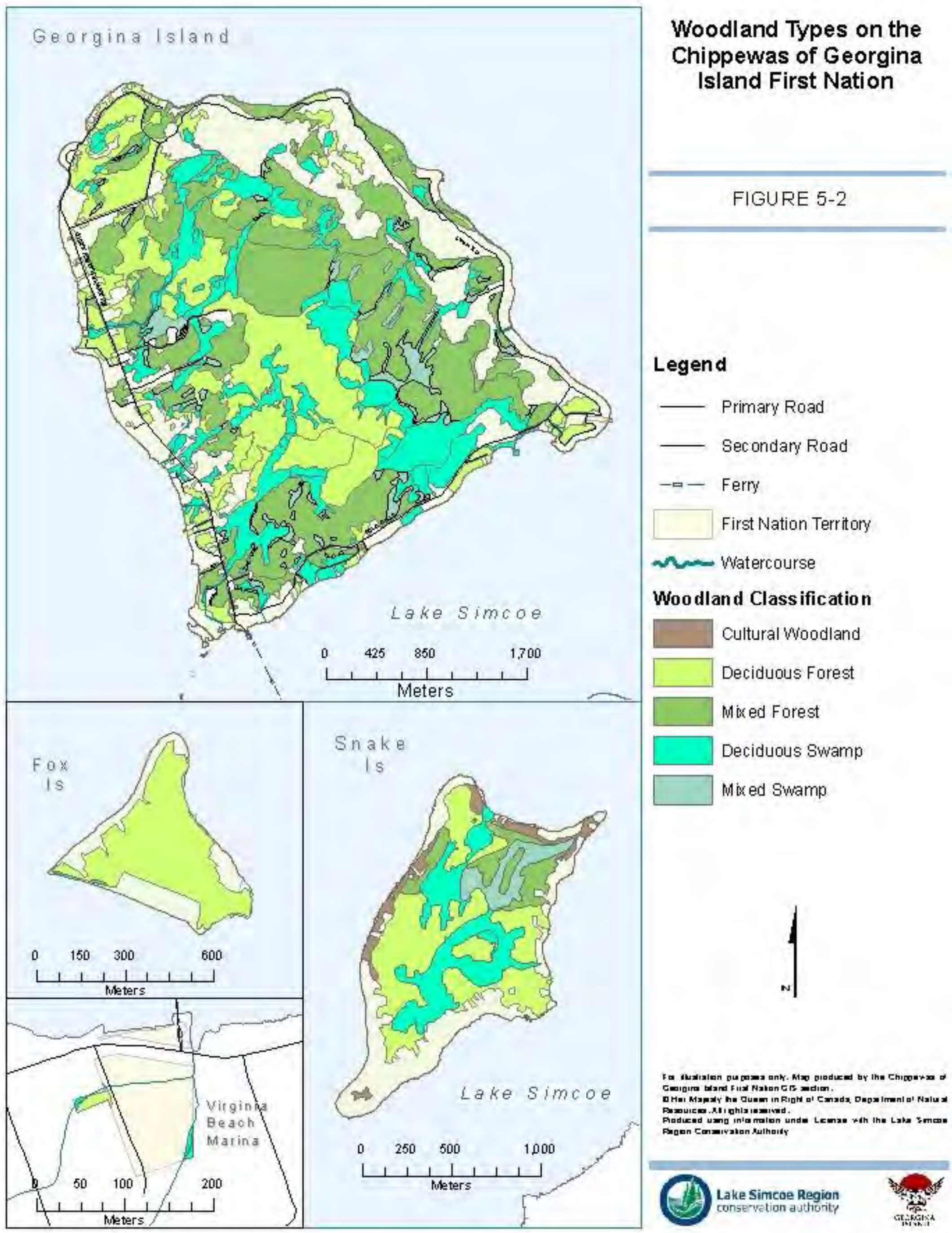


Figure 5-2: Woodland types on Georgina, Fox, and Snake Island

Table 5-1: Woodland cover types on Georgina, Fox, and Snake Islands

Woodland Type		Woodland Cover – Georgina Island		Woodland Cover – Fox Island		Woodland Cover – Snake Island		Woodland Cover - Mainland	
		Area (ha)	Area (%)	Area (ha)	Area (%)	Area (ha)	Area (%)	Area (ha)	Area (%)
Upland forest	Cultural Woodland (CUW)	0	0	0	0	7.4	5.5	0	0
	Deciduous Forest (FOD)	295.0	22.8	14.0	68.7	47.0	34.7	0.045	3.5
	Mixed Forest (FOM)	402.3	31.1	0	0	11.8	8.7	0	0
Swamp forest	Conifer Swamp (SWC)	0	0	0	0	0	0	0	0
	Deciduous Swamp (SWD)	223.2	17.3	0.1	0.6	26.4	19.5	0.03	2.4
	Mixed Swamp (SWM)	27.7	2.1	0	0	8.2	6.1	0	0
	Thicket Swamp (SWT)	18.7	1.4	0	0	0	0	0	0
Total upland forest		**697.3**	**54.0**	**14.0**	**68.7**	**66.2**	**48.8**	**0.045**	**3.5**
Total forest		**966.9**	**74.9**	**14.1**	**74.0**	**100.8**	**74.4**	**0.075**	**5.9**
Target (LSPP)[1]			**40**		**40**		**40**		**40**
Target (LSRCA IWMP)[2]			**25**		**25**		**25**		**25**

Note: Data for Georgina Island was obtained from the 2016 forest mapping (SILV-ECON, 2016) as well as the 2014 wetland evaluation (Adopt-A-Pond Wetland Conservation Programme, 2014). Data for Fox and Snake Islands were obtained by the LSRCA landcover data (2016).

The most common forest types on Georgina Island are mixed forests (defined as a natural community with greater than 60% canopy cover, where neither the deciduous nor the coniferous composition of the community is less than 25%.); deciduous forests (defined as a natural community with greater than 60% canopy cover and greater than 75% deciduous composition); and deciduous swamps (defined as a wetland community where tree cover is greater than 25%, and the deciduous tree content is greater than 75% of the canopy cover). Mixed forests are characterized by white cedar (*Thuja occidentalis*), sugar maple (*Acer saccharum*), yellow birch (*Betula alleghaniensis),* white ash (*Fraxinus americana*), and white birch (*Betula papyrifera*). Deciduous forest habitats are characterized by red maple (*Acer rubrum*), sugar maple, speckled alder (*Alnus rugosa*), yellow birch, black and green ash, bur oak, white cedar and American elm (*Alnus americana*) (MNRF 2015). Deciduous swamps are dominated by green ash (*Fraxinus pennsylvanica*), black ash (*Fraxinus nigra*), poplar (*Populus* spp.) and silver maple (*Acer saccharinum*), with some bur oak (*Quercus macrocarpa*) and black walnut (*Juglans nigra*).

[1] The Lake Simcoe Protection Plan sets a target of 40% high quality natural vegetative cover (which includes, but is not restricted to, woodlands) for the entire Lake Simcoe watershed

[2] LSRCA's Integrated Watershed Management Plan recommends a target of 25% woodland cover per subwatershed

Sugar Maple

The sugar maple was given to our people as a gift by the creator in a time of need. It is used as a natural cleanser when fasting, a natural sweetener among other purposes. There are many sugar maple stands within the First Nation which our members still tap and make such things as maple sugar and maple candy.

Relatively uncommon are and mixed swamps (defined as a wetland community where tree cover is greater than 25%, and where both deciduous and coniferous composition of the community is greater than 25%) and thicket swamps, which account for less than 4% of the total woodland on Georgina Island (Table 5-1). Mixed wood swamps are characterized by white cedar, white pine (*Pinus strobus*), balsam fir (*Abies balsamea*), white spruce (*Picea glauca*), eastern hemlock (*Tsuga canadensis*), willow (*Salix* spp.), poplar, and silver maple (Chippewas of Georgina Island, 1999).

Several invasive species have also been noted in the woodlands on Georgina Island. European buckthorn and enchanter's nightshade occur along the forest trails, particularly near the north and south ends of the island, and dog strangling vine has begun to spread in the northern forests. This is described in more detail in section 5.3.5.

On Fox Island, there are only two woodland types. Deciduous forests (defined as a natural community with greater than 60% canopy cover and greater than 75% deciduous composition) are the most common (68.7%), while deciduous swamps comprise only 0.6% of the forest cover. The deciduous forest stands on Fox Island are generally characterized by sugar maple, basswood (*Tilia americana*), American beech (*Fagus grandifolia*), red oak (*Quercus rubra*), American elm, and riverbank grape (*Vitis riparia*) (MNRF 2015). However, the forest in the middle of the island is dominated by mature red oaks, which is a relatively uncommon forest type in the Lake Simcoe watershed. Also present in these stands are some invasive species including climbing poison ivy (*Toxicodendron radicans*), dog strangling vine (*Vincetoxicum rossicum*), enchanter nightshade (*Circaea lutetiana*) and buckthorn (*Rhamnus cathartica*) (OMNRF 2015).

The most prevalent forest types on Snake Island are deciduous forests (47% of the forest cover), deciduous swamps (26% cover) and mixed wood forests (12%). Deciduous forest stands on this island are characterized by American beech, sugar maple, ironwood (*Ostrya virginiana*), red oak, white ash (*Fraxinus americana*), white birch (*Betula papyrifera*) and American elm (MNRF 2015). Deciduous swamps generally contain silver maple, basswood, balsam poplar, white ash, American elm, riverbank grape, American beech, largetooth aspen (*Populus grandidentata*) and black and white ash (MNRF 2015). The mixed forest stands are represented by white ash, basswood, ironwood, sugar maple, American beech and eastern hemlock (MNRF 2015). Apple trees were also observed in some forest stands within the southern portion of the island, which appears to be an abandoned apple orchard. Invasive species are relatively common in on Snake Island and include dog strangling vine, honeysuckle (Lonicera spp.), buckthorn and enchanter's nightshade.

Additionally, a small area (0.045 ha) of deciduous forest occurs along the western side of the mainland portion of the first nation.

Cedar Trees

Cedar is one of the four main traditional medicines used in the First Nation culture. Like many traditional medicines, it is used to purify the home. Cedar branches are also used in ceremonies as a form of protection. Another way in which cedar is used is in the bath and is very healing. It can also be made as a tea to help fight colds, flu and other sicknesses.

Structural diversity of habitat is a key driver of biodiversity. In woodlands, habitat niches can range from microhabitats such as the surfaces of fissured trunks, leaves, and rotting logs to macrohabitat features such as the horizontal layers within the woodland (e.g., supercanopy, canopy, subcanopy). In addition, woodlands are present in a wide variety of topographic settings and soil and moisture regimes. For all of these reasons it is not surprising that many woodland species are obligates (i.e., they are only found in woodlands), or that woodlands provide habitat for a wide range of flora and fauna. They form important building blocks of the natural heritage system.

The forest management plan completed by the Chippewas of Georgina Island in 1999 contained an inventory of six shrub and deadwood habitat features within the forests of Georgina Island. Snags (standing dead trees), woodpecker feeding sites, fallen logs, excavated-cavity trees, natural-cavity trees, escape trees and shrub cover were all observed in above-average abundance within numerous forest stands, suggesting a high structural diversity of the forests on Georgina Island.

Although the total extent of forest cover in a subwatershed is the primary driver for many forest-dependent ecological processes, some species are also sensitive to the size of remnant forest patches (Robbins *et al.,* 1989; Lee *et al.,* 2002), the amount of 'interior' forest habitat (Burke and Nol, 1998a; Burke and Nol, 2000), and the proximity or connectivity between remnant forest patches (Nupp and Swihart, 2000).

Beyond issues of habitat size however, is the issue of amount of interior habitat available. Many species and ecological functions have been shown to be influenced by forest edges, a symptom known as 'edge effect'. These effects can extend up to 20 m into the woodland for climatic factors such as light, temperature, moisture levels and wind speed (Burke and Nol, 1998b), up to 40 m for the prevalence of non-forest plant species (Matlack, 1994), and 100 m or greater for the rate of predation on nesting birds (Burke and Nol, 2000). Although this research has typically been interpreted such that 100 m becomes the rule of thumb for differentiating between 'edge' and 'interior' forest habitats, more recent research (Falk *et al.,* 2010) suggests that the impacts of edge effect on predation rates and nest survival in forest-dwelling songbirds may extend over 300 m into woodlots.

The study area contains a wide range of forest patch sizes, ranging from less than 0.5 hectares to over 885 hectares. Approximately 25% of the subwatershed's forest patches are less than 0.5 hectares in size, although these patches account for less than 1% of the subwatershed's forest area. Being islands, there are far fewer large forest patches, yet these account for a large proportion of the subwatershed's forest area. The largest forest patch accounts for almost 90% of the forest cover and the rest is found in patches 20 ha or smaller.

As can be seen in Figure 5-3, there are several interior forest patches in the Georgina, Fox and Snake Islands subwatershed. Over a third of these are less than 0.5 ha in size, but there are also some larger patches, with one patch close to 50 ha in size and one over 500 ha in size. These two largest patches account for over 90% of the interior forest in the subwatershed, and likely support a diverse array of sensitive forest species. In addition, "deep forest core" areas, which are those areas lying deeper than 200 metres from the forest edge, were analyzed for the subwatershed. Three such areas were identified, ranging in size from 0.9 ha to over 400 ha. These deep core patches account for close to 40% of the forest cover in the subwatershed and could potentially support some of the most sensitive forest dwelling species, with few edge effects being felt.

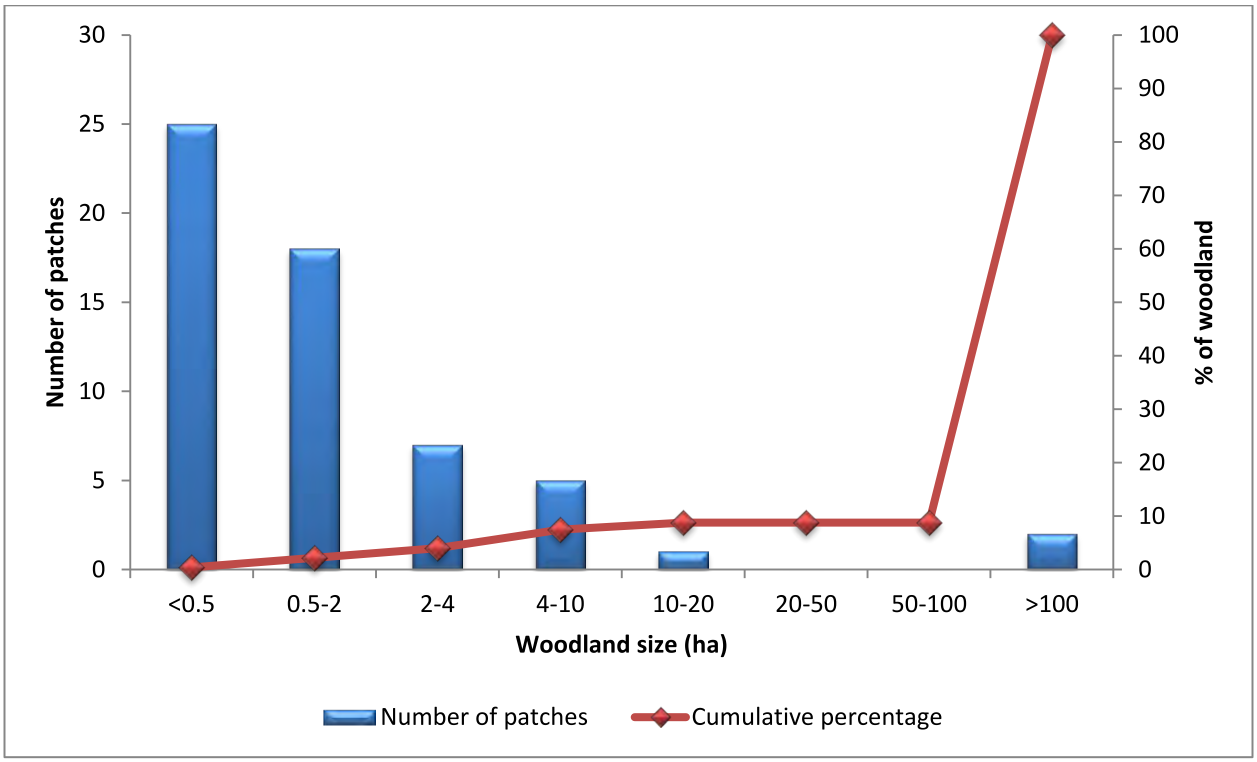


Figure 5-3: Woodland patch size distribution in the Georgina, Fox and Snake Islands subwatershed

The core forests on Georgina, Fox and Snake Islands also provide important stopover habitat for migratory birds. As the northernmost point of land on the southern shore of Lake Simcoe, these islands provide a strategic location for northward migrating birds to rest of restore fat deposits before continuing their migration across the lake (EPDI 2015). As such, it is important to maintain the quality and function of these forest habitats to provide sufficient food and shelter for migrating birds.

Birch Tree

The birch tree is one of the strongest trees in the forest. It has many culturally significant uses, including the construction of canoes, wigwams and baskets that were used to boil liquids as well as a variety of different crafts.

5.2.2 Wetlands

The Provincial Policy Statement defines wetlands as lands that are seasonally or permanently covered by shallow water, as well as lands where the water table is close to or at the surface. In either case the presence of abundant water has caused the formation of hydric soils and has favoured the dominance of either hydrophytic or water tolerant plants. The four major types of wetlands are swamps, marshes, bogs, and fens. Georgina, Fox, and Snake Islands contain two of these wetland types – swamps and marshes.

Wetlands provide numerous functions for an ecosystem. These include (OMNR, 2010):

- **Natural water filtration:** by removing contaminants, suspended particles, and excessive nutrients, wetlands improve water quality and renew water supplies
- **Habitat:** wetlands provide nesting, feeding and staging ground for several species of waterfowl and other wildlife including reptiles and amphibians, as well as spawning habitat for fish
- **Natural shoreline protection:** these vegetated areas protect shorelines from erosion
- **Natural flood control:** by providing a reservoir, wetlands help to control and reduce flooding through water storage and retention
- **Contribution to natural cycles:** wetlands provide a source of oxygen and water vapour, thus playing a role in the natural atmospheric and climatic cycles
- **Opportunities for recreation:** these include hiking, bird watching, fishing, and hunting

In its 'How Much Habitat Is Enough?' guidelines (2013), Environment Canada recommends that, at a minimum, the greater of 10% of a watershed, or 40% of the historic wetland coverage, should be protected and restored. Subwatersheds that meet these characteristics experience greatly reduced flood frequencies, and more stable base flow. The additional benefits of wetland cover, listed above, are also maintained. In addition, improvements to water quality have been found when wetlands occupy more than 18% of a given watershed, and amphibian and fish communities are more persistent when wetlands occupy more than 30% and 50% of the total watershed area respectively (Detenbeck *et al.,* 1993; Gibbs, 1998; Brazner *et al.,* 2004). Although the Lake Simcoe Protection Plan does not set a quantitative target for wetland cover within the watershed, it identifies the "protection of wetlands" as a target, implying no further loss of wetland beyond that in existence when the LSPP came into force.

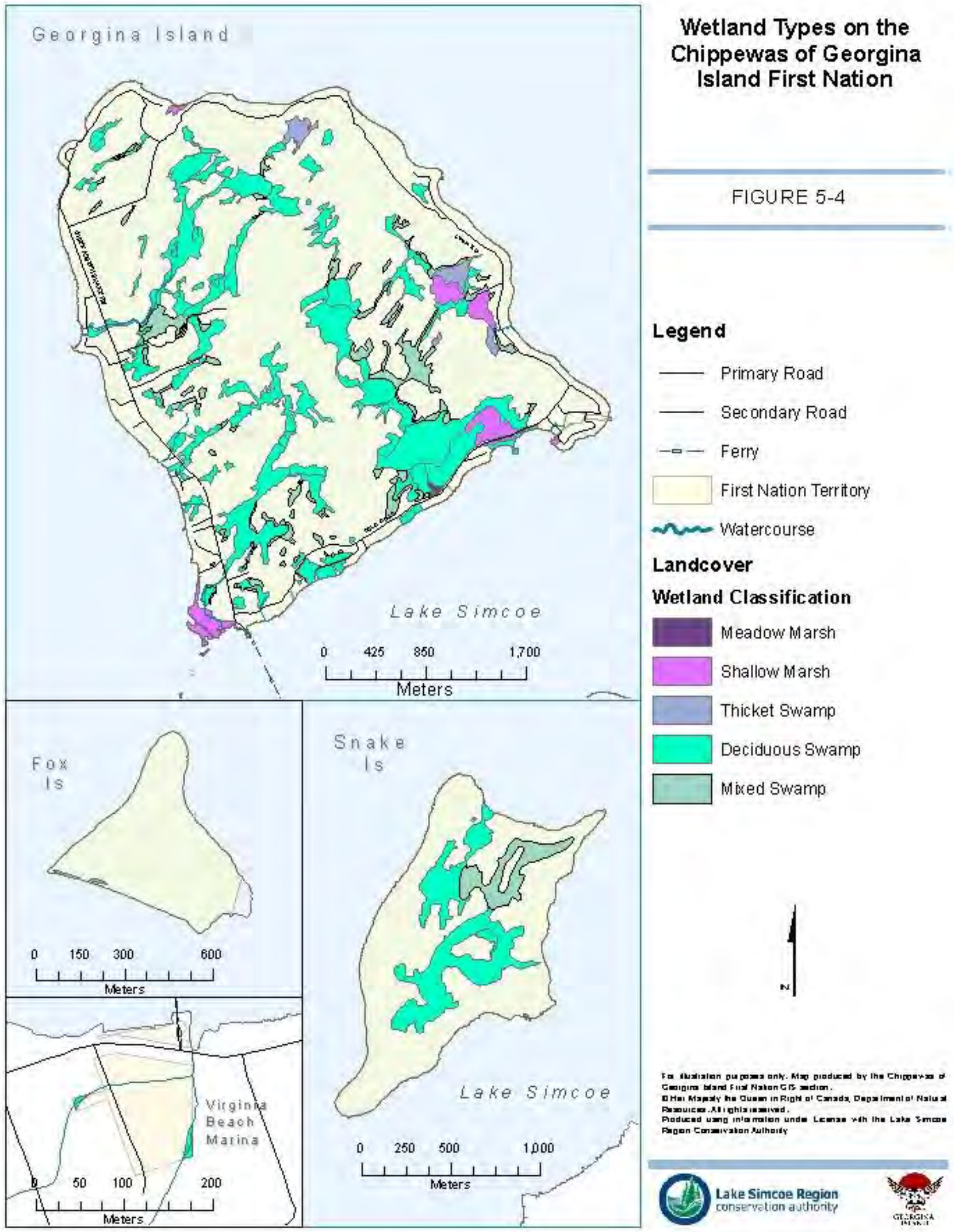


Figure 5-4: Wetland types in the Georgina, Fox and Snake Islands subwatershed

As part of the Georgina Island Climate Change Adaptation Project, a Traditional Ecological Knowledge Survey for Climate Change was completed by the Chippewas of Georgina Island First Nation in 2015, which addressed changes in wetland areas on Georgina Island. The survey found that community members have noticed several shifts in wetland areas over the years, including the swamps and ponds along the road disappearing with road development; swamps behind the island shrinking or drying up; wetlands draining faster or not property; and the East point swamp getting bigger (Chippewas of Georgina Island First Nation and OCCIAR 2015).

According to data available from the MNRF, LSRCA and the Adopt-A-Pond Wetland Conservation Programme (2015), there are currently 839 ha of wetland in the Georgina, Fox and Snake Islands subwatershed, comprising approximately 58% of the landscape (Figure 5-4, Table 5-2).

Table 5-2: Distribution of wetland types on Georgina, Fox and Snake Islands

Wetland type	Wetland Cover – Georgina Island		Wetland Cover – Fox Island		Wetland Cover – Snake Island		Wetland Cover - Mainland	
	Area (ha)	Area (%)	Area (ha)	Area (%)	Area (ha)	Area (%)	Area (ha)	Area (%)
Meadow marsh (MAM)	0.8	0.06	0	0	0	0	0	0
Shallow marsh (MAS)	29.5	2.3	0	0	0	0	0	0
Submerged shallow aquatic (SAS)	0.009	0	0	0	0	0	0	0
Deciduous swamp (SWD)	223.2	17.3	0.1	0.6	26.4	19.5	0.03	0
Mixed swamp (SWM)	27.7	2.1	0	0	8.2	6.1	0	0
Thicket swamp (SWT)	18.7	1.4	0	0	0	0	0	0
Total marsh	**30.3**	**2.3**	**0**	**0**	**0**	**0**	**0**	**0**
Total swamp	**269.6**	**20.9**	**0.1**	**0.6**	**34.7**	**25.6**	**0.03**	**2.36**
TOTAL	**299.9**	**23.2**	**0.1**	**0.6**	**34.7**	**25.6**	**0.03**	**2.36**

As can be seen from Table 5-2, Georgina Island contains a large area of wetland habitat (23% of the island), comprised of several wetland types. The two dominant wetland types on Georgina Island are silver maple mineral swamps, and marsh wetland communities. The silver maple swamps extend throughout much of the interior portion of the island and contain plant species such as eastern hemlock eastern white cedar, green ash, red maple, American elm, black ash, sensitive fern (*Onoclea sensibilis*), wood ferns (*Dryopteris* sp.), false nettle (*Boehmeria cylindrical*), and wood nettle (*Laportea canadensis)*. The marsh wetland communities are found along the shorelines of the island and the vegetation is comprised of soft stem bulrush (*Schoenoplectus tabernaemontani*), sedges (Carex spp.), marsh fern (*Thelypteris palustri*), cattails (*Typha* spp.), and purple loosestrife (*Lythrum salicaria*). The majority of the wetlands on Georgina Island are in close proximity and have connecting hydrology; this qualifies the entire island's wetlands to be classified as one large wetland complex. Based on the wetland complex's large size, the diversity of wetland types, the presence of species at risk and migratory breeding birds, and the use of some wetlands for cultural and educational purposes, it is likely to have an Ontario Wetland Evaluation System score that qualifies the complex as a provincially significant wetland (Adopt-A-Pond Wetland Conservation Programme, 2015).

What is a Provincially Significant Wetland?

The Ontario Wetland Evaluation System (OWES) was developed by the Ontario Ministry of Natural Resources (1993). It was implemented in a response to an increasing concern for the need to conserve wetland habitats in Ontario. The wetland evaluation system aims to evaluate the value or importance of a wetland based on a scoring system where four principal components each worth 250 points make a total of 1000 possible points.

The four principal components that are considered in a wetland evaluation are the biological, social, hydrological, and special features. Wetlands which score 600 or more total points (or 200 points in the biological or special feature components) are classified as being Provincially Significant. The Province of Ontario, under the Provincial Policy Statement (PPS) protects wetlands that rank as Provincially Significant. The PPS states that *"Development and site alteration shall not be permitted in significant wetlands."*

Snake Island also contains a large area of swamp habitat (26% of the area), which occurs mostly in the island interior and towards the north end of the island. Common plants in these areas include basswood, white ash, silver maple, balsam poplar (*Populus balsamifera*), ironwood, and ostrich fern (*Matteuccia struthiopteris*) (MNRF 2015). However, Fox Island contains a very small amount of wetland area, with only 0.6% of the total area comprised of swamp habitat, which occurs along the southwestern point of the island. A small area of deciduous swamp (0.03 ha) also occurs on the mainland portion of the first nation.

Like forests, wetland size and proximity to other natural areas has a significant influence on some wildlife species and ecological functions (e.g. Detenbeck *et al.,* 1993; Gibbs 1998; Guadagnin & Maltchik, 2006). Contiguous wetland areas have been calculated and the distribution of wetland patch sizes is displayed in Figure 5-5 below. There are 70 wetland patches ranging in size from less than 0.5 ha to over 600 ha. Similar to the forest patch distribution, the majority of the wetland cover (78%) falls into one large wetland patch measuring 670 ha.

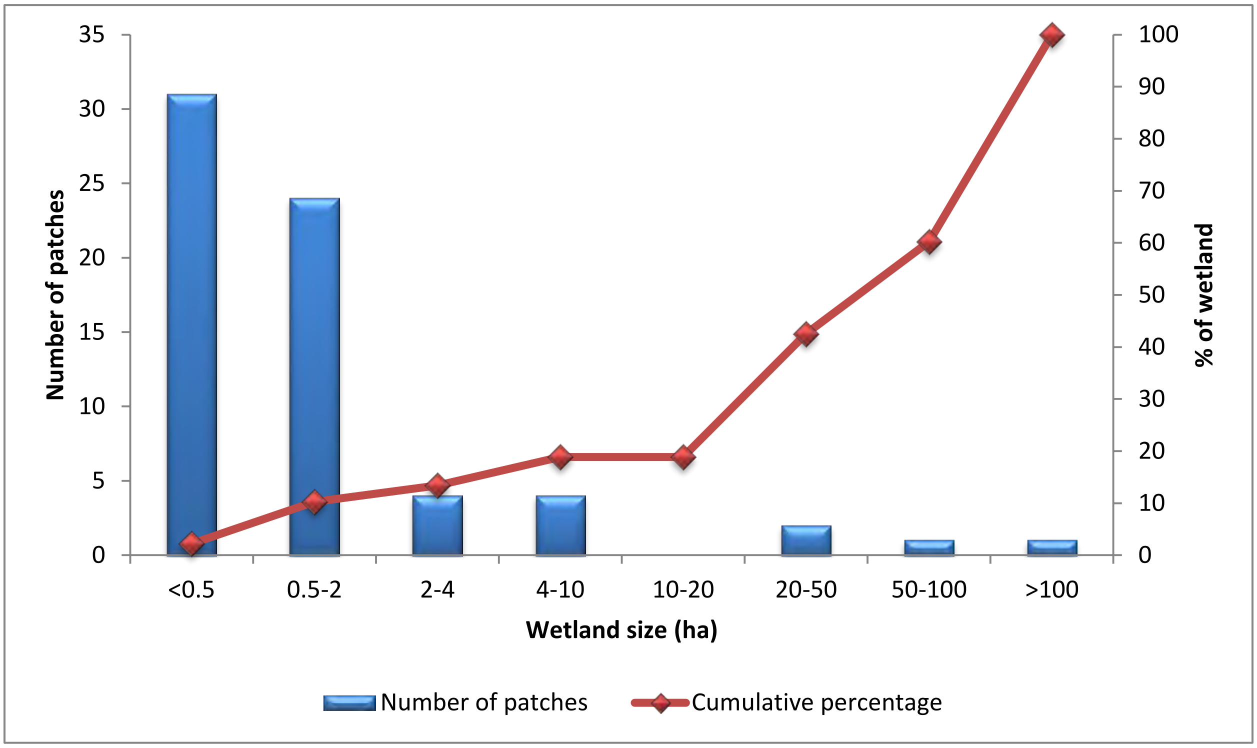


Figure 5-5 Wetland patch size distribution in the Georgina, Fox and Snake Islands subwatershed

Sweetgrass

Sweetgrass is also known to First Nations as Mother Earth's hair. It is traditionally harvested and braided and used in ceremonies, and to cleanse and get rid of negative energy. Its aroma has a calming effect and it often represents the teaching of kindness.

5.2.3 Grasslands

In addition to these rare and at-risk species, there are also rare ecosystems. There are a few documented remnants of tallgrass prairie ecosystems in the Lake Simcoe watershed. These small relict ecosystems are dominated by big bluestem (*Andropogon gerardii*), Indian grass (*Sorghastrum nutans*), and little bluestem (*Schizachyrium scoparium*). Historic records provide a more detailed plant list of these remnants, including 17 plant species which are rare in the Lake Simcoe watershed (Reznicek, 1983). One such tallgrass prairie remnant is located at the south end of Fox Island.

Even grasslands dominated by non-native plants (i.e. hayfields or old-field ecosystems) can be home to a number of at-risk species including monarch butterflies, bobolinks, and eastern meadowlark (*Sturnella magna*; recommended by COSEWIC, not yet listed). In fact, grassland-dependent wildlife are experiencing significant population declines in Ontario (McCracken, 2005). There are scattered grasslands throughout Georgina Island, with the majority present along the north and west portions of the island. These grassland areas comprise close to 11% of the subwatershed area (Table 5-3).

Table 5-3: Distribution of grassland types in the Georgina, Fox and Snake Islands subwatershed

Grassland type	Grassland Cover	
	Area (ha)	Area (%)
Tallgrass prairie (TPO)	0.1	0.007
Cultural meadow (CUM)	38.6	2.7
Cultural thicket (CUT)	113.5	7.8
Total	**152.2**	**10.5**

Clover

Clover (purple or pink) is found in many areas within the First Nation. Its medicinal purpose is related to blood health. When ingested it helps build up iron levels in the blood stream and can help with the prevention of varicose veins and blood flow issues associated with diabetes.

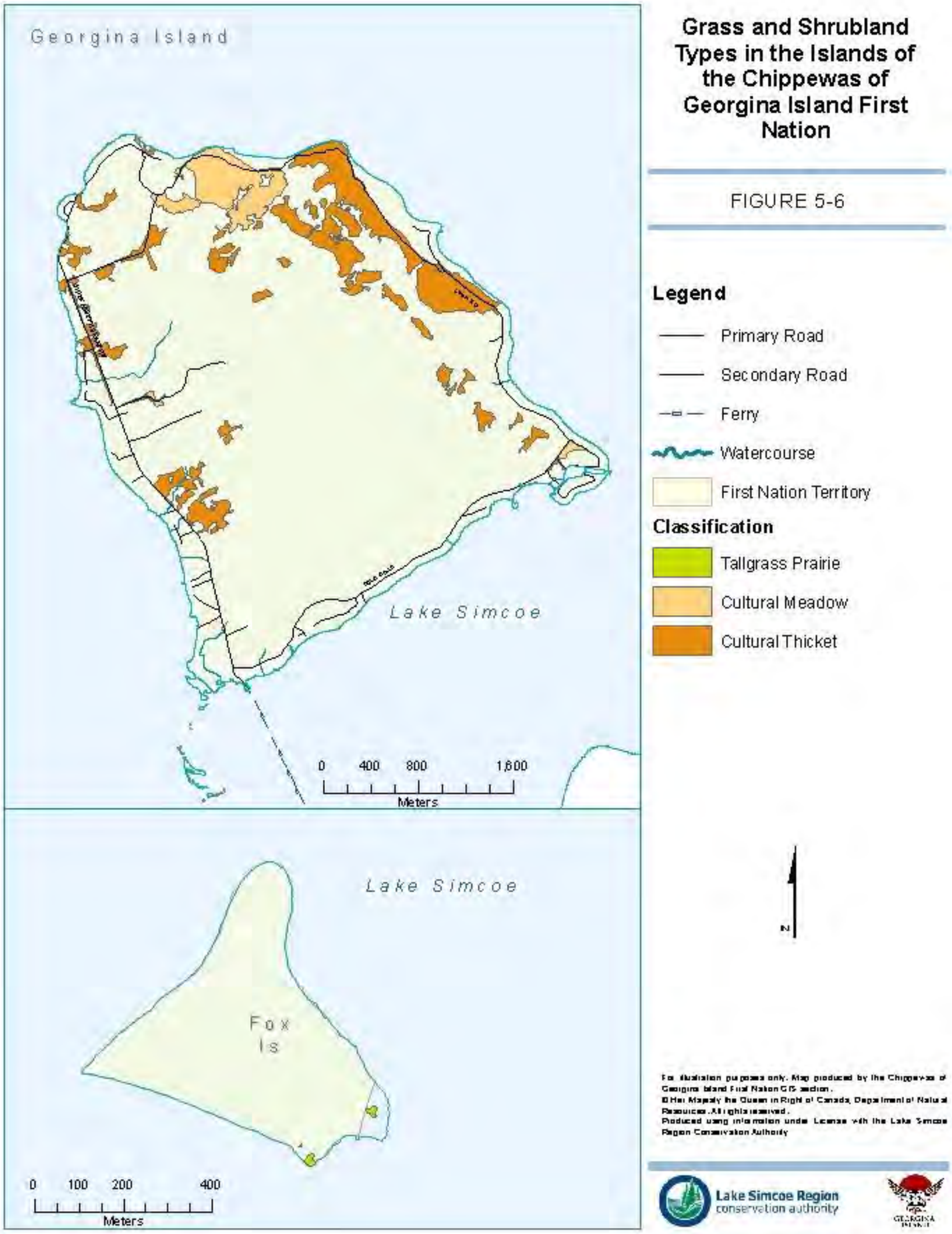


Figure 5-6: Grassland and shrubland types in the Georgina, Fox and Snake Islands subwatershed

5.2.4 Shoreline and riparian habitat

The term riparian refers to the area of land adjacent to a stream, river, or lake. These areas provide important fish and wildlife habitats, such as natural linkages among different habitat features that create critically important wildlife migration corridors (Environment Canada, 2013).

Riparian vegetation contributes to ecological function within a watershed in a number of ways:

- The flow of stormwater is slowed, causing sediment to be deposited on land rather than in the river, stream or lake
- The slower moving stormwater has increased opportunity for infiltration into the groundwater, replenishing aquifers and helping to maintain baseflow
- The roots of the plants absorb some of the contaminants contained in stormwater, preventing them from reaching the waterway
- Erosion of the shoreline or streambank is prevented, as the roots help to keep the soil in place
- Vegetation provides shade, helping to maintain cool water temperatures
- Falling debris (branches, leaves) from the riparian vegetation provide food and shelter for benthic invertebrates and fish
- The linear nature of these features are extremely important to migrating birds and other terrestrial wildlife travelling throughout the watershed
- The seasonal flooding of most riparian areas provides habitat to specialized plant communities that may not be found elsewhere in the watershed

Plaintain (*Arigis Niipisia*)

The Plantain plant can be eaten to help with digestive tract disorders. It can also be chewed and placed onto skin or made into ointments or tonics to treat things such as bee stings, insect bites, open wounds and burns.

The Lake Simcoe Integrated Watershed Management Plan (LSRCA, 2008) aspires to have all streams within the watershed naturally vegetated, with a 30 metre buffer containing natural vegetation on either side of the watercourse. Although the Lake Simcoe Protection Plan does not specify a quantitative target, it sets a target of "naturalized riparian areas on Lake Simcoe and along streams," referring to a minimum to a 30 m width along watercourses and the Lake Simcoe shoreline. In its '*How Much Habitat is Enough'* (2013) document, Environment Canada sets a guideline of 75% natural vegetation within a 30 metre buffer on either side of a watercourse.

Georgina Island has a relatively high level of natural cover within the 30 m riparian buffer along its watercourses, with 71.7% of this area occupied by natural heritage features (Figure 5-85-6). The stream banks on the island are however very limited in nature and no streams exist on Fox or Snake Island. The proportion of naturally vegetated shoreline was also assessed on all three islands and results vary between them. Georgina Island has the highest amount of naturalized shoreline (59.2%), particularly along the northern and southern shores (Figure 5-7 and Figure 5-8). Fox Island also has a relatively high percentage of shoreline with adequate riparian buffer (31%), especially along the western shore (Figure 5-7 and 5-8). Snake Island has the lowest amount of riparian vegetation, with only 19.5% or its shoreline containing natural cover (Figure 5-7 and 5-8).

Although neither the Lake Simcoe Protection Plan nor the Lake Simcoe Integrated Watershed Management Plan identify a quantitative target for natural cover along the Lake Simcoe shoreline, the LSPP identifies “no further loss of natural shorelines” as a management target. The shoreline of the subwatershed has experienced heavy development pressures and shoreline manipulation; with an average of 36.6% of the shoreline remaining in a naturally vegetated state.

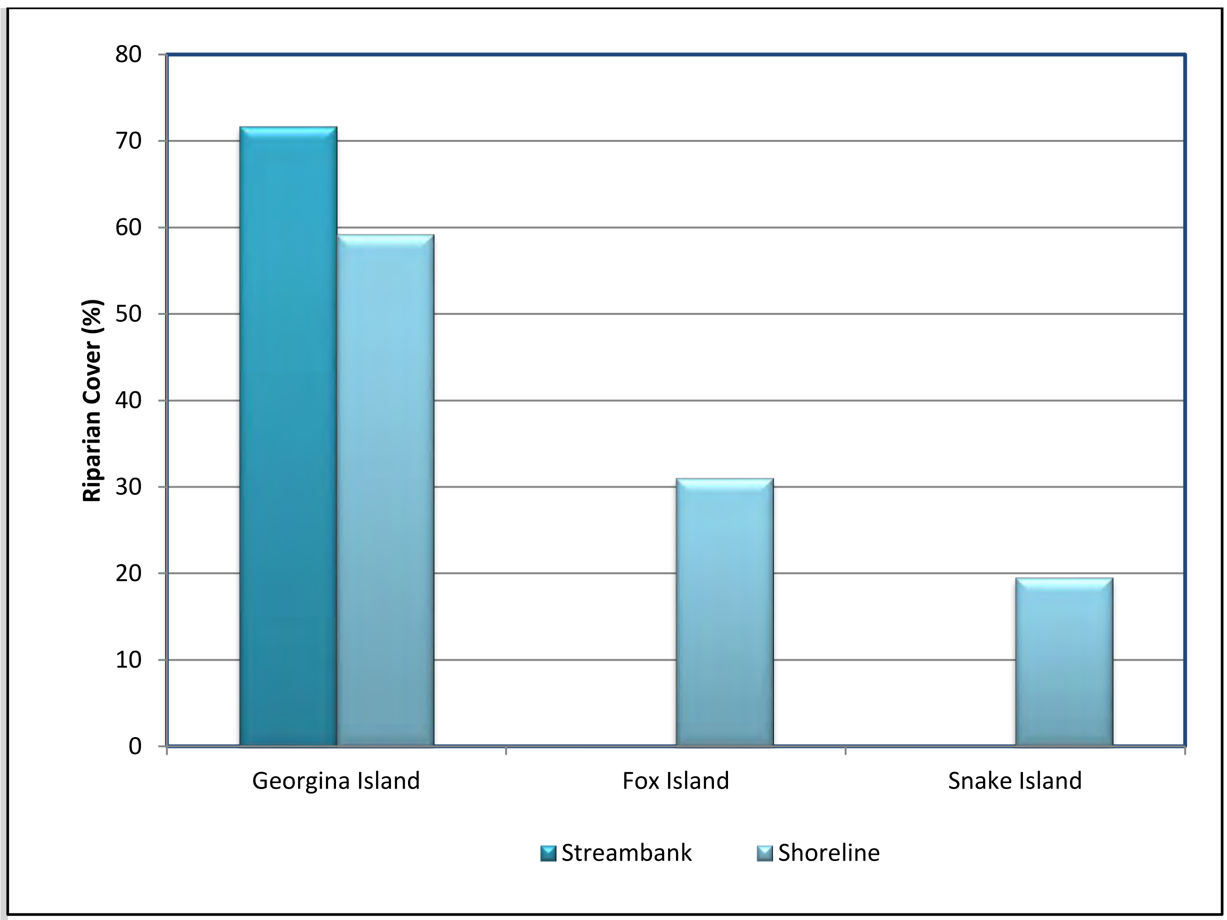


Figure 5-7 Streambank and shoreline riparian cover percentage for Georgina, Fox and Snake Islands

****Note: Fox and Snake Islands do not contain any streams**

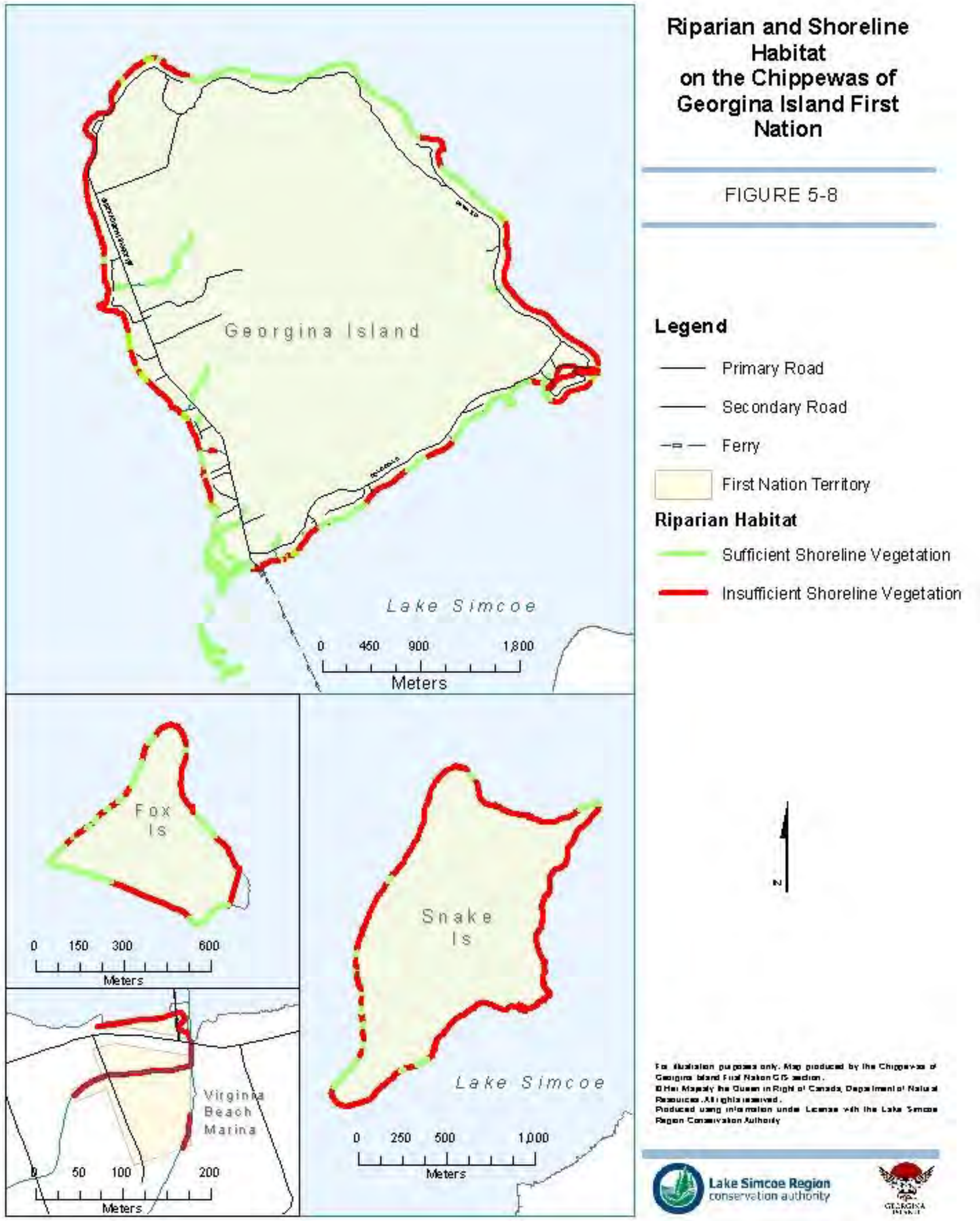


Figure 5-8 Riparian and shoreline vegetation in the Georgina, Fox and Snake Islands subwatershed

5.2.5 Species of conservation concern

The frequency of occurrence of all native species of plants, mammals, birds, amphibians, reptiles, and fish in Ontario have been documented by the Ministry of Natural Resources using a series of S-ranks (or Sub-national ranks). Those designated as being provincially rare (i.e. ranked S1-S3) are those which are typically considered as being of 'conservation concern.' Other species may be further protected by designation as being Endangered, Threatened, or of Special Concern under the Federal *Species at Risk* Act or Provincial *Endangered Species Act*.

A Species at Risk Assessment was completed by Oakridge Environmental in 2008 on Georgina, Fox and Snake Islands. The study identified eleven (11) species of conservation concern on the three islands. Six (6) of these are both federally and provincially rare, and five (5) are provincially rare. Additionally, a Wetland Evaluation on Georgina Island completed by Toronto Zoo's Adopt-A-Pond Wetland Conservation Programme was conducted in 2014 identified two (2) provincially rare species on Georgina Island. A breeding bird survey was also completed on Georgina, Fox and Snake Islands by E.P.D.I. in 2015. The survey identified five (5) bird species which are both federally and provincially rare, as well as one species which is federally rare.

The species identified in these assessments are outlined in the following sections.

American Ginseng (*Panax quinquefolius*; S2; Endangered)

American ginseng is a perennial herb whose roots are traditionally used was for medicinal purposes. Mature plants have a cluster of small greenish-white flowers in the center of a whorl of leaves, and the fruit consists of a cluster of bright red berries.

The most significant threat to ginseng populations on Georgina Island is over-harvesting of the plants; their roots are used for medicinal purposes. Additional threats include loss or alteration of its forest habitat and recreational activities on the island, including ATV trails.



Butternut (*Juglans cinerea*; S3; Endangered)

Butternut (or "white walnut") is a species of walnut tree with light gray bark, growing to 20 m tall. The male trees display yellow-green catkins and the fruit is a nut which normally grows in groups of 2-3 and is lemon-shaped.

Butternut trees were identified on all three islands within a variety of habitats; however the majority were present within mature deciduous forests dominated by sugar maple, red oak and American beech, with minor eastern hemlock. Most of the butternut populations on the islands were observed on Snake Island, including some old-growth trees.

The main threat to butternut populations on the islands is a fungus referred to as "butternut canker" which can ultimately kill infected trees. The canker has infected the majority of butternut trees on all three islands, with trees on Fox Island exhibiting the poorest health. A second threat to butternut populations is human harvesting of trees for wood products (building, fuel or carving).



Monarch (*Danaus plexippus*; S4B, S2N; Special Concern)

Monarchs are a familiar butterfly species in North America and have a distinguishing orange and black wing pattern. The main food source and larval host plant is the milkweed; adult monarchs feed on their leaves and lay their eggs on the plant so that the hatching larvae have a ready source of food. The eastern North American monarch population migrates thousands of kilometers annually between Canada and Mexico.

Monarchs were observed on Georgina Island within the southeastern corner along Loon Road and within the northern fields where a relatively stable population of milkweed occurs. They were also identified on the western portion of Snake Island at the edge of the trails prior to a woodland area. On Fox Island, monarchs were seen along the mid-eastern section in the rear yards of three seasonal residences, where milkweed plants were also observed.

The main potential threats to monarchs are from the residual use of herbicides and pesticides as well as degradation of their critical tallgrass habitat due to development.



Milksnake (*Lampropeltis triangulum*; S3; Special Concern)

The milksnake is grey or tan with alternating red or reddish brown blotches that are distinctly outlined in black along its back and sides. Milksnake belongs to the constrictor family, meaning it catches its prey by initially striking it and then wraps its body around it and squeezes.

Milksnakes can be found in a variety of habitats including rocky outcrops, open fields/tallgrass areas, mature forest edges and shorelines of lakes, wetlands and rivers. The milksnake hibernates underground, in rotting logs or in the foundations of old buildings.

Milksnake has only been observed on Georgina Island by island residents. They have been seen in the southwest corner of the island, mainly along Chief Joseph Snake Road, as well as along the northeastern side of the island along Loon Road.

Threats to milksnake populations of Georgina Island may include road mortality since snakes tend to bask on warm roadways and migrate across them, as well as human persecution due to fear, and degradation of hibernaculum habitat.

Hooded Warbler (*Setophaga citrina*; S4B; Threatened)

The hooded warbler is a small yellow bird species. The male is predominantly yellow with olive-green back, wings and tail, bright yellow face, breast and belly, and a distinctive black hood. The female is similar but lacks the black hood. Hooded warblers nests in shrubby clearings within mature deciduous or mixedwood forests.

A female hooded warbler was observed at the northern tip of Fox Island near the end of the summer season. The warbler was observed in a shrubby clearing within the forest canopy on the main trail which accesses the seasonal homes on the northern end of the island. A potential hooded warbler nest was also observed on the southeast corner of the island. It did not appear to be inhabited during that summer and therefore it was presumed that the hooded warbler identified on the island was migrating through the area.

Potential threats to hooded warbler in the Georgina Island First Nation include loss of forest habitat through development or forestry; this species requires large tracts of mature forest to breed. A second potential threat is the use of pesticides and herbicides, which can cause sterilization or weakening of the eggs.

Peregrine Falcon (*Falco peregrinus*; S3B; Special Concern)

The peregrine falcon is a raptor species which feeds primarily on birds, but will occasionally hunt small mammals, reptiles or insects. It has a grey-blue black, barred underparts and a black head with a distinct black 'moustache'. Peregrine falcons typically nests on tall cliff ledges that are close to large bodies of water.

A peregrine falcon was observed off the east tip of Fox Island in September 2008. It was observed being chased by an American robin (*Turdus migratorius*) out over the water and then flew into the woodlands of Fox Island. Because this was the first and only sighting in the area, it is believed to have been migrating through the area to the south.

The use of pesticides is the main threat to peregrine falcons because they are top predators and are susceptible to bioaccumulation. Another threat to the species is the degradation of cliff habitat through development or recreation.

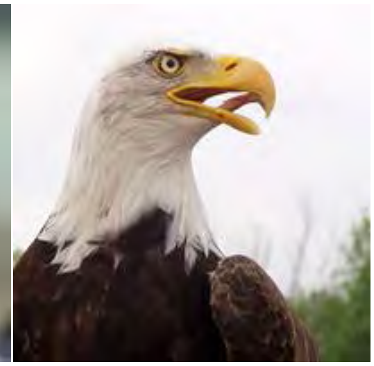
Bald Eagle (*Haliaeetus leucocephalus*; S4B, S2N; Special Concern)

Bald eagles are large raptors with a white head and tail and a dark brown body, with a large yellow beak and feet. They nest in a range of habitats and forest types near large lakes and rivers. Bald eagles are opportunistic predators and feed primarily on fish, birds and mammals.

A pair of bald eagles was observed on the southeastern part of Fox Island in February and March 2008. As no sightings occurred in the summer, it is expected that the observed birds were a migratory pair from the north and were overwintering in the area. It is unlikely that they remain to nest during the spring/summer breeding period.

Threats to bald eagles in the Georgina Island First Nation include disturbance or alteration of winter roosting habitat.





Bald Eagle

The Eagle is one of the most sacred animals in the Anishinabek Culture. It is our messenger to the creator as it is the highest flying creature possessing the gift of broad sight.

Great Egret (*Ardea alba*; S2B)

Great egrets are white, long-legged wading birds with a long curved neck and long sharp yellow-orange bill. They are colonial nesters and will typically build a nest in tall trees or shrubs in woods or thickets near bodies of water.

A single male was observed within the marsh habitat on the southwestern corner of Georgina Island in early September 2008, and according to anecdotal information had arrived there in mid to late July. No stick nests were observed during the survey period, and so the individual was presumed to have already mated elsewhere that season.

Threats to great egrets on Georgina Island include loss of marsh habitat through development or infilling, removal of dead trees, which provide nesting locations, and boat traffic in the wetland and around the Sand Islands.



Canvasback (*Aythya valisineria*; S1B, S4N)

Canvasbacks are large diving ducks with a long sloping profile. The adult male has a rusty head, white body and black chest and rear. The ducks rarely inhabit or breed in Ontario, but migrate through southern Ontario during fall/winter on their way to wintering grounds along the Atlantic Coast of the United States.

A pair of canvasback was observed dabbling within the marsh on the southwestern corner of Georgina Island in October 2008. According to traditional ecological knowledge from island residents, thousands of canvasbacks are often observed in the marshland and on the Sand Islands.

Potential threats to canvasback on Georgina Island include development or infilling along the shoreline in the area of the marsh, and hunting pressure during the fall season.



<u>Caspian Tern (*Hydroprogne caspia*; S3B)</u>

Caspian terns are large gull-like birds with a white body, black cap and a large coral red bill. The birds nest on sandy or gravelly beaches and shell banks along coastlines or large inland lakes and forage for fish in shallow aquatic habitats.

The Sand Islands and the embayment on the southwest corner of Georgina Island appeared to be the main habitat where Caspian terns congregate, and provides ideal foraging and nesting habitat.

The only potential threats to Caspian terns in the area would be any further development to the Sand Islands.



<u>Great Black-backed Gull (*Larus marinus*; S2B)</u>

Great black-backed gulls are the largest gulls in the world are stout-bodied with a heavy, slightly bulbous bill. Adults are white with slate-black upperwings and backs and have a yellow bill with a red spot near the tip. Juveniles are checkered gray-brown above with white-based, blacktipped tails, black bills and blackish flight feathers. They nest on the ground on rocky coasts and islands, or sometimes along the edge of inland lakes.

Approximately a half dozen individuals were observed in the area of the Sand Islands during the summer of 2008.

Similar to the other colonial waterbirds inhabiting the southwestern corner of Georgina Island, the only threat to the great black-backed gull is further development and human usage of the Sand Islands and associated marsh habitat.

Additionally, the Wetland Evaluation on Georgina Island (Toronto Zoo's Adopt-A-Pond Wetland Conservation Programme, 2014) identified two SAR turtle species as present within marshes on the southwestern point of Georgina Island: Blanding's turtle (*Emydoidea blandingii*) and snapping turtle (*Chelydra serpentina*).

<u>Blanding's Turtle (*Emydoidea blandingii*; S3; Threatened)</u>

Blanding's turtles are aquatic turtles with a bright yellow throat and chin and a black-brown domed shell with yellow flecks. They live in shallow water, usually in large wetlands and shallow lakes with lots of water plants.

Threats to Blanding's turtles include habitat loss and fragmentation, vehicle collisions, climate change and nest predation.

Snapping Turtle *(Chelydra serpentina*; S3; Special Concern)

The snapping turtle is Canada's largest freshwater turtle and can weigh up to 16kg. They have large black, olive or brown shells, often covered in algae and a long tail with triangular 'dinosaur-like' crests. Snapping turtles live in a variety of freshwater habitats, preferring areas with shallow water, soft mud bottoms and abundant aquatic vegetation.

Threats to snapping turtles include habitat loss and fragmentation, vehicle collisions, climate change and nest predation.



Turtles

Turtles traditionally play a very important role in the natural purification process of the water and are a significant part of all Indigenous cultures. In our creation story, Mother Earth is in fact established on a turtles back.

A breeding bird survey conducted by EPDI. in 2015 identified six (6) bird species of conservation concern on the three islands. Five (5) of these are both federally and provincially rare, and one (1) is federally rare.

Bank Swallow *(Riparia riparia*; S4B; Threatened)

Bank swallows are small, slender songbirds with white colouring underneath and brown on top. They live in low areas along rivers, streams and coasts, as well as sand and gravel pits. Bank swallows nest in colonies ranging from several to a few thousand pairs on banks and vertical cliffs.

Bank swallows were identified as breeders/foragers on Georgina Island. Threats to this species include habitat loss/destruction, pesticides, climate change and vehicle collisions.

Barn Swallow (*Hirundo rustica*; S4B; Threatened)

Barn swallows are medium-sized songbirds with a steel-blue back and wings, a rusty forehead and throat, and a long forked tail. Barn swallows live in open areas such as parks, fields and over open water and require structures such as barns, bridges or cliffs to build their nests on.

Barn swallows were identified as breeder/foragers on all three islands. They were observed to use the marsh and shoreline area at the south end of Georgina Island, in conjunction with nesting habitat around structures at the ferry dock.

The main potential threats to barn swallows are the demolition/renovation of structures used for nesting, as well as pesticide use.

Canada Warbler (*Cardellina canadensis*; S4B; Threatened)

Canada warblers are small songbirds with a slate gray back, yellow underparts and a 'necklace' of dark streaks across the chest. They breed in a range of deciduous and coniferous forests with a dense shrub layer which helps conceal nests built near the ground on logs, stream banks or hummocks.

Canada warblers were identified on Fox Island only following a major fallout of migratory species. The major threat to Canada warblers is habitat destruction.

Eastern Wood-Pewee (*Contopus virens*; S4B; Special Concern)

The eastern wood-pewee is a medium-sized flycatcher with long wings and a peaked crown. They are olive-gray with dark wings. Eastern wood-pewees live in nearly any woodland habitat including mature woodlands, urban shade trees, roadsides, woodlots, and orchards.

Eastern wood-pewees were observed to forage/breed on all three islands but were seen in relatively low numbers. They were observed in deciduous as well as mixedwood forests. The main threats to this species include loss of habitat, reductions in their insect food source and predation of eggs and fledglings.

Rusty Blackbird (*Euphagus Carolinas*; Special Concern)

The rusty blackbird is a medium-sized blackbird with a slender bill and medium-length tail. Breeding males are dark glossy black, and become rust-brown in the fall and winter. Females are gray-brown and both have pale yellow eyes. Rusty blackbirds nest in wet areas, including swamps, marshes, bogs and pond edges within the boreal forest. During the winter, they migrate to the United States and frequent damp forests and some cultivated fields.

This species was observed on Georgina Island but was relatively uncommon. Threats to rusty blackbirds include habitat loss and degradation, and blackbird control programs in the United States.



Wood Thrush (*Hylocichla musteline*; S4B; Threatened)

Wood thrushes are medium-sized songbirds with cinnamon brown upperparts, white underparts and black spots on the breast and sides. The wood thrush breeds in mature deciduous and mixed forests with well-developed understorey and abundant leaf litter.

Wood thrushes were observed within the larger forest interior on Georgina Island and were seen in relatively low abundance. Major threats to this species include habitat loss and fragmentation, particularly the loss of interior forest habitat, overbrowsing of the understorey by deer, and parasitic cowbirds, which were also seen on Georgina Island.



Chamomile (*Omus Kway Pways Ki Wusk*)

Chamomile has been known to be found within the First Nation and can be used to calm an upset stomach and/or help with digestive issues such as acid reflux. It can also help to soothe and relax, helping with anxiety as well as insomnia.

Key Points - Current Terrestrial Natural Heritage Status:

- The Georgina, Fox and Snake Islands subwatershed contains a relatively high amount (88.8%) of natural heritage cover, with 58.0% wetland, 73.9% upland forest, and 10.5% grassland.
- While the amount of streams on Georgina Island is limited, they are well vegetated, with 72% of the area within a 30m buffer along its watercourses consisting of natural heritage cover. Environment Canada recommends that 75% of this area be in natural cover (EC, 2013).
- The amount of shoreline that contains 30m of riparian vegetation varies between the three islands (59% on Georgina, 31% on Fox and 19% on Snake)
- There is a wide range of forest patch sizes, with a number of patches containing forest interior habitat, which supports a number of sensitive bird species. There are two of these patches that are over 50 ha in size. In addition, there are also several patches of deep forest interior, which is the core forest found greater than 200 m from the forest edge
- There is also a wide range of wetland patch sizes. The majority of the patches are smaller than 0.5 ha in size. Close to eighty percent of the wetland area is contained within a single wetland patch that is over 600 ha in size.
- Nineteen Species of Conservation Concern occur in this subwatershed, including American ginseng, butternut, monarch, and numerous bird and reptile species.
- Due to the close proximity and connecting hydrology of the wetlands on Georgina Island, they are classified as one large wetland complex which, as a result of its size, the diversity of wetland types and presence of species at risk and migratory birds, as well as its cultural and educational importance, is likely to qualify as a provincially significant wetland.

5.3 Factors impacting natural heritage status – Stressors

There are numerous factors that can affect terrestrial natural heritage features. They range from natural factors such as floods, fires, and droughts; to human influences, such as land use conversion, water use, the introduction of invasive species, and climate change. Natural factors are generally localized and short in duration, and a natural system is generally able to recover within a relatively short period. Some degree of natural disturbance is often a part of the life cycle of natural systems. Conversely, human influences are generally much more permanent – a forest cannot regenerate after it has been urbanized, natural communities have a great deal of difficulty recovering from the introduction of an invasive species, and wetlands may be unable to survive when their water source has been drawn down.

5.3.1 Shoreline development

The Lake Simcoe shoreline has long been a draw for cottage and housing development, but this type of development has impacts on native species and habitats as well. The impacts of shoreline development on fish and aquatic habitats (as described in **Chapter 4 – Aquatic Natural Heritage**) is perhaps best documented, but the clearing of vegetation along shorelines has also been associated with a decline in native songbirds (Clark *et al.,* 1984; Henning and Remsburg 2009), amphibians (Henning and Remsburg 2009), and small mammals (Racey and Euler, 1982), and an increase in non-native species.

The lakeshore has been subject to significant residential development. Currently, only 36.6% of the shoreline in the Georgina, Fox and Snake Islands subwatershed remains under natural cover. Much of the shoreline area that has been changed from natural cover is residential, and there are also some areas of commercial use (eg. ferry docks), and manicured parklands.

5.3.2 Land use change

Prior to settlement of the islands, the Georgina, Fox and Snake Islands subwatershed was almost entirely covered by upland forest and wetland (Larson *et al.,* 1999; DUC, 2010). The loss of natural habitat and its conversion to residential development land use began almost immediately upon settlement, and have been ongoing. This habitat conversion represents the most significant threat to terrestrial natural heritage features in this subwatershed.

Natural heritage features within settlement areas are those most susceptible to land use change, as these areas are experiencing the greatest relative growth pressure, and as these areas aren't subject to the higher level of protection provided by policies under the Lake Simcoe Protection Plan. Ecosystem types that are under this type of pressure include wetlands and deciduous and mixed forests.

While the loss of natural areas has not been as extensive in the study area as in other areas of the Lake Simcoe watershed, there has been a significant loss of natural features. Natural habitat remains just over 88% of the Georgina, Fox and Snake Islands subwatershed, with areas in the rest of the subwatershed being converted to residential land uses (Figure 2-3).

Additionally, another land use change that has been more recently observed is the reversion of agricultural land to natural habitat. This has been seen in the remnant apple orchard areas of Snake Island and the northern farmlands on Georgina Island. While this reversion back to a more naturalized vegetative cover is a positive change, there have been some observed negative impacts on these areas, including the proliferation of invasive species

5.3.3 Road development

In addition to the loss and fragmentation of habitat associated with land use change, the development and use of roads can have impacts on natural heritage values as well. Roads can have significant impacts on wildlife communities and the ability of wildlife to move throughout their home ranges. Direct mortality of animals related to roads can be particularly significant for species such as frogs, turtles, and salamanders, which are relatively slow moving but need to travel from wetland to upland areas to fulfil the requirements of their breeding cycle (Fahrig and Rytwinski, 2009). Even more mobile animals such as mammals (Findlay and Houlahan, 1997) and birds (Kociolek *et al.,* 2011) can be subject to increased mortality along roads. In addition to the direct impacts associated with mortality, roads can decrease the value of adjacent natural areas as breeding habitat, by increasing noise levels and increasing illumination at night (Kociolek *et al.,* 2011), and by acting as a source of chloride or petrochemicals to amphibian breeding ponds (Fahrig and Rytwinski, 2009). Conversely of course, some scavenger species such as American crows and red-tailed hawks respond positively to the presence of roads, as roads provide a consistent food source for them.

Research in the United States and Europe suggests that this 'road effect zone' can extend for hundreds of metres from roads (Forman and Deblinger, 2000), suggesting that many of the natural heritage features in the study area may be exhibiting these types of impacts, although this would be limited to the perimeter of the islands since currently roads are restricted to these areas. However, if these effects are not considered, further development in the subwatershed could increase the number of natural areas vulnerable to these effects.

Additionally, the creation of roads can alter the hydrology of an area, and results of the TEK survey indicate that swamps and ponds along the roadways have decreased with road development (Chippewas of Georgina Island and OCCIAR 2015).

5.3.4 Changes to hydrologic regime

Although the current status of, and stressors on, surface water hydrology are dealt with more fully in **Chapter 3 – Water Quantity**, changes to the hydrological regime in the subwatershed can have impacts on the extent and quality of natural heritage features as well, particularly wetland and riparian ecosystems. These ecosystems and their associated vegetation are dependent upon natural variations in hydrologic conditions such as baseflow rates, seasonal flooding, and drainage. Any alteration to the hydrologic regime can lead to loss or changes in the condition of these ecosystem types. Factors leading to changes in hydrologic regime include loss of upland and wetland natural heritage features, and their conversion to impervious cover.

The results of the Traditional Ecological Knowledge survey completed as part of the Climate Change Adaptation Plan (Georgina Island First Nation and OCCIAR, 2015) identified changes in local wetlands, including shifts in drainage patterns as well as wetlands shrinking and drying up. This relationship is discussed more fully in Chapter 4.

5.3.5 Invasive species

Non-native species can be a significant threat to biodiversity as well. Some species, when in the absence of predators or disease to check the growth of their populations, can become extremely abundant. This is particularly the case with species which aren't native to North America. Many of these species, when introduced as a garden plant or house pets, or inadvertently through international shipping, can become extremely aggressive invasives. The most aggressive of these can reduce biodiversity by outcompeting native species for resources such as food (e.g. red-eared slider), breeding habitat (e.g. house sparrow), sunlight (e.g. dog-strangling vine), or through direct consumption (e.g. emerald ash borer).

Through the forest management plan, vegetation plot surveys and transect surveys, several invasive species have been found to inhabit Georgina, Fox and Snake Islands. While Fox Island doesn't currently contain an abundance of invasive species, they are quite established on Georgina and Snake Islands. According to the forest mapping on Georgina Island, invasive species are present throughout the island, with a heavy abundance of species (primarily dog-strangling vine and buckthorn), along the north and east sections of the island as well as an area along the western edge (Figures 5-9 and 5-10).

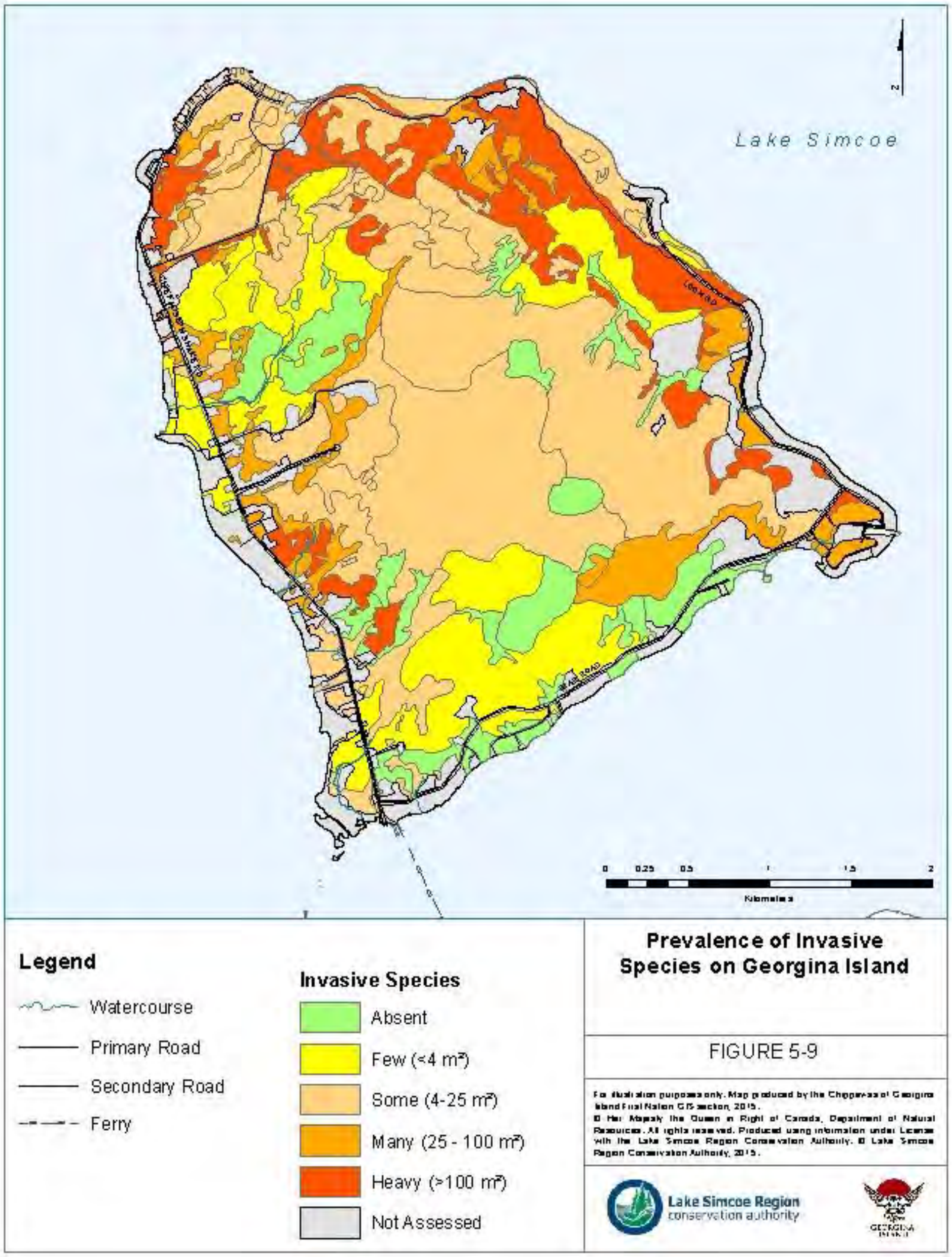


Figure 5-9: Invasive species locations and abundance on Georgina Island

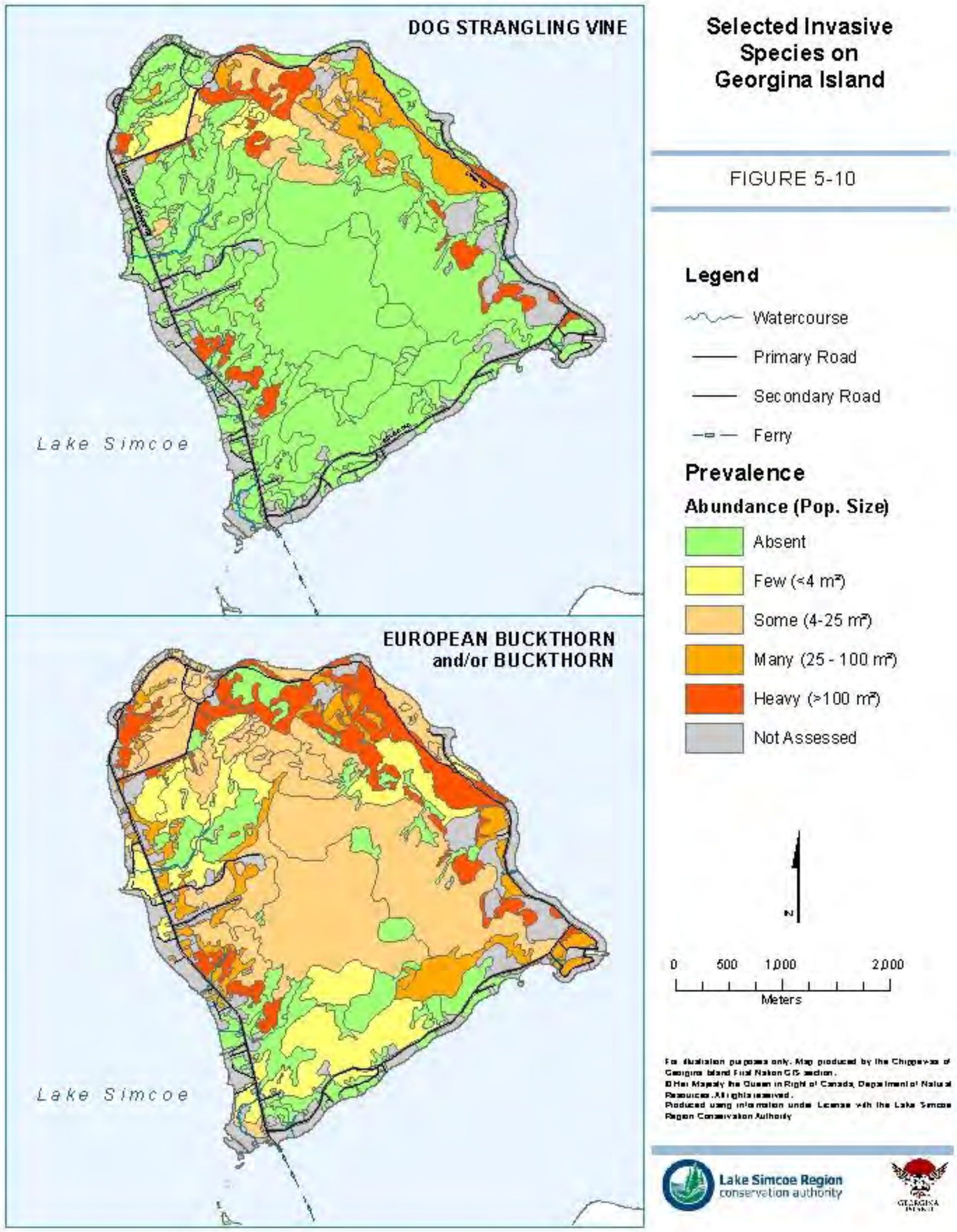


Figure 5-10: Locations and abundance of dog strangling vine and European or common buckthorn on Georgina Island

Descriptions of the invasive species found on Georgina, Fox and Snake Islands, as well as their impacts, are detailed in the following sections.

Common or European buckthorn (*Rhamnus cathartica*)

Common buckthorn is a deciduous shrub or small tree which was introduced to North America in the 1880s as an ornamental plant. This species can thrive in a variety of conditions and can therefore invade a wide range of habitats. Most often, it is found in woodlands and open fields there it forms thick stands there few other plants can grow. Its fruit is often dispersed by birds, allowing it to rapidly spread and displace native vegetation. It also acts as a host to soybean aphids and alfalfa mosaic virus and crown fungus, which causes oat rust disease.

Buckthorn was observed to be aggressively growing in sixteen forest stands on Georgina Island, frequently occurring along trails and in forests with a broken canopy (Chippewas of Georgina Island, 1999; Figure 5-10). It was also observed in two locations in the forest on Fox Island, and was relatively common on Snake Island.

Dog strangling vine (*Vincetoxicum rossicum*)

Dog strangling vine is a perennial vine related to milkweed that was introduced into North America in the 1800s. This plant prefers open sunny areas, and grows aggressively up to 2m high by wrapping itself up trees and other plants. Dog strangling vine can produce up to 28,000 seeds per square metre and new plants can grow from root fragments, allowing it to rapidly colonize habitats and making it difficult to destroy.

Dense stands of dog strangling vine can crowd out native plants and young trees, preventing forest regeneration; they also interfere with forest management and recreational activities. The leaves and roots can also be toxic to pets, wildlife and livestock. Additionally, monarchs occasionally lay their eggs mistakenly on dos strangling vine, and caterpillars hatched on dog strangling vine plants die because they don't have the food they need.

Dog strangling vine was observed in abandoned farm fields, ditches and in poplar stands within the northwest portion as well as the east side of Georgina Island (Figure 5-10). On Fox Island, it was observed only in one area along a trail on the outside edge of the island; however it is relatively common on Snake Island.

Invasive Phragmites (*Phragmites australis subsp. australis*)

Invasive phragmites (or European common reed) is an aggressive perennial grass that has been spreading throughout Ontario for decades. The plant spreads quickly and out-competes native species for water and nutrients. It grows in extremely dense stands (as many as 200 stems/m^2) and can grow up to 5m tall. It also releases toxins from its roots into the soil to inhibit growth of surrounding plants. It is very similar in appearance to a closely related native subspecies, making it difficult to identify.

Impacts of phragmites include crowding out native vegetation and resulting decreased plant biodiversity, providing poor habitat and food quality for wildlife, decreased water levels through increased transpiration, increased fire hazard (dead stalks), and impacts on agriculture, road safety and recreational activities (swimming, boating, angling).

Phragmites was observed in a ditch along Bear Road, very close to a marsh on Georgina Island, but has not been seen on Fox or Snake Islands.

Invasive Honeysuckle (*Lonicera* spp.)

Invasive honeysuckles are herbaceous shrubs which were introduced to North America from Asia in the late 1800s. Three species of exotic honeysuckles are found in Ontario: amur, morrow and tatarian. They are often found in old fields, floodplains, forest edges and roadsides. Invasive honeysuckles rapidly invade areas, forming dense patches that choke out native species. They also produce toxic chemicals to prevent other plants from growing nearby and attract more pollinators, causing native plants to reduce the amount of seeds they produce. Invasive honeysuckles were observed to be relatively common on Snake Island, but have not been seen on Georgina or Fox Island.

The Lake Simcoe Protection Plan recommends the development and implementation of a monitoring program which will document the presence and extent of terrestrial invasive species on Georgina, Fox and Snake Islands.

The Lake Simcoe Protection Plan has also developed a 'watch list' of invasive species which are not yet in the Lake Simcoe watershed, but which, if they do appear here, are expected to have significant negative impacts on natural areas. Terrestrial species on that list are: kudzu (*Pueraria lobata*), Asian long-horned beetle (*Anoplophora glabripennis*), chronic wasting disease (which affects deer), oak wilt, and white nose syndrome (which affects bat populations). Within five years of the release of the LSPP (i.e. 2014), the MNRF was to develop response plans to address invasive species in the watershed and those on the watch list.

Figure 5-11: Invasive species on Lake Simcoe Protection Plan 'watch list' – Asian long-horned beetle (top-left, photo: David Copplefield, Ontario's Invading Species Awareness Program); Kudzu (bottom, photo: Sam Brinker, MNRF)

Black Ash Trees and Emerald Ash Borer

There are many traditional uses for Black Ash for our people. It was used to make such things as baskets for harvesting and for sale, cordage for binding materials and slats for canoes. Due to the invasive species the Emerald Ash Borer our community is in danger of losing our ash trees and those traditional uses.

5.3.6 Recreation

Despite the social values related to outdoor recreation, if not properly managed, recreation itself can become a stressor on natural heritage features. Impacts from recreational activities can include increased soil erosion (e.g. Marion and Cole, 1996), destruction of vegetation (Cole, 1995), introduction of invasive species (Potito and Beatty, 2005), and disturbance to resident wildlife (Miller *et al.,* 1998). These impacts can be largely mitigated with the appropriate design and location of trails and other recreational features, and the management of recreational users, to ensure that motorized vehicles and off-leash dogs are prohibited from sensitive sites.

While development in this subwatershed will be limited compared to other areas of the watershed, these types of impacts will no doubt increase, as the combination of larger populations and small lot sizes will tend to increase the numbers of people looking for opportunities for outdoor recreation. As a result, as development proceeds, the need to manage the impacts associated with outdoor recreation will only intensify.

5.3.7 Cormorants

Double-crested cormorants (*Phalacrocorax auritus*) are colonial waterbirds which have an established nesting colony on the southern shore of Georgina Island. This native species was historically abundant in the Great Lakes basin but experience large declines in the late 1800s and 1950s -1970s (Wires and Cuthbert 2006). Since the populations have rebounded in recent decades, there has been controversy regarding populations since many people view them as invasive species that threaten fisheries and destroy forest habitat.

5.3.8 Pesticide/Herbicide Use

Pesticides and herbicides are compounds commonly used for the treatment of unwanted or nuisance plants. While their use is regulated, they are frequently used for agricultural or residential landscaping purposes. Pesticides can have adverse effects on the environment as well as on human health (Sanborn *et al.* 2002). Pesticides can directly harm plants and wildlife, and excess residues can runoff through stormwater into streams and lakes. Where there is insufficient riparian and shoreline vegetation, pesticides can travel more directly into watercourses, and have adverse effects on fish, benthic invertebrates (Liess and Von Der Ohe 2005) and water quality. Pesticides can also leach into soil where they can persist for decades and impact soil quality and biodiversity (Burrows and Edwards 2002).

5.3.9 Climate change

Projections suggest that climate change will have significant impacts on terrestrial natural heritage features in the Lake Simcoe watershed. Recent modeling work was completed for the Lake Simcoe watershed, examining the response of tree species to climate change, as influenced through factors such as the current range of the species, its current local abundance, phenology, and seed production (Puric-Mladenovic *et al.,* 2011). As climates change, the model predicts that balsam fir, yellow birch, paper birch, American beech, and eastern hemlock will all exhibit slight decreases in their occurrence in the forests of the Georgina, Fox and Snake Islands subwatershed. In fact, the projected shifts in climate may cause some species which are currently relatively widely distributed to become more narrowly restricted to remaining habitat, including red maple becoming restricted to wetlands, as they shift to areas with moister soil, and yellow birch becoming restricted to ravines, as they shift to areas with cooler and moister microclimate. Other species, notably red oak are anticipated to become more common as a result of the warming climate.

Modeling results suggest that forests in cooler microclimates in ravines and north facing slopes, which tend to have a relatively high dominance of eastern hemlock, yellow birch, and American beech, may be among the most sensitive ecosystem to the changing climate. Sadly though, the species which the model suggests are the most vulnerable to climate change are those which we think of as being prototypically Canadian. Both sugar maple (Canada's national symbol), and white pine (Ontario's provincial tree) are predicted to experience severe declines in the Georgina, Fox and Snake Islands subwatershed (Puric-Mladenovic *et al.,* 2011).

A separate set of models, developed to assess the vulnerability of wetland ecosystems, suggest that a 'worst case' climate change scenario would have catastrophic impacts on wetlands in the Lake Simcoe watershed. The increases in average annual temperature and decreases in average annual precipitation projected to occur by the year 2100 is estimated to make 90% of the swamps and 84% of the marshes in the Lake Simcoe watershed vulnerable to drying. As drying occurs, it is expected that marshes would shift in composition to become swamp (or thicket swamp) type communities, and treed swamps would shift to become mesic forests. These same models suggest that the wetlands in the study area are quite vulnerable to these changes, due to the changes in groundwater discharge combined with changes in air temperature and precipitation (Chu, 2011). With almost 60% of the land mass on Georgina, Fox and Snake Islands being wetland, this could have large impacts on future land use and natural heritage features.

In sum, these models suggest that there will be a shift in community composition in the natural areas in the Georgina, Fox and Snake Islands subwatershed, and a net loss of tree species diversity; although the relatively high levels of natural cover in this subwatershed may to provide refugia for some species. Unfortunately, natural areas lacking in biodiversity tend to be more vulnerable to other threats such as insects, disease, and invasive species, suggesting that the impacts seen to terrestrial natural heritage features may become cumulative in nature.

This loss in native tree species diversity may be mitigated somewhat by the ability of species not currently found here to thrive in the expected new climate. Species found in southern

Ontario (such as black maple [*Acer nigrum]*) or the southeastern US (such as black hickory [*Carya texana*]) may become relatively common in forests in this subwatershed, further influencing the shift in plant community composition. However, the fragmented nature of the landscape that these species would need to cross will no doubt limit their ability to colonize forest remnants, without assisted migration (i.e. planting) (Puric-Mladenovic *et al.,* 2011).

Other, less desirable, species may also be able to respond positively to changing climates as well. Some invasive species are projected to experience a northward range expansion (e.g. Kudzu [*Pueraria lobata*], an extremely invasive vine), or experience increased growth rates and biomass (e.g. Eurasian water milfoil [*Myriophyllum spicatum*], a widespread invasive aquatic plant) (Sager and Hicks, 2011).

Shifts in forest community composition have already been noted by the community through the TEK survey (Chippewas of Georgina Island First Nation and OCCIAR 2015). Trees such as butternuts, maples, white ash and elms have decreased in abundance in recent years. Also, medicinal plants including ginseng, pigweed, leeks and fiddleheads are becoming harder to find.

The predicted impacts of climate change on wildlife are less clear. Some authors (e.g. Walpole and Bowman, 2011) suggest that as average annual temperature increases, more species of both birds and mammals will be able to inhabit the Lake Simcoe watershed. Others caution that, for some species, the disadvantages of climate change may outweigh the advantages. For example, wetland-dependent species may suffer significant population declines as wetlands dry up (Chu, 2011). Similarly, although some migratory birds have been able to take advantage of warmer springs and are migrating earlier, other species appear less able to adapt their behaviour to changing temperature and are vulnerable to not being able to find sufficient food resources or suitable nesting sites later in the season (Burke *et al.,* 2011). These relationships may be even more complicated in this subwatershed however, as the interacting effects of climate change, and development may constrain the ability of wildlife to colonize habitat areas, and to persist within them.

Some of these changes have already been observed by community members (Chippewas of Georgina Island First Nation and OCCIAR 2015). These include the arrival of new bird species to the subwatershed (eg. eagles, swans, mourning dove), increased abundance of owls, geese and spiders, and decreased abundance of frogs, reptiles and bees.

Additionally, a Climate Change and Adaptation Plan was completed by the Chippewas of Georgina Island First Nation and the Ontario Centre for Climate Impacts and Adaptation Resources (OCCIAR) in 2015. The objective of the plan was to expand knowledge on historical and current climate change impacts, and recommended adaptation measures to deal with current and future impacts.

The plan used climate data from Environment Canada (Shanty Bay station 1973-2012) as well as a Traditional Ecological Knowledge (TEK) survey to gather historical data. It then used models based on Environment Canada's Canadian Climate Change Scenarios Network (CCCSN), Huang et al (2012), and Gula and Peltier (2012) to project future climate changes for the Lake Simcoe watershed.

The following historical results were noted in the plan:

- Temperature increased for all seasons and all variables over the period of record
- Winter warmed more than the other seasons
- All seasons saw an increase in precipitation
- Winter saw the largest increased in precipitation
- The area experienced an increase in total annual rain (52mm), and a decrease in total annual snow (-16cm)
- Results of the TEK survey showed that island residents have noticed winters becoming shorter, milder winters with more rain than snow and ice melting faster. They have also noted that storms have become more frequent and severe and that wind is more severe than it used to be.

The plan then projected the following future changes in temperature and precipitation:

- Mean temperature is projected to increase in all seasons into the 2050s, with the greatest increase expected to occur in the winter.
- Annual precipitation projects are variable – they range from -10 to 16.6% change
- In regards to the seasonal changes in precipitation, the results vary between models, but all three predict a decrease in summer precipitation.

These projected changes in the local climate could result in several climate hazards which could have serious impacts, including thinner ice, a shorter lifespan for the ice road, decreased water quality, flooding, drought, and wildfire.

Key Points – Factors Impacting Terrestrial Natural Heritage - stressors

- There are multiple stressors to natural heritage systems in the Georgina, Fox and Snake Islands subwatershed, many of which interact.
- Over the short term, the greatest impact to natural heritage features is expected to be due to changes in land use. These impacts can only be expected to increase as development in this subwatershed increases.
- In addition to the direct loss of natural areas, development is typically associated with an increase in roads (which can cause mortality in wildlife and disturbance to remaining nearby natural areas), an increase in impervious surfaces (which can affect the hydrology of remnant natural areas), and the loss of natural habitat along shoreline and other riparian areas (which tend to be disproportionately important to wildlife).
- Remnant natural areas in settled landscapes typically face more intense stresses as well, including an increase in the number and diversity of invasive species, increased pressure from recreational users, and trophic cascades caused by changes in food webs and other inter-species relationships.
- The emerging threat of climate change will interact with all of these threats, creating additive long-term stresses on natural areas and wildlife populations. Although research in this area is still emerging, initial predictions and TEK suggest a loss of wetlands and wetland-dependent species, and a loss of some of our most-loved species of native trees and medicinal plants.

5.4 Current Community Initiatives

Various programs exist to protect and restore terrestrial natural heritage features in the Lake Simcoe watershed, ranging from regulatory mechanisms, to education programs, to funding and technical support provided to private landowners. Many of these programs already address some of the stresses facing terrestrial natural heritage in the Georgina, Fox and Snake Islands subwatershed.

The Georgina Island First Nation has undertaken measures to protect the abundant terrestrial natural heritage found within the First Nation, which includes:

- Completing studies including a forest management plan, wetland evaluation, breeding bird survey, forest plot sampling, and invasive species mapping. These studies help create a baseline knowledge of species present on the islands, which can be compared to future programs to monitor change over time. The studies also identified species of concern (species at risk and invasive species), for which to target actions.
- Undertaking the Traditional Ecological Knowledge/Climate Change study, in partnership with the Ontario Centre for Climate Impacts and Adaptation Resources. This study drew upon the extensive knowledge of the island's residents to identify changes that have occurred over time. This 'on-the-ground' knowledge and identification of changes and issues, has led to the identification of a number of management actions.
- Conducting annual Earth Day cleanups to keep Georgina Island clean of waste

5.5 Management gaps and recommendations

As can be seen in the previous sections, there are a number of programs in place to protect and enhance the natural heritage features in the Georgina, Fox and Snake Islands subwatershed. Despite this strong foundation, there are a number of gaps and limitations in the current programs and initiatives that could be improved upon in the future of subwatershed management.

Listed below is an initial 'long list' of recommendations for improving the state of natural heritage values in the Georgina, Fox and Snake Islands subwatershed, for discussion.

It is recognized that many of the undertakings in the following set of recommendations are dependent on funding from all levels of government. Should there be financial constraints, it may affect the ability of the partners to achieve these recommendations. These constraints will be addressed in the implementation phase.

5.5.1 Stewardship Implementation

In addition to protecting existing natural heritage features, programs which support the stewardship, restoration, or enhancement of private lands will be critical to meet or maintain the targets and objectives of the subwatershed plan. The success of these programs is however limited by the number of private landowners who voluntarily participate and so encouraging and facilitating landowner uptake is critical.

Recommendation 5-1 – That the Chippewas of Georgina Island First Nation encourage the implementation of stewardship projects on Georgina, Fox and Snake Islands by incorporating traditional teachings into stewardship projects (eg. Clan teachings, 4 element teachings, and teachings on the cultural and medicinal importance of plantings).

Recommendation 5-2 - That the Chippewas of Georgina Island First Nation implement Traditional ceremonies as a Community celebration to mark the changing of the seasons, giving thanks to the Creator for all She provides.

Recommendation 5-3 - That the Chippewas of Georgina Island First Nation develop tools to educate and promote stewardship uptake in the community, including:

- Medicinal Plant Booklets specific to terrestrial plants that the Community Members can use as a reference guide in determining plants to select for planting during restoration projects and their Traditional uses – building on our cultural connection.
- Terrestrial Species Booklets to identify existing and historical native species as well as invasive species and the best management practices for removal and control of invasive species.
- Traditional guides in regards to natural products to replace chemical products for use as weed and pest control.

Recommendation 5-4 – That the Chippewas of Georgina Island First Nation, the LSRCA and MNR, with the assistance of the MOE, use their draft 'Delineation of

Priority Areas for Restoration' report to develop a spatially-explicit decision support tool to assist in targeting terrestrial stewardship projects in the Lake Simcoe watershed. In the context of the Georgina, Fox and Snake Islands subwatershed, this decision tool should take into account factors including:

- The need to increase the extent of natural shoreline and riparian cover;
- The need to protect and restore grassland habitat; and,
- Opportunities to enhance resilience to climate change.

Recommendation 5-5 – That the Chippewas of Georgina Island First Nation create a full time position for the regular monitoring and updating of information on the Community web page, which would include opportunities for Community Members, as well as cottage residents, to access funding opportunities, attend educational outreach events, and participate in stewardship projects.

5.5.2 Invasive Species

Invasive species are a serious threat to forest and wetland biodiversity and their uncontrolled spread can have a number of effects on native ecosystems as described above. With climate change, the potential for invading species to establish in the First Nation is increased. While Fox Island doesn't currently contain an abundance of invasive species, they are quite established on Georgina and Snake Islands and managing their spread is critical to protecting the islands' natural heritage features.

Recommendation 5-6 - That the Chippewas of Georgina Island First Nation Identify invasive species within the First Nation territories and develop mapping as well as a Management and Removal plan.

Recommendation 5-7 - That the Chippewas of Georgina Island First Nation identify invasive species that may have a positive effect for the First Nation (i.e. plants that have similar characteristics and uses for the replacement of native species that may not survive with the changing climate)

Recommendation 5-8 - That the Chippewas of Georgina Island First Nation develop protocols and/ or policies for inspecting vehicles being transported on the ferry boat for invasive species. Develop protocols and / or policies for Snake and Fox Islands and ensure that all are being implemented.

5.5.3 Monitoring and Assessment

Long-term monitoring is required to identify changes and trends occurring in the terrestrial community. Regular assessments of forest composition and health, species at risk and migratory and resident bird populations are also intended to provide information that will direct future rehabilitation efforts. Additional environmental characteristics such as invasive species spread, ash and butternut tree health, and the water availability of wetlands will need to be considered to provide the information to look at the system in an integrated and holistic way. A renewed need for regular monitoring and reporting of the results and a systematic re-evaluation of the program is also required.

> **Recommendation 5-9 –** That the Chippewas of Georgina Island First Nation develop a monitoring plan to identify gaps in existing research and prioritize research and monitoring needs. This could include groundwater monitoring, nearshore lake studies, stream monitoring, regular monitoring of keystone species, and/or forest species composition monitoring, among other. The monitoring plan should consider other monitoring and assessment recommendations from the subwatershed plan.
>
> **Recommendation 5-10** - That the Chippewas of Georgina Island First Nation collect Traditional Ecological Knowledge from the Community Members 1-4 times per year through a survey, summer student or other program, in order to collect the qualitative information on the health of the forests and terrestrial species.
>
> **Recommendation 5-11** - That the Chippewas of Georgina Island First Nation identify specific wildlife and plant species to be monitored annually or even seasonally (e.g., salamanders) that would indicate the overall health of the terrestrial natural heritage of the First Nation lands. Species identified could also be incorporated into traditional teachings to the community.
>
> **Recommendation 5-12** - That the Chippewas of Georgina Island First Nation identify specific species to be monitored that have a correlation to terrestrial health (e.g. frogs and turtles) and monitor them regularly. Species identified could also be incorporated into traditional teachings to the community**.**
>
> **Recommendation 5-13** - That the Chippewas of Georgina Island First Nation develop a protocol to direct and ensure that the First Nation Administration Departments have up to date information in a centralized location.
>
> **Recommendation 5-14** - That the Chippewas of Georgina Island First Nation access and utilize partnerships with other organizations such as the LSRCA, MOE, York Region Health, etc.
>
> **Recommendation 5-15** - Given the apparent "quasi old-growth" nature of the forest on Fox Island, that the MNR should establish one or more of their long-term natural heritage monitoring plots at this location.
>
> **Recommendation 5-16** - That the Chippewas of Georgina Island First Nation, with support from the LSRCA initiate further research to determine the cause of the wetlands drying up.
>
> **Recommendation 5-17** - Given the importance of the islands as migratory bird stopover habitat, that the Chippewas of Georgina Island First Nation develop a program to educate the community and promote seasonal bird counts.
>
> **Recommendation 5-18** - That the Chippewas of Georgina Island First Nation Develop a program to monitor and manage the ginseng populations.

Recommendation 5-19 - That the Chippewas of Georgina Island First Nation expand the current forestry mapping to include Fox and Snake Islands.

5.5.4 Climate Change

The adaptation plan, developed through the Georgina Island First Nation and Ontario Centre for Climate Impacts and Adaptation Resources three-year climate change study, identified a number of recommended adaptation actions to address and/or mitigate some of the changes that have been observed on the island by its residents and are thought to be due to climate change. They have been placed into four categories: Engage People, Reduce Threats, Improve Knowledge, and Enhance Adaptive Capacity. Relevant adaptations are included below under these four categories.

<u>Engage People</u>

Recommendation 5-20 - That the Chippewas of Georgina Island First Nation develop communication plans to notify community members of:

- Extreme weather events
- Ice conditions (ice road, ice road landings, presence of pressure cracks, and overall ice conditions for recreation purposes)
- Dry conditions (including fire bans and precautions)
- Wind conditions

This could include such measures as signage at beaches and specified areas around the island, a communications board at the mainland access points, the development of an e-mail distribution list, the posting and/or distribution of Environment Canada's automated weather notices, among other actions.

<u>Reduce Threats</u>

Recommendation 5-21 - That the Chippewas of Georgina Island First Nation bridge gaps between those who conduct agricultural activities with organizations like OMAFRA and educate them on best management practices and encourage them to implement them.

<u>Improve Knowledge</u>

Recommendation 5-22 - That the Chippewas of Georgina Island First Nation improve communication with the Community to promote outreach activities.

Recommendation 5-23 - That the Chippewas of Georgina Island First Nation educate the Community members in terrestrial monitoring protocols to promote citizen science programs.

Enhance Adaptive Capacity

Recommendation 5-24 - That the Chippewas of Georgina Island First Nation develop a program to replace ash trees with other native species, as they are removed due to emerald ash borer.

Recommendation 5-25 - That the Chippewas of Georgina Island First Nation develop a program to collect and propagate nuts from butternut and oaks, to be used in reforestation projects.

5.5.5 Recreation

Although recreational activities (eg. ATVs, hiking) promote the appreciation of natural areas, excessive or incorrect use of trails can have negative effects on terrestrial ecosystems. The management and maintenance of trail systems and education of users is important for the protection of natural features.

Recommendation 5-26 - That the Chippewas of Georgina Island First Nation update the existing trail maps within the First Nation on Georgina, Fox and Snake Islands.

Recommendation 5-27 - That the Chippewas of Georgina Island First educate landowners on the importance of maintaining recreational trails and potential impacts on terrestrial natural heritage when trails are not used appropriately or maintained.

Recommendation 5-28 - That the Chippewas of Georgina Island First Nation develop a trails guide outlining rules, regulations and restrictions for both community members and cottagers.

Recommendation 5-29 - That the Chippewas of Georgina Island First Nation develop and post signage in designated areas outlining rules, regulations and restrictions of trail use.

6 Integration and Implementation

6.1 Introduction

This subwatershed plan has been developed with technical chapters arranged thematically, to allow us to examine each theme in detail, and to allow this document to address the specific issues identified in the Georgina Island First Nation Climate Change Adaptation Plan and the Lake Simcoe Protection Plan. This integration chapter, however, is intended to highlight the interactions between water quality, terrestrial ecosystems, shoreline ecosystems and aquatic ecosystems, and to describe some of the natural processes supporting biodiversity and watershed health in the Georgina, Fox and Snake Islands subwatershed. An understanding of how these factors interact is important to gain a full understanding of the watershed ecosystem, and to design conservation programs which are both effective and cost-efficient. To help build this understanding, this chapter examines how some of the key points highlighted in Chapters 3 to 5 interact, through the use of conceptual diagrams. Conceptual diagrams are useful tools for synthesizing complex, detailed information in a form that is attractive and informative. Conceptual diagrams are ‘thought drawings’ that provide representations of ecosystems or watersheds, and highlight key attributes and interactions, in a form that is readily understandable by a wide range of audiences (Longstaff *et al*., 2010).

6.2 Shoreline interactions - activities in and near the lakeshore, water quality, and aquatic wildlife

Of particular importance to this island subwatershed is the role played by Lake Simcoe and its shoreline. The shoreline along Georgina, Fox and Snake Islands, as well as the mainland has been the focus of development and public use for nearly a century, which has led to an increase in the extent of impervious surfaces and hardened banks, and increased population levels (Figure 6-1). A large proportion of the native vegetation has been removed from the shoreline in this subwatershed, and what is left is often mowed right to the water's edge.

The loss of shoreline vegetation has negative impacts on nearshore aquatic communities, through an increase in water temperature and sediment input, and a decrease in input of woody debris (which is an important component of habitat for many aquatic organisms). Unfortunately, the impacts of this loss of vegetation are often exacerbated by other works along the shoreline, such as the installation of concrete, steel, or wood as retaining walls to prevent erosion or to make the shoreline more conducive for recreation. The loss of the natural shoreline and associated aquatic vegetation associated with this construction means a loss of spawning and feeding habitat for native fish (Figure 6-1).

This type of shoreline development, in combination with an increase in impervious surfaces, also increases the amount of contaminants in runoff. Increased nutrients and an increase in temperature create an ideal growing situation for algae and aquatic plants, which can be a nuisance to swimmers and boaters, can impact drinking water sources, and can also create anoxic conditions for aquatic communities. Shoreline areas are also disproportionately important for terrestrial wildlife as well, as the clearing of shoreline areas for cottages or homes leads to loss of habitat for songbirds, amphibians, turtles, and small mammals.

Although the development of individual shoreline properties may seem small in nature, the cumulative effect of all of these small developments can add up to significant impacts. Of the shoreline length of Georgina, Fox and Snake Islands, approximately 70%, 65% and 85% is currently developed, respectively.

Stewardship options for shoreline properties include septic system repairs, shoreline naturalization, erosion control projects, and tree planting (Figure 6-2). Support for these types of projects is provided by the MNRF and LSRCA.

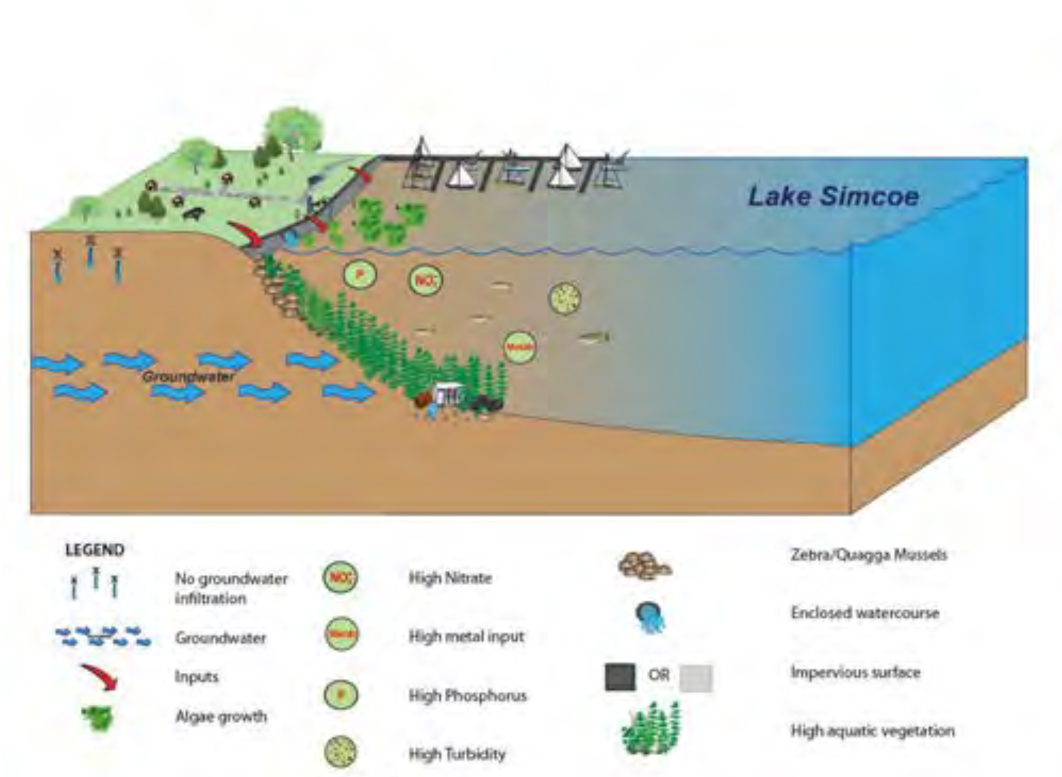


Figure 6-1: Influences of shoreline land use on subwatershed health

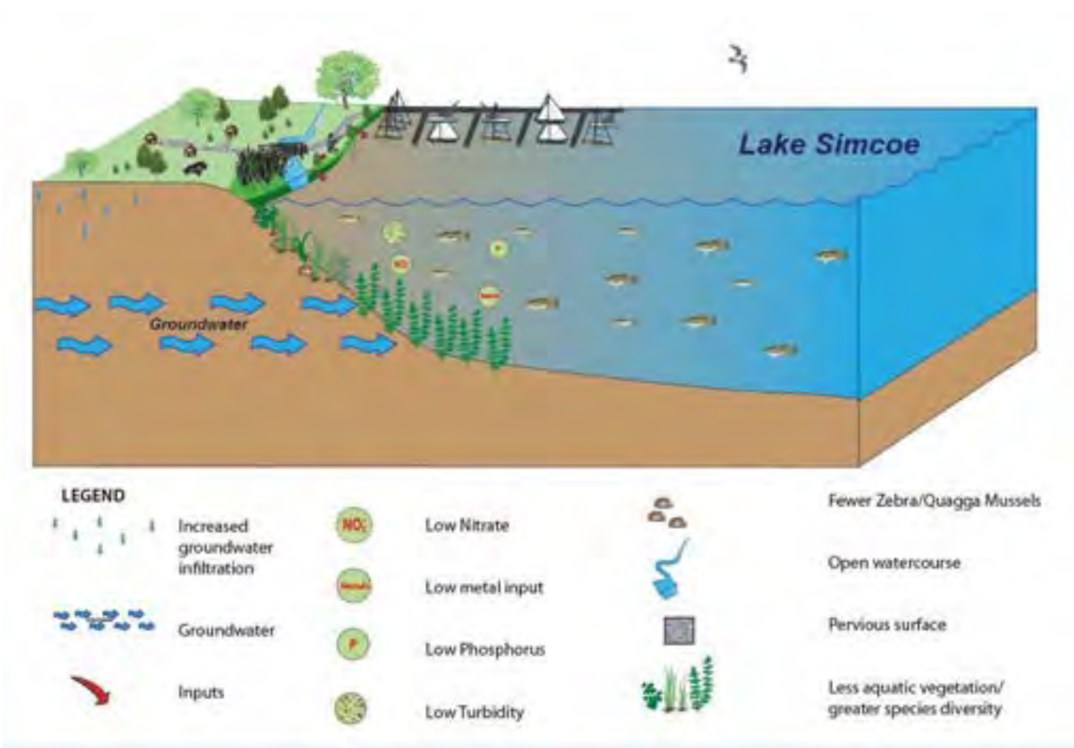


Figure 6-2: Shoreline area with appropriate best practices implemented to protect subwatershed health

6.3 In-stream interactions - activities in and near creeks, water quality, and aquatic wildlife

In addition to actions being undertaken across the watershed as a whole, actions in or near creeks can have even more direct impacts to hydrologic and ecologic systems. The riparian buffers along the edges of watercourses or the lake make important contributions to aquatic wildlife, as the plant debris that is dropped into the water body provides an important food source for aquatic invertebrates, which form the base of aquatic food webs. The shade provided by vegetation along the banks, particularly for small streams like many of the tributaries in this subwatershed, plays an important role in reducing water temperature in mid-summer, which is a particularly important factor in providing habitat for more sensitive species. Riparian vegetation also makes an important contribution to terrestrial wildlife, acting as a productive source of food for many species, and acting as a migration corridor through landscapes that are often otherwise lacking in native vegetation. In fact, given the fragmentation of habitat by roads, agriculture, and urban communities in parts of this subwatershed, riparian zones can provide some of the best opportunities to maintain and increase connectivity for wildlife.

When this vegetation is cleared, these benefits are lost. The impacts of lost riparian vegetation can be exacerbated by other more extreme interventions such as stream channelization, bank hardening, or climate change. These types of interventions remove habitat for aquatic species, and increase the velocity of water, causing an increase in erosion downstream of the hardened or enclosed site, or in areas where the hardening begins to fail, which in turn increases sedimentation and phosphorus inputs (Figure 6-3).

Figure 6-3: Influences of riparian land use on subwatershed health

These impacts can also be worsened by barriers in creeks, such as perched culverts which can affect water flow through a drainage system and alter the flow of oxygen and nutrients. Barriers in creeks can fragment fish habitat, impeding the seasonal travel of migrant spawners such as white sucker, and impeding the ability of other species to disperse through the drainage network. Over time, barriers can lead to a loss in fish biodiversity, as isolated stream reaches become more vulnerable to local extinctions (Figure 6-3). Septic systems, which support many of the l residences in this subwatershed, can also be a source of phosphorus to nearby watercourses as well as the lake and can impact water quality, if they are not properly maintained.

Creek-based stewardship activities beyond the establishment of additional riparian vegetation can be difficult however, as projects related to channel restoration can be extremely expensive, and in some developed areas, options to establish a naturally meandering channel can be extremely constrained due to conflicting land uses. Despite that, several opportunities to remove barriers from creeks and naturalize creeks which have been channelized remain in this subwatershed, where adjacent land uses permit (Figure 6-4).

Figure 6-4: Riparian area with appropriate best practices implemented to protect subwatershed health

6.4 Groundwater interactions - land cover, groundwater, and aquatic habitats

The amount of precipitation that infiltrates through the soil to contribute to groundwater depends on the permeability of the soil. Groundwater recharge is most significant in areas with coarse, highly permeable soils such as sandy or gravelly sites on heights of land, and is often found in the headwaters of watersheds (Figure 6-5) (Earthfx, 2014). In the case of the Georgina, Fox and Snake Islands subwatershed, the regional groundwater flow contribution from within the subwatershed supports numerous wetland and stream features, especially on Georgina Island. Forests promote infiltration by intercepting the rain and reducing the force at which it strikes the soil. They also increase soil porosity through the actions of root growth and decomposition, and the actions of small mammals and other burrowing wildlife.

The groundwater flow in this subwatershed is not well known but likely has a large influence on water availability for streams and wetlands, as well as drinking water wells.

For some watercourses, particularly small ones, groundwater discharge can be a significant contributor to flow during times of limited rainfall where these systems tend to dry up in the summer months when the shallow sub-surface flow is depleted. In cases where the watercourses supported by groundwater sources, such as in the headwaters, the addition of this water obviously plays a role in protecting fish habitat, but even in larger systems, the typically cold discharged groundwater can decrease the temperature of the creek, helping it to support healthier fish communities. As such, the preservation of groundwater recharge and discharge, even at relatively large distances from creeks, is critical to preserving the fish habitat that is present in this subwatershed.

In areas that have become developed, this groundwater relationship can be interrupted (Figure 6-5). Because developed areas constitute such a small portion of the study area, it is not likely that there have been significant impacts to infiltration.

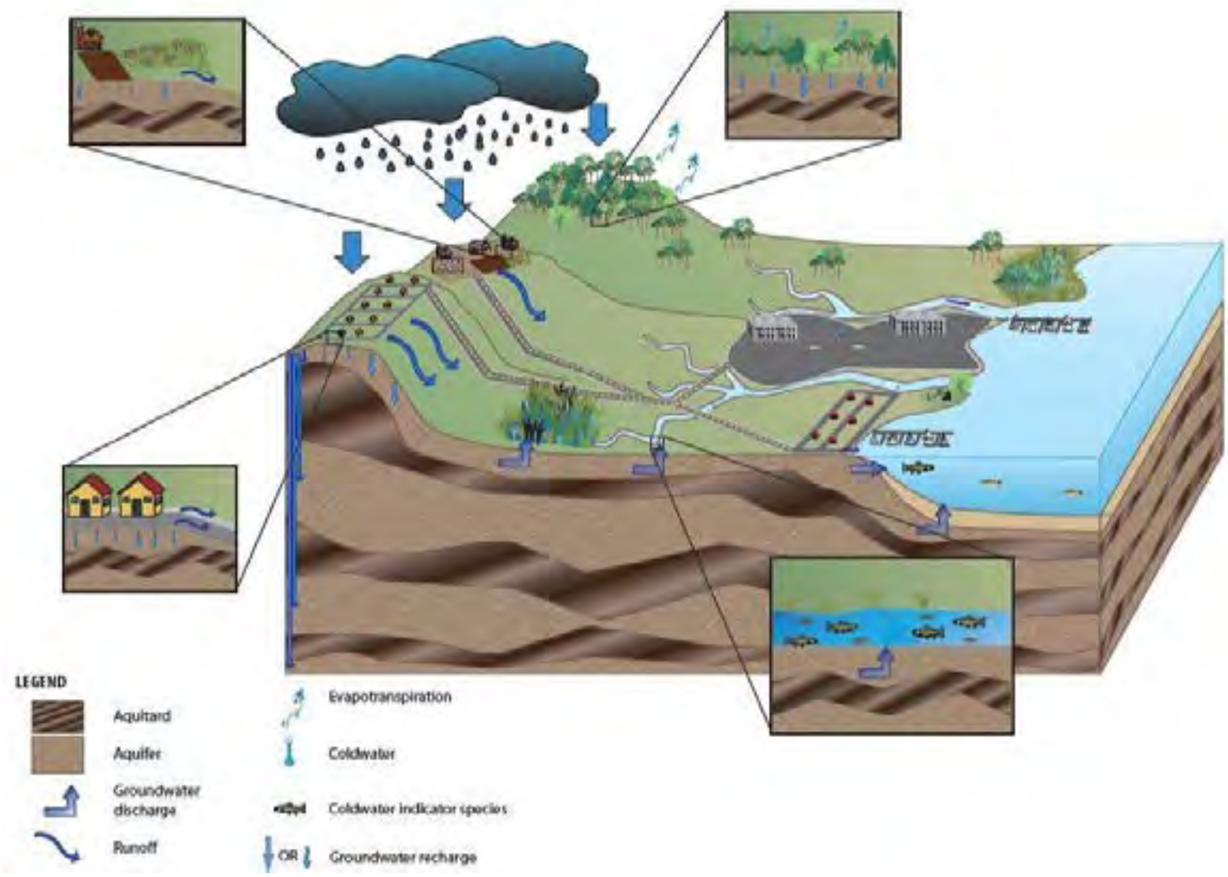


Figure 6-5: Groundwater interactions in the Georgina, Fox and Snake Islands subwatershed

6.5 Developing an implementation plan

The Georgina, Fox and Snake Island Subwatershed Plan includes an assessment of the current state of the environment in the subwatershed, the stressors upon its health, and the current management framework and community initiatives to address those stressors. As a result of that assessment, the subwatershed plan has developed a list of recommended actions which, if implemented, would provide additional guidance on the protection and restoration of that subwatershed.

Achieving these recommendations will require the coordinated response of the Georgina Island First Nation, the LSRCA, as well as many cottagers, working together in a multifaceted approach to protecting and improving subwatershed health. To ensure these actions are fostered and coordinated, this subwatershed plan will be complemented with a Subwatershed Implementation Plan.

The Subwatershed Implementation Plan is a brief document, intended to provide the necessary support and direction to achieve a short list of priority recommendations within five years of the completion of this subwatershed plan. To meet that goal, the implementation plan is written with more specific detail on timelines, deliverables, and the specific steps necessary to achieve those priority recommendations.

7 Combined Recommendations

This chapter provides a compiled list of the recommendations identified in the detailed technical chapters of this subwatershed plan. These recommendations have been brought forward and prioritized in the development of an implementation plan for the Georgina, Fox and Snake Islands subwatershed. Those recommendations that were carried forward into the implementation plan have been highlighted in grey.

The recommendations in this chapter have been grouped into categories of similar issues. Thus, for example, recommendations derived from the terrestrial natural heritage chapter may be grouped with recommendations derived from the water quality chapter, in cases where they address shared issues. In such cases, the numbering system will allow the reader to trace the recommendation back to the chapter where it originated.

Recommendations in the following list are numbered as chapter number – recommendation number. In cases where a recommendation originated from more than one chapter, it is numbered based on its first occurrence, with all other occurrences listed in parentheses.

It is recognized that many of the undertakings in the following set of recommendations are dependent on funding from all levels of government. Should there be financial constraints, it may affect the ability of the partners to achieve these recommendations. These constraints will be addressed more fully in the implementation phase.

7.1 Protection and policy

7.1.1 Protecting natural heritage

Recommendation 3-27 - Develop programs to reduce the nutrient load into the lake and tributaries, and to reduce the amount of contaminants entering the lake from agricultural practices and septic systems. Measures under such programs could include promoting the use of phosphorus free fertilizers, implementing a septic system inspection program and encouraging the regular maintenance of septic systems, and stewardship efforts to enhance vegetation along streams and shorelines.

Recommendation 3-36 (5-21) - That the Chippewas of Georgina Island First Nation bridge gaps between those who conduct agricultural activities with organizations like OMAFRA and educate them on best management practices and encourage them to implement them.

Recommendation 4-10 – That measures be taken to mitigate increases in water temperature and barriers to fish and benthic invertebrate movement, including planting riparian vegetation and removing perched culverts.

Recommendation 4-22- That GIFN and its partners undertake projects to establish healthy buffer zones around the lake and tributaries to reduce the amount of contaminants and nutrients entering the lake and tributaries, including during and after extreme rainfall events.

Recommendation 4-23 (3-30) - That the GIFN develop a shoreline protection program or initiatives. Possible mechanisms for this program might include:

- The development and distribution of educational materials for landowners, such as fact sheets and public workshops/presentations;
- The requirement, through permits required for shoreline works, to stipulate that a natural buffer be left along the shoreline, or that the shoreline should be managed in such a way that it enhances conditions for fish and wildlife, or that mimics its natural condition;
- Discouraging shoreline hardening using materials such as concrete and armourstone, and giving preference to more natural shoreline stabilization solutions such as bioengineering and rock revetments (as referenced in http://www.ourlakesimcoe.com/documents/pdf/shorelinemanagement_landowner.pdf);
- Working with landowners to replace hardened shore walls with more natural features (http://www.ourlakesimcoe.com/documents/pdf/shorelinemanagement_landowner.pdf); and,
- Ensuring that docks are designed and built such that they do not negatively impact fish habitat (http://www.ourlakesimcoe.com/documents/pdf/shorelinemanagement_landowner.pdf)

Recommendation 4-24 - Develop ecosystem restoration, creation, or enhancement projects to restore and protect creeks and wetlands/swamps on the island (see section 5.5.1 above for more detail around stewardship recommendations.

Recommendation 4-25 - That the GIFN develop and enforce bylaws to limit clearing of sites and maintain existing vegetative cover and buffer zones to the maximum extent practicable.

Recommendation 4-27 - That the GIFN develop a program to educate the community on the importance of keeping drainage ways (e.g. creeks and culverts) clear of debris. This should be balanced with the need to ensure that any ecological function in these ditches is maintained (e.g. if drainage ways are dredged, ensure that any fish using the ditch for habitat and/or spawning will not be affected. This could include the identification of timing windows for these types of works). This could include printed brochures and/or fact sheets, and presentations and displays at community events

7.1.2 Protecting drinking water resources

Recommendation 3-19 - That the Georgina Island First Nation develop a source water protection plan.

7.1.3 Improving construction practices

Recommendation 3-1 - That the Georgina Island First Nation amend the Building By-law and Land Use Plan to include erosion and sediment control requirements, and ensure enforcement of the requirements through the addition of enforcement staff.

Recommendation 3-2 - That the Georgina Island First Nation promote and encourage the adoption of best management practices to address sedimentation and erosion controls during construction and road development. This may include, but will not be limited to, explicit wording in permits detailing what is required in this regard.

7.1.4 Improving trail use

Recommendation 3-20 - That the Georgina Island First Nation complete a comparison of historical trails and existing trails to identify areas which may be causing water quality issues and may need to be closed and / or require restoration work.

Recommendation 3-21 (5-26) - That the Chippewas of Georgina Island First Nation update the existing trail maps within the First Nation on Georgina, Fox and Snake Islands.

Recommendation 3-22 (5-27) - That the Chippewas of Georgina Island First educate landowners on the importance of maintaining recreational trails and effects of sediment runoff on water quality when trails are not used appropriately or maintained.

Recommendation 3-23 (5-28) - That the Chippewas of Georgina Island First Nation develop a trails guide outlining rules, regulations and restrictions for both community members and cottagers.

Recommendation 3-24 (5-29) - That the Chippewas of Georgina Island First Nation develop and post signage in designated areas outlining rules, regulations and restrictions of trail use.

7.1.5 The adaptive watershed planning process

Recommendation 7-1 - That the GIFN, LSRCA, and other relevant and interested stakeholders establish an implementation working group to assist in coordinating the implementation priority recommendations to address the most significant threats in these subwatersheds.

Recommendation 7-2– That the GIFN and LSRCA, with the assistance of government agencies and stakeholder groups involved in implementing the recommendations of this subwatershed plan, report on the progress of this implementation annually.

Recommendation 7-3 – Within five years of the completion of this subwatershed plan, that the GIFN and LSRCA, in collaboration with MOECC, MNRF, and other interested and relevant stakeholders, review progress on achieving its recommendations and update the subwatershed plan accordingly.

7.1.6 Invasive species

Recommendation 4-11 (5-6) - Identify invasive species within the First Nation territories and develop a Management and Removal Plan.

Recommendation 4-12 (5-7) - Identify non-native species that have similar characteristics and uses as replacement for native species that may not survive with the changing climate.

Recommendation 4-13 (5-8) - That the Georgina Island First Nation put a protocol and/ or policy in place for checking vehicles on the ferry boat and ensue that they are being implemented. Put protocols and/or policies in place for Snake and Fox Islands as well.

Recommendation 4-14 - That the Georgina Island First Nation post information at marinas, on the ferry, in the band office, and in other public areas about invasive species of concern, and what individuals can do to prevent their introduction and spread in the Lake Simcoe watershed.

7.2 Restoration and remediation

7.2.1 Increasing uptake of stewardship programs

Recommendation 3-4 (4-1, 5-2) - Implement Traditional ceremonies as a Community celebration to mark the changing of the seasons, giving thanks to the Creator for all She provides.

Recommendation 3-6 (4-3) - Develop maps that identify natural water flow and connectivity that Community Members could utilize in determining locations for developmental purposes as well as stewardship efforts; ensuring those pathways are healthy and stay connected so that there is the proper flow and filtering before the water hits the lake. Also to ensure that maps are continually updated to reflect any development or stewardship projects that has occurred.

Recommendation 3-8 - Educate and encourage people to maintain or recreate the vegetated buffer zones along the shoreline and any other waterway on their properties.

Recommendation 3-9 (5-1) - Incorporate traditional teachings into stewardship projects (ie. water teaching, teachings on the different plants that are being planted and their cultural and medicinal purpose).

Recommendation 3-26 (4-21, 5-5) - That the Chippewas of Georgina Island First Nation Create a full time position for the regular monitoring and update of information on the Community web page, which would include opportunities for community members - as well as cottage residents - to access information and funding opportunities, and participate in stewardship projects.

Recommendation 4-6 - Create and/or publicize link to a website that provides information and contact information on available funding programs for stewardship works, and ensure that this site is kept current.

Recommendation 4-8 – Implement traditional ceremonies to honour the water and give thanks to the creator and Mother earth and to bring awareness to the community members and others of the importance of water.

Recommendation 5-3 (3-5, 3-7, 4-2, 4-4, 4-5) - That the Chippewas of Georgina Island First Nation develop tools to educate and promote stewardship uptake in the community, including:

- Medicinal Plant Booklets specific to terrestrial plants that the Community Members can use as a reference guide in determining plants to select for planting during restoration projects and their Traditional uses – building on our cultural connection;

- Terrestrial Species Booklets to identify existing and historical native species as well as invasive species and the best management practices for removal and control of invasive species;
- Traditional guides in regards to natural products to replace chemical products for use as weed and pest control; and,
- Aquatic plant booklets, identifying filter plants that could be planted in wetland areas and shorelines, such as the water lily and identify the traditional medicinal uses building on our cultural connection.
- Aquatic species booklets, identifying existing and past species as well as invasive species, including the BMPs for removal and control of invasive species.

Recommendation 5-22 - That the Chippewas of Georgina Island First Nation improve communication with the Community to promote outreach activities.

7.2.2 Prioritizing stewardship projects

Recommendation 3-3 - That the recently developed spatially-explicit prioritization tool be used to properly allocate stewardship resources, so that projects are undertaken in locations where maximum phosphorus reduction can be achieved. The undertaking of stewardship projects should be a priority in the study area, as they present some of the best opportunities to improve water quality and aquatic health. Further, that these tools should be updated continually to reflect updated information and the completion of projects.

Recommendation 4-7 – That prioritized restoration areas identified through the recently developed tool be integrated into a stewardship plan that ensures prioritized restoration opportunities are undertaken as soon as feasible. If needed the parameters for the tool should be refined to reflect the unique nature of the study area, and specific priorities for the study area should be identified.

Recommendation 5-4 – That the Chippewas of Georgina Island First Nation, the LSRCA and MNR, with the assistance of the MOE, use their draft 'Delineation of Priority Areas for Restoration' report to develop a spatially-explicit decision support tool to assist in targeting terrestrial stewardship projects in the Lake Simcoe watershed. In the context of the Georgina, Fox and Snake Islands subwatershed, this decision tool should take into account factors including:

- The need to increase the extent of natural shoreline and riparian cover;
- The need to protect and restore grassland habitat; and,
- Opportunities to enhance resilience to climate change.

7.2.3 Reducing salt use

Recommendation 3-35 - Encourage the strategic placement of snow fencing in the winter to reduce drifting snow over roads and in ditches to reduce overland run off during the spring thaw.

Recommendation 3-37 - Regulate and reduce traffic on the ice road to minimize the amount of salt and other pollutants from vehicles reaching the lake and the landings (ie. through the implementation of tolls for non-member use).

Recommendation 4-9 – In conjunction with the LSRCA, utilize programs and train public work staff as well as staff hired for the mainland access points in the Smart about salt program.

7.2.4 Reforestation

Recommendation 5-24- That the Chippewas of Georgina Island First Nation develop a program to replace ash trees with other native species, as they are removed due to emerald ash borer.

Recommendation 5-25 - That the Chippewas of Georgina Island First Nation develop a program to collect and propagate nuts from butternut and oaks, to be used in reforestation projects.

7.3 Science and Research

7.3.1 Improving knowledge transfer

Recommendation 3-15 (5-14) - That the Georgina Island First Nation access and utilize partnerships with other organizations such as the LSRCA, MOE, York Region Health, etc.

Recommendation 3-16 - That the Georgina Island First Nation mandate that consultants share information with the First Nation in regards to changes they may have noticed within the First Nation lands.

Recommendation 4-16 (5-13) – Develop a protocol to direct and ensure that the First Nations administration departments have up to date information in a centralized location.

Recommendation 4-18 – That LSRCA and its partners work to create a centralized location for reports and resources pertaining to Lake Simcoe and its watershed such that information can be accessed by all interested stakeholders.

7.3.2 Monitoring and assessment

Recommendation 3-10 - That the Georgina Island First Nation undertake regular monitoring of the water quality in island tributaries, potentially through the development of a Citizen Science program, and/or as a Water Treatment Plant Operator responsibility.

Recommendation 3-11 - That the Georgina Island First Nation develop a groundwater monitoring program to include the installation of monitoring wells and regular monitoring of groundwater quality, levels and flow.

Recommendation 3-12 - That the Georgina Island First Nation implement regular monitoring and maintenance of the First Nations Landfill site to ensure that there is no groundwater or surface water contamination.

Recommendation 3-13 - That the Georgina Island First Nation continue with the septic system repair and replacement program until all systems are up to date and functioning properly. Develop and implement a septic system monitoring and maintenance program; create full-time position for the enforcement of this program.

Recommendation 3-14 - Monitor the salt use (both road salt and water softeners) at the mainland access points as well as on the First Nation, and their effect on water quality.

Recommendation 4-15 (5-10) – That the Chippewas of Georgina Island First Nation collect Traditional Ecological Knowledge 1-4 times per year from the community members through a survey or summer student or other program to collect the qualitative information on the health of the systems and species.

Recommendation 4-17 – That LSRCA, with support from the Chippewas of Georgina Island First Nation, aim for improved spatial and temporal resolution in annual monitoring of aquatic habitat, including water quality, fish, and benthic indicators.

Recommendation 5-9 – That the Chippewas of Georgina Island First Nation develop a monitoring plan to identify gaps in existing research and prioritize research and monitoring needs. This could include groundwater monitoring, nearshore lake studies, stream monitoring, regular monitoring of keystone species, and/or forest species composition monitoring, among other. The monitoring plan should consider other monitoring and assessment recommendations from the subwatershed plan.

Recommendation 5-23 - That the Chippewas of Georgina Island First Nation educate the Community members in terrestrial monitoring protocols to promote citizen science programs.

7.3.3 Additional research needs

Recommendation 3-17 - Identify specific species to be monitored that have a correlation to water quality such as the frog and turtles and monitor them. Species identified could also have traditional teachings about them to the community.

Recommendation 3-18 - That the Georgina Island First Nation initiate a research study on the effects of personal care products and pharmaceuticals on water quality.

Recommendation 4-19 - Initiate research into factors affecting aquatic natural heritage features, including the impacts of interior wetlands and water softeners.

Recommendation 4-26 - That the GIFN, in partnership with LSRCA, develop a long-term monitoring program to monitor the change in water plants around Georgina Island with changing climate.

Recommendation 5-11 - That the Chippewas of Georgina Island First Nation identify specific wildlife and plant species to be monitored annually or even seasonally (e.g., salamanders) that would indicate the overall health of the terrestrial natural heritage of the First Nation lands. Species identified could also be incorporated into traditional teachings to the community.

Recommendation 5-12 - That the Chippewas of Georgina Island First Nation identify specific species to be monitored that have a correlation to terrestrial health (e.g. frogs and turtles) and monitor them regularly. Species identified could also be incorporated into traditional teachings to the community.

Recommendation 5-15 - Given the apparent “quasi old-growth” nature of the forest on Fox Island, that the MNR should establish one or more of their long-term natural heritage monitoring plots at this location.

Recommendation 5-16 - That the Chippewas of Georgina Island First Nation, with support from the LSRCA initiate further research to determine the cause of the wetlands drying up.

Recommendation 5-17 - Given the importance of the islands as migratory bird stopover habitat, that the Chippewas of Georgina Island First Nation develop a program to educate the community and promote seasonal bird counts.

Recommendation 5-18 - That the Chippewas of Georgina Island First Nation Develop a program to monitor and manage the ginseng populations.

Recommendation 5-19 - That the Chippewas of Georgina Island First Nation expand the current forestry mapping to include Fox and Snake Islands.

7.4 Climate Change

7.4.1 Adapting to climate change

Recommendation 3-25 (4-20, 5-20) - That GIFN develop communication plans to notify community members of:

- Extreme weather events;
- Ice conditions (ice road, ice road landings, presence of pressure cracks, and overall ice conditions for recreation purposes);
- Dry conditions (including fire bans and precautions);
- Wind conditions; and,
- Beach closures, among other things.

This could include such measures as signage at beaches and specified areas around the island, a communications board at the mainland access points, the development of an e-mail distribution list, and the posting and/or distribution of Environment Canada’s automated weather notices, among other actions.

Recommendation 3-28 - Undertake remediation projects that address water quality issues that might arise during and/or after an extreme rain event.

Recommendation 3-29 - Develop remediation or restoration measures to address water quality issues that might arise as a result of warmer water temperatures to ensure the safety of the community.

Recommendation 3-31 - Develop a shoreline protection program or stewardship initiatives that reduce the risk to drinking water associated with climate change

Recommendation 3-32 - Develop public and private stewardship initiatives to restore water quality

Recommendation 3-33 - Develop water conservation programs

Recommendation 3-34 - That the Georgina Island First Nation upgrade the water treatment plant and water distribution infrastructure; ensure regular maintenance of infrastructure

Recommendation 3-38 - Develop program(s) to monitor algal blooms around the island.

Recommendation 3-39 - Enhance communication with community members in regards to outreach and education for monitoring programs.

Recommendation 3-40 - Develop best management program to educate home and cottage owners on how to protect the quality of water in their well.

Recommendation 3-41 - Encourage and promote community members and cottagers alike to get involved and participate in water quality improvement projects.

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