SOUTH NATION
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# State of the Nation Technical Report

June 2014

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## Executive Summary

This report evaluates natural resources and habitat features within the jurisdiction of South Nation Conservation (SNC) as they relate to watershed health, and should be viewed as a technical companion to the Subwatershed Report Cards and the State of the Nation report. These reports are essential communication products that will inform the community on the status of natural resources within their respective subwatersheds using comprehensive indicators, in a simplified, user-friendly format.
The objectives of this report are to:

- Communicate watershed health to those involved in land-use planning and management (i.e., Municipalities, public, watershed managers, planners, and developers).

- Provide recommendations for stewardship and restoration activities that will aid in the improvement of watershed health within SNC jurisdiction.

This document summarizes information that has been collected on forests, wetlands, and rivers within the SNC jurisdiction from 2008 to 2012, to provide context of the health of the watershed, and highlight areas that are faring well, and those which may need improvement.

The results of habitat and water quality assessments are compared to several target-setting guidelines set out in Conservation Ontario's 2011 Guide to Developing Conservation Authority Watershed Report Cards. Assessments are provided at both the 5th order and 6th order subwatershed scale. 5th order assessments provide a more detailed analysis of what's happening on the landscape, while 6th order assessments provide a summary of resource conditions across SNC's jurisdiction.

Several water quality parameters were chosen to link water quality results to specific non-point source influences in the watershed. Parameters are compared to available Water Quality Objectives, published as Provincial Water Quality Objectives (PWQO) or Canadian Water Quality Guidelines for the Protection of Aquatic Life (CWQG). Total phosphorus levels are evaluated using long-term data to provide an understanding of how this parameter is changing spatially throughout the South Nation River, and its tributaries. Results are also examined for changes over time.

<u>Report findings:</u>

*Forest Conditions*

Overall, forest cover is good in SNC's jurisdiction at 29.5%. Although total forest cover and percent forest interior fell slightly below the provincially recommended value, they were well represented throughout the SNC jurisdiction. Percent riparian forested cover requires improvement across the entire study area.

*Wetland Conditions*

Wetland cover results are excellent within SNC's jurisdiction, with 17% of the study area in wetland cover. All of the 5th order subwatersheds exceeded the provincial wetland cover objective of 10%.

*Water Quality Conditions*

The biological condition of streams varies across the study area. 77% of streams monitored were observed in good to fair condition, while 23% require improvement. A correlation exists between the amount of natural cover on the landscape, particularly forest cover, and the condition of surface water resources. Sites that are located in areas with high forest cover result in good to fair assessments, while sites that are located in areas of low forest cover require improvement.

Generally, surface water quality in the SNC jurisdiction is considered fair. Nitrate, chloride and zinc levels are low (with minor exceedences), while total phosphorus levels exceed the Provincial Water Quality Objective at every water quality station across the watershed. Total Phosphorus exceedences are minor in the headwaters of the SNR; as the river flows downstream, it accumulates additional inputs. Total phosphorus levels increase the most as the south branch of the SNR flows to the main branch, as well as between the Chesterville and Casselman surface water quality stations. This emphasizes the importance of continuing to implement phosphorous reducing programs within these areas.

Total phosphorus levels are decreasing over time. Initial declines observed in the 1980's and 1990's can be attributed to the construction or improvement of sewage treatment lagoons, as well as the decision to restrict phosphate concentrations in detergents. Declines in total phosphorus continue to be observed – the result of improvements in agricultural land management, projects implemented through the Clean Water Program and the Total Phosphorous Management Program, as well as the increase of forest cover on the landscape.

Results indicate that there has been an overall improvement in the condition of water resources within SNC's jurisdiction and that the projects and outreach initiatives, such as the Clean Water Program, and the tree planting Program are having a positive effect.

<u>Recommendation:</u>

- That SNC Program Managers review the results of this report and investigate how Program uptake can be tailored to improve resource conditions in areas identified as requiring improvement.

- It is believed that with ongoing partnerships and collaboration efforts with various stakeholders, the condition of forests, wetlands and rivers will continue to improve and persist for future generations.

# Table of Contents

## List of Tables

## List of Figures

# 1 Introduction

This report evaluates natural resources and habitat features within the jurisdiction of South Nation Conservation (SNC) as they relate to watershed health, and should be viewed as a technical companion to the *Subwatershed Report Cards* and the *State of the Nation* report. These reports are essential communication products of South Nation Conservation's Environmental Monitoring Program. They are public documents that will inform the community on the status of natural resources within their respective subwatersheds using comprehensive indicators, in a simplified, user-friendly format.

This document summarizes information that has been collected on forests, wetlands, and rivers within the SNC jurisdiction, in order to provide context of the health of the watershed, and highlight areas that are faring well, and those which may need improvement. These monitoring techniques are an important step for effective water management as they provide feedback on the effectiveness of programs and allow for a review of policies and legislation (Jones, 2006). Furthermore, the results of the habitat and water quality assessments are compared to several target-setting guidelines set out in Conservation Ontario's 2011 Guide to Developing Conservation Authority Watershed Report Cards. These guidelines are minimum ecological requirements to ensure there is adequate forest, riparian and wetland habitat to sustain minimum viable wildlife populations and maintain selected ecosystem functions and attributes.

## *1.1 Report Objectives*

- Communicate watershed health to those involved in land-use planning and management (i.e., Municipalities, public, watershed managers, planners, and developers).

- Provide recommendations for stewardship and restoration activities that will aid in the improvement of watershed health within SNC jurisdiction.

## *1.2 The Study Area*

SNC's jurisdiction (Figure 1) is located within the counties of Leeds and Grenville, Stormont, Dundas and Glengarry, Prescott-Russell, and the City of Ottawa. It embodies the South Nation River watershed, which flows in a north-easterly direction from the headwaters just before Brockville to Plantagenet before discharging into the Ottawa River. This watershed is approximately 4200 $km^2$, and descends a total of 80m in elevation over a length of 180km.

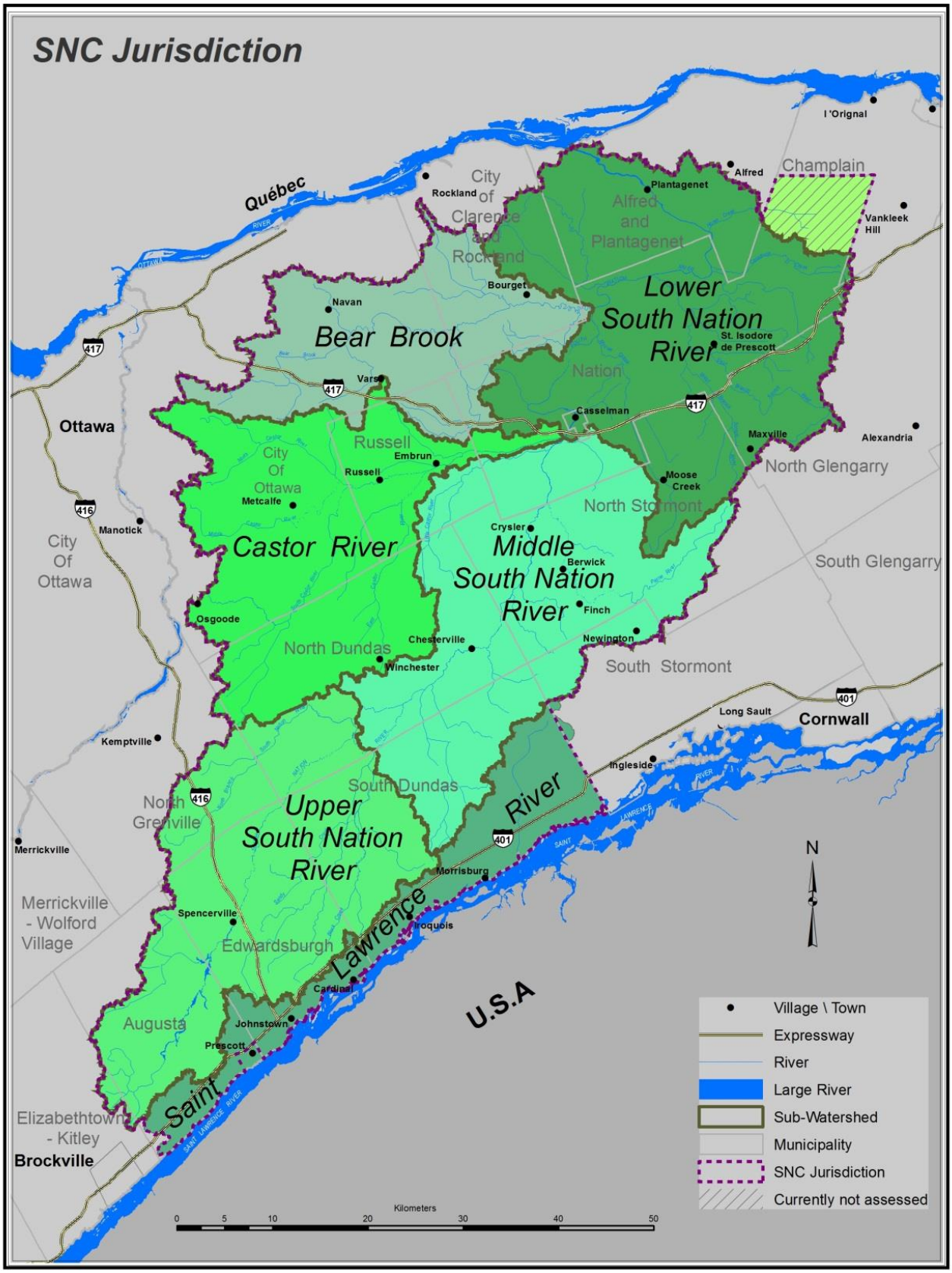


*Figure 1: South Nation Conservation jurisdiction, 2014.*

The South Nation watershed was divided into 5 areas (6th order subwatersheds) that were suitable for reporting to the public and feasible for the purpose of sampling and reporting on a 5-year cycle. Each 6th order subwatershed is made up of a series of smaller 5th order subwatersheds. Monitoring efforts are stratified based on 5th order size (area) to ensure adequate coverage across the entire 6th order subwatershed. Resource assessments are provided at both the 5th order and 6th order scale. 5th order assessments provide a more detailed analysis of what's happening on the landscape, while 6th order assessments provide a summary of resource conditions across SNC's jurisdiction. The following maps illustrate each of the 6th order subwatersheds and their component 5th order divisions:

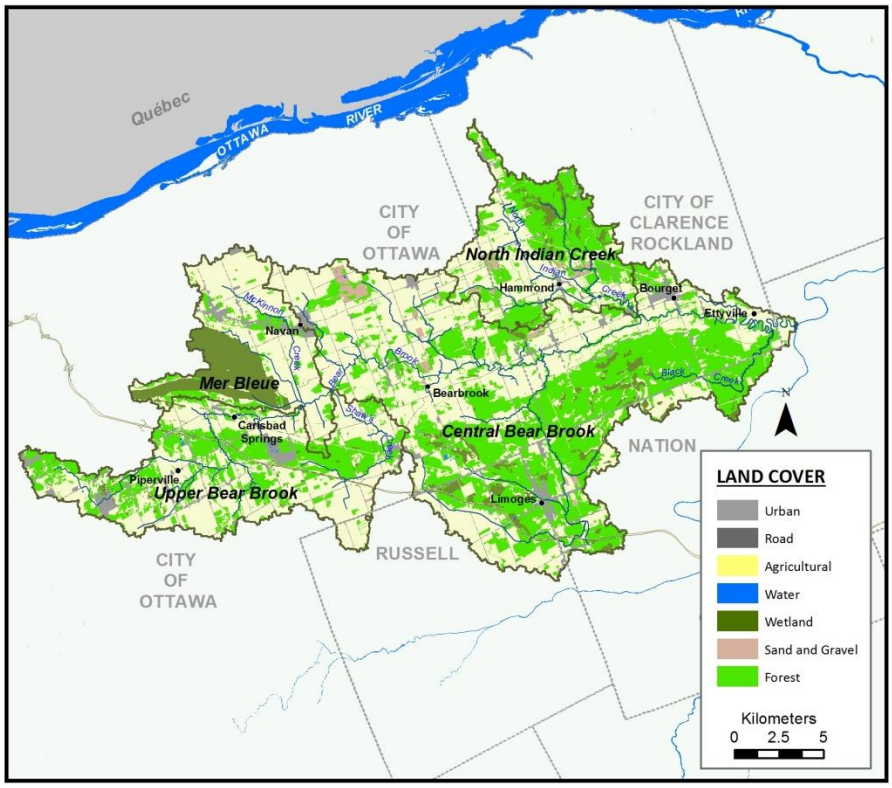


*Figure 2: Bear Brook 6th order subwatershed, monitored in 2008*

5th Order Subwatersheds:

- Upper and Central
- Bear Brook
- Mer Bleu
- North Indian Creek
- Wolf Creek

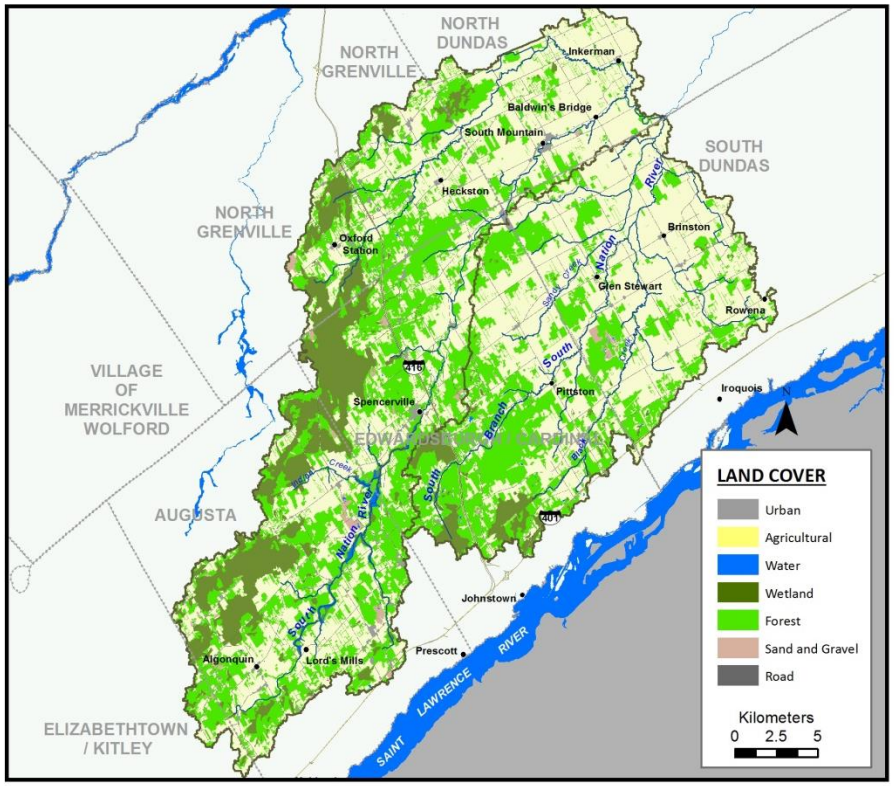


*Figure 3: Upper South Nation 6th order subwatershed, monitored in 2009*

5th Order Subwatersheds:

- Headwaters South Nation River
- South Branch South Nation River

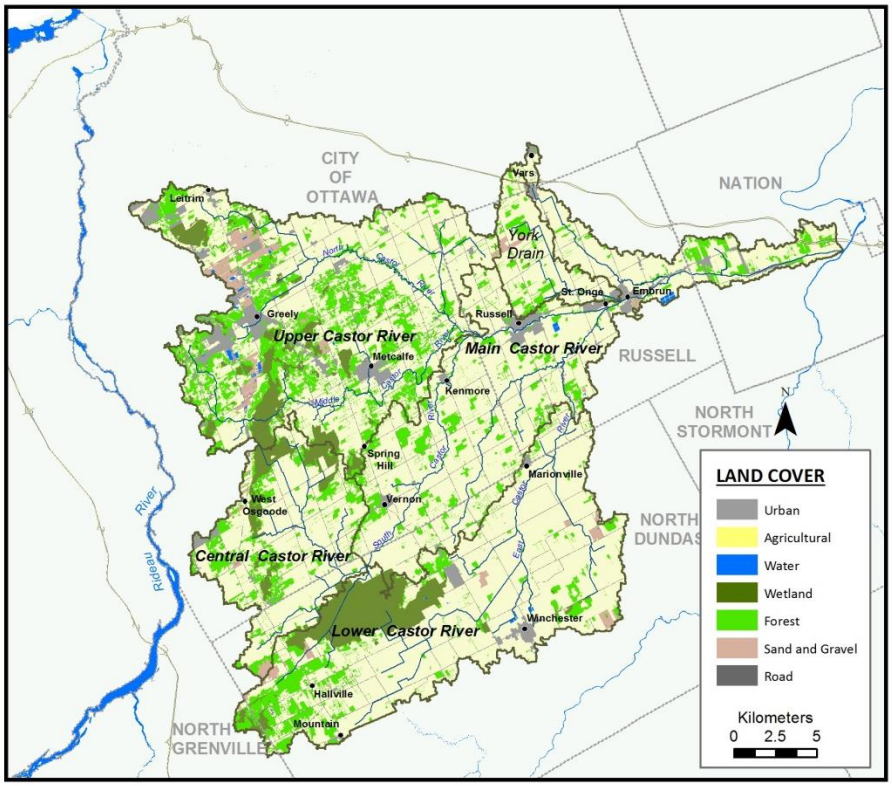


*Figure 4: Castor River 6th order subwatershed, monitored in 2010*

5th Order Subwatersheds:

- Main Castor River
- Upper Castor River
- Central Castor River
- Lower Castor River
- York Drain

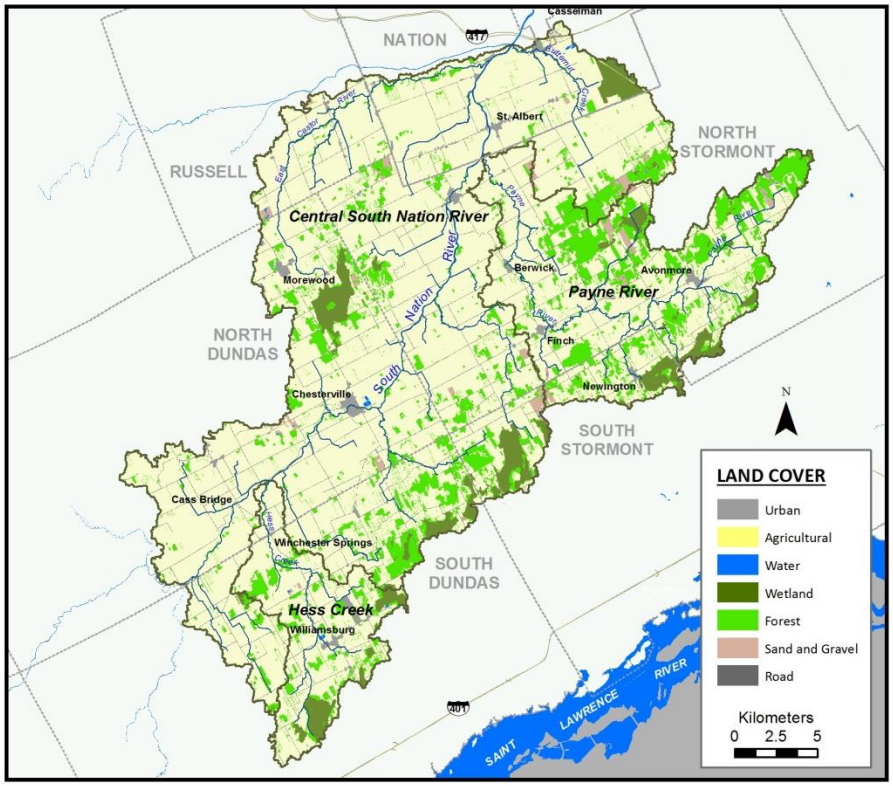


*Figure 5: Middle South Nation River 6th order Subwatershed, monitored in 2010*

5th Order Subwatersheds:

- Central South Nation River
- Hess Creek
- Payne River

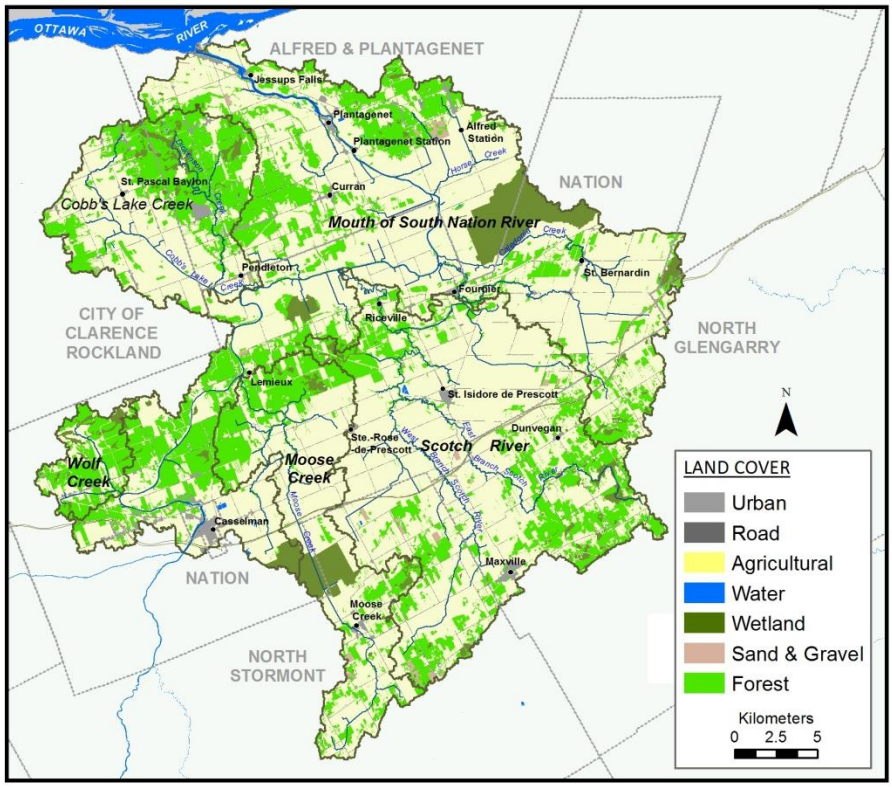


*Figure 6: Lower South Nation River 6th order Subwatershed, monitored in 2012*

5th Order Subwatersheds:

- Cobb's Lake Creek
- Moose Creek
- Mouth of South Nation River
- Scotch River

It should be noted that the SNC jurisdiction also includes several streams that flow directly to the St. Lawrence River. Resource assessments for these systems have been grouped together and evaluated as one St. Lawrence River subwatershed area. Furthermore, Nation Municipality was fully incorporated into the jurisdiction of SNC in 2012, including several watercourses that are not part of the South Nation basin, but flow to the Ottawa River. Assessments of these rivers are not provided in this report, but will be included in the next cycle of publications.

### *1.3 Physiographic Units*

SNC's jurisdiction was once covered by a temporary inlet of the Atlantic Ocean, known as the Champlain Sea, which was created by retreating glaciers during the end of the last ice age. The Champlain Sea at one time covered the lands that are now known as the provinces of Quebec and Ontario, as well as parts of New York and Vermont in the United States. As this glacier retreated, sediment was deposited between the Ottawa and St. Lawrence River, creating vast clay plains which ultimately formed the distinct landscape we see today. The location of these unique plains within the SNC watershed (Figure 7) should be considered when evaluating the current condition of forest communities and wetlands within the SNC jurisdiction. Additionally, the following terms from Cathy Keddy's *Forest History of Eastern Ontario: Information Report NO.1* (1993), have been included in order to provide a definition the physiographic units found within SNC.

**Smith's Falls Limestone Plain**: This is the largest and most continuous tract of shallow soil over limestone in southern Ontario. Due to gentle gradients, drainage is poor and wetlands are numerous. Remnants of old marine beaches often provide the only areas of deep soil for cultivation or for road construction materials.

**Edwardsburg Sand Plain**: The bedrock and most of the boulder clay are covered by sand. The sand surface is largely level with hummocks or ridges in some places. The soils are acid and deficient in nutrients.

**Russell & Prescott Sand Plains**: Old deltaic deposits have created sand plains. The sand texture varies from coarse in the north to fine in the south. It reaches a maximum depth of around 9 m. Soils are well-drained with the water issuing from river bluffs into clay valleys.

**Ottawa Valley Clay Plain**: The clay plain is interrupted by ridges of rock or sand. The proportion of acid soil is greater than in the Winchester Clay Plain.

**Winchester Clay Plain**: Although clay plains dominate, they are punctuated by other features such as till protrusions, low drumlins, bars and beaches. The soils are generally poorly drained.

**North Gower Drumlin Field**: Drumlins arise from a clay plain. While the drumlins have good drainage, the clay soils are poorly drained.

**Glengarry Till Plain**: The undulating to rolling surface consists of drumlins with clay flats. The loamy till is often less than 8 m deep, but does reach a depth of 30 m. Its stoniness is noticeable.

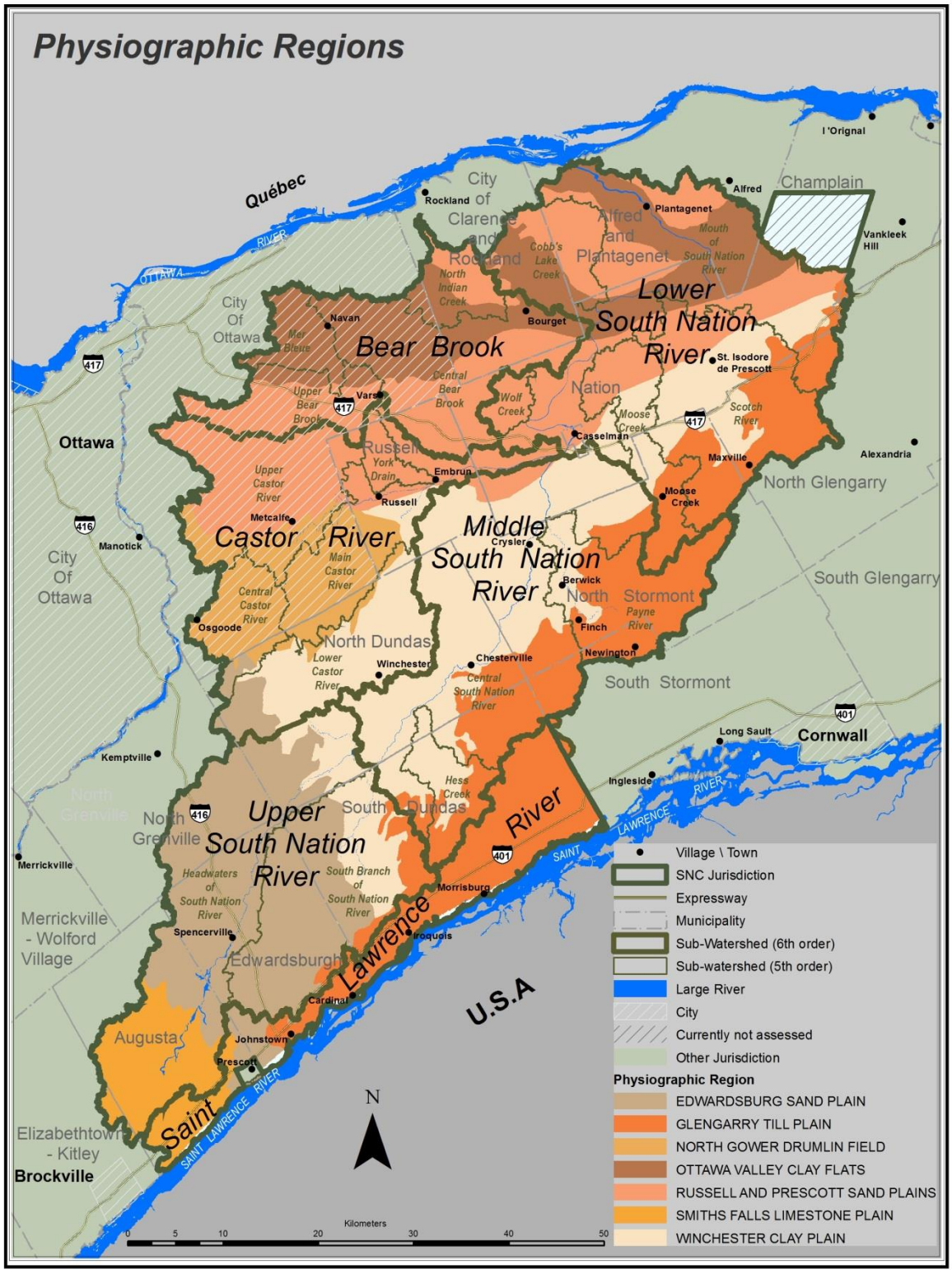


*Figure 7: Physiographic Regions within the State of the Nation Study Area*

# 2 Methods

The following protocols illustrate how the conditions of forests, wetlands and water resources, are assessed in order to determine surface water quality and watershed health. The grading schemes recommended by Conservation Ontario's 2011 Guide to Developing Conservation Authority Watershed Report Cards are also presented.

## *2.1 Forest Resources*

Many flora and fauna species cannot survive without forested habitats, as these ecosystems offer unique habitats, known as niches, which cannot be found in other ecosystems. Forest communities provide food, water and shelter for species, whether they are breeding and require more permanent protection, or are residing in the forest for a short time during their migration across the landscape. It is understood that the more complex an ecosystem is, the greater the species diversity it can support, which in turn strengthens the ecosystems resiliency to human impacts (Environment Canada, 2013). As such, in order to effectively assess a forests condition at the watershed and subwatershed scale, three indicators were monitored: **Percent Forest Cover, Percent Forest Interior, and Percent Forested Riparian Cover.** The three parameters have been classed based on the grading scheme that was used for the Subwatershed Report Cards (Table 1).

### 2.1.1 Data and ArcGIS

SNC initiated a forest cover and trends analysis project in 2012 to allow for an update of the Natural Resource Values Information System (NRVIS) Woodlands GIS layer. The layer was updated using 2008 orthophotography, acquired under the Digital Raster Acquisition Project East (Base Data, 2014).

The editing of wooded areas was captured to the same standard used during Southern Ontario Land Resource Information System (SOLRIS) Phase 2, which was documented in the SOLRIS Woodland Editing Guide (OMNR. 2008). This provided a standardized method of capturing woodland boundaries through orthophotography, consistent with other jurisdictions in Ontario (SNC, 2014).

### 2.1.2 Percent Forest Cover

There is increasing evidence that the total forest cover in a given area is a major predictor of the persistence and size of bird populations and this pattern likely extends to other flora and fauna groups. It has been identified that **30% forest cover at the watershed scale is the minimum forest cover threshold.** This equates to a high-risk approach that may only support less than one half of the potential species richness, and marginally healthy aquatic systems (Environment Canada, 2013).

### 2.1.3 Percent Forest Interior

The structure and functions of habitat edges are inherently different from those within habitat cores, and as a result, these areas support a different type, number and range of species (Environment Canada, 2013). This phenomenon is known as edge effect. In both scientific and technical studies, 100meters from the forest edge is typically used as the standard

measure of where edge effects taper off, and where more undisturbed "core" habitat conditions begin (e.g., Dunford and Freemark 2004; Driscoll et al. 2005; Nol et al. 2005; Weber et al. 2008, in Environment Canada, 2013). **The proportion of the watershed that is forest cover and 100 meters or further from the forest edge, known as percent forest interior, should be greater than 10%.**

### 2.1.4 Percent Forested Riparian Cover

Riparian habitat performs a range of functions that have ecological, social and economic value. It has been proven that maintaining a portion of land covered with native vegetation along streams and rivers can help maintain good water quality, provide habitat for wildlife, protect people and buildings against flooding, and extend the life of reservoirs (Wenger 1999).

Environment Canada (2013) recommends that **streams have naturally vegetated lands adjacent to watercourses that are at least 30 meters wide on both sides.** The 30-metre width guideline is a minimum approximation intended to capture processes and functions typical of the active riparian zone of a floodplain and the floodplain-to-upland transition.

*Table 1: Watershed Report Card grading scheme for forest resources*

| % Forest Cover | % Forest Interior | %Riparian Zone Forested (30-m widths) | Point Score | Grade | Overall Forest Conditions | |
|---|---|---|---|---|---|---|
| | | | | | Final Points | Final Grade |
| >35.0 | > 11.5 | > 57.5 | 5 | A | >4.4 | Excellent (A) |
| 25.1 – 35.0 | 8.6 – 11.5 | 42.6 – 57.5 | 4 | B | 3.5 – 4.4 | Good (B) |
| 15.1 – 25.0 | 5.6 – 8.5 | 27.6 – 42.5 | 3 | C | 2.5 – 3.4 | Fair (C) |
| 5.0 – 15.0 | 2.5 – 5.5 | 12.5 – 27.5 | 2 | D | 1.5 – 2.4 | Poor (D) |
| < 5% | < 2.5 | < 12.5% | 1 | F | <1.5 | Very Poor (F) |

## *2.2 Wetland Resources*

Wetlands provide valuable ecological and hydrological functions at site-specific and watershed scales. Many of southern Ontario's flora and fauna inhabit wetlands during part or all of their life cycle, including many species at risk. Wetlands are known to be biologically diverse habitats, tending to support a wider range of flora and fauna than other habitat types, particularly on a species per area basis (Environment Canada, 2013).

### 2.2.1 Date and ArcGIS

The wetland resources indicator (wetland cover) was determined through a desktop GIS exercise. The data layers used to conduct this analysis included SOLRIS is a primary data layer that provides a comprehensive, standardized, landscape level inventory of natural, rural and urban lands in Ecoregions 6E and 7E, current to 2000-2002. It is based on MNR's Ecological Land Classification (ELC) for southern Ontario (Lee *et al*, 1998).

Release Notes: The initial release of SOLRIS (Version 1.1 - November, 2006) is restricted to a geographic area generally constrained by the Greater Toronto Area. The current release of SOLRIS (Version 1.2 - April, 2008) covers Ecoregions 6E and 7E in entirety, but unlike Version 1.1, does not provide a classification of agricultural land use.

### 2.2.2 Percent Wetland Cover

At a minimum, **the greater of 10% of each major watershed or 40% of the historic watershed wetland coverage, should be protected and restored.** The guideline addresses basic minimal generic ecological functions and does not address the overall loss of unique wetland ecosystems that dominated portions of southern Ontario. Table 2 depicts the grading scheme that was used for the Subwatershed Report Cards.

*Table 2: Watershed Report Card grading scheme for wetland resources*

| % Wetland Cover | Grade |
|---|---|
| > 11.5 | Excellent (A) |
| 8.6 – 11.5 | Good (B) |
| 5.6 – 8.5 | Fair (C) |
| 2.5 – 5.5 | Poor (D) |
| < 2.5 | Very Poor (F) |

## *2.3 Surface Water Quality*

Clean water is critical to both human and ecological well-being. The quality of water in local rivers affects the quality of life within local communities. Healthy ecosystems, including healthy aquatic communities, provide significant socio-economic benefits, as well as opportunities for recreation.

### 2.3.1 Bioassessment

Bioassessment enables the assessment of aquatic ecosystem condition using biological effect-based measures of biotic response to stress. We use benthic macroinvertebrate community composition as our biological indicator. These animals have many traits that make them useful as indicator organisms and have been widely used throughout the World as indicators of ecological health.

The study design used a stratified random sampling design. Every stream/road intersection in 2$^{nd}$ to 4$^{th}$ order streams was identified and considered as a candidate sampling location. The sampling effort within each 5$^{th}$ order subwatershed was stratified based on the subwatershed's relative size; then test sites were randomly selected. A landowner contact process was initiated to request permission to access the site. If a landowner did not grant access to the site, the next randomly selected test site on the list was chosen, and the landowner contact process started again. Once permission was granted, the test site was sampled using the Ontario Stream Assessment Protocol.

As part of the OSAP protocol, benthos were collected during the months of September/October in each sample year. Benthos were collected using the Ontario Benthos Biomonitoring Network Transect Kick (Jones *et al*., 2005) and a hand-held D-net. Samples were randomly sub-sampled to obtain an approximately 100-animal fixed count (the entire sub-sample containing the 100$^{th}$ animal was processed to permit estimates of total sample abundance). Invertebrates were preserved for archiving purposes in 95% ethanol. Invertebrates were identified to family level.

We used a 3-step reference-condition approach to bioassessment (Bowman and Somers, 2005; Jones *et al*., 2005):

1. Summarize the composition of the benthos community using a set of indices.
2. Select appropriate reference sites, which are used to define normal or expected community composition, based on the similarity of reference sites' natural habitat to that of the test site.
3. Test the hypothesis that the test site is in reference condition normal range.

Appendix A provides the above methodologies on how to summarize the biological condition of test sites, utilize the reference condition approach, and test the bioassessment null hypotheses.

**Tests for Impairment in the South Nation Watershed**

- The benthic community of each test site has been compared to a set of 13 reference stations having similar habitat conditions (i.e., physiographic region, catchment size).
- If the test site falls within the normal range of variability, then the site is likely "**unimpaired**" or in "good" condition and additional analysis is not required.
- If the test site falls outside of the normal range of variability, then the site is termed "**atypical**" or "poor". Further scrutiny of the test site will determine whether human related impacts are a potential factor.

In cases where Time Series Analysis test statistics (i.e. D, F, p) are "**marginal**" near the rejection limit, a subjective judgment call is made to determine whether to pass or fail the site. This judgment calls on available water quality and habitat information. For the purpose of this report, sites that are near the rejection limit are considered as "fair" condition.

### 2.3.2 Water Chemistry

The Provincial Water Quality Monitoring Network (PWQMN) and Watershed Characterization Network (WCN) enables the routine sampling of chemical parameters that may have a potential impact on aquatic life, recreational activities, and agricultural practices.

These monitoring programs aid in establishing baseline conditions (i.e., baseflow and stormflow), and detecting spatial and temporal changes in river systems. Changes may be a result of changing environmental (i.e., climatic, etc.) and/or human factors.

There are 13 PWQMN and WCN stations located throughout the South Nation River. Samples are collected from the river at these locations 8 times a year and sent to a Ministry of Environment laboratory for analysis. To account for variance, samples were collected under a variety of stream-flow conditions to estimate the range of chemical conditions during the ice-free season.

Several parameters were chosen to link water quality results to specific non-point source influences in the watershed. Parameters are compared to available Water Quality Objectives, published as Provincial Water Quality Objectives (PWQO) or Canadian Water Quality Guidelines for the Protection of Aquatic Life (CWQG). Table 3 describes each parameter, as well as their source, potential impacts, and published guideline value.

Data collected through the PWQMN and WCN Programs from 2008 to 2012 (5 years) are compared to published guideline values using 75$^{th}$ percentiles. Frequencies of excedences are also evaluated for each parameter using all records collected over the 5 year period at each monitoring station.

*Table 3: Water quality parameters and their associated sources and grading schemes*

| Parameter | Source | Impacts | Water Quality Guideline |
|---|---|---|---|
| Total Phosphorus (TP) | Sewage Treatment Plants | Phosphorus is associated with eutrophication—the enrichment of a body of water with nutrients resulting in accelerated algal or plant production.<br><br>The PWQO for TP is intended to prevent the nuisance growth of algae. TP is not toxic to people or aquatic life, but excess concentrations can lead to undesirable changes in aquatic ecosystems (i.e., reduced biodiversity, reduced oxygen conditions, toxic algae blooms, impaired aesthetics and impaired recreational opportunities). | 0.03 mg/L (PWQO) |
| Total Chlorides | Road or overland runoff (road salts) | Chlorides have been designated a 'toxic' substance under the Canadian Environment Protection Act. | 20 mg/L (CWQG) |
| Zinc | Urban run-off; most metal materials loading into rivers is a result of storm events (Allen et al., 2007) | Runoff from urbanized surfaces, as well as municipal and industrial discharges, result in increased loading of metals such as Zinc (Paul, 2001). Zinc has the potential to cause acute or chronic toxic impacts for aquatic life. | 0.02 mg/L (PWQO) |

### 2.3.3 Total Phosphorus Levels Over Time

Total phosphorus concentrations (mg/L) are elevated in the South Nation watershed. In 1993, SNC responded to the elevated TP concentrations in the SNR by introducing the Clean Water Program (CWP). The CWP unites the rural communities in SNC's jurisdiction by reducing non-point sources of nutrients through cost-share agri-environmental projects. Since 1993, over 600 projects have received over $2 million in cost-share grants for local farmers and landowners to implement best management practices that protect surface and groundwater resources.

In addition to this initiative, SNC, in partnership with the Ministry of Environment, and other local partners, implemented a Total Phosphorus Management (TPM) credit trading program in 2000. Increased phosphorus loading from any new or expanding wastewater treatment plants is offset with the purchase of credits from phosphorus reducing best management practices completed through the CWP.

For the purpose of this report, total phosphorus levels are evaluated over time using PWQMN data. 15-year 75$^{th}$ percentiles are compared spatially from the headwaters of the South Nation river at Roebuck, to the mouth of the South Nation River at Plantagenet (before it flows to the Ottawa River). Results are presented so that 15-year percentiles can be compared temporally as well.

# 3 Results

## *3.1 Forest Resources*

Forest cover results range from excellent to fair within SNC's jurisdiction, while forest interior and forested riparian habitat range from excellent to poor (See Figure 8); Table 4 provides a summary of the findings[1]. Tables 5 to 10 and Figures 9 to 13 provide forest results for the St. Lawrence subwatersheds, as well as the 5$^{th}$ order subwatersheds for the South Nation watershed. Grading according to Conservation Ontario Guidelines is also presented.

*Table 4: Forest Resources results for 6$^{th}$ order subwatersheds*

| Subwatershed | Total Forest Cover % | Forest Interior % | Riparian Cover % |
|---|---|---|---|
| Recommended Minimum Value | 30% | 10% | 75% |
| Bear Brook | 37.6 | 10.5 | 27.2 |
| Upper South Nation River | 40.0 | 13.5 | 30.5 |
| Castor River | 19.9 | 3.0 | 18.0 |
| Middle South Nation River | 17.9 | 5.0 | 17.2 |
| Lower South Nation River | 28.8 | 9.1 | 24.2 |
| St. Lawrence River | 36.5 | 15.7 | 36.5 |
| **SNC Jurisdiction** | **29.5%** | **8.7%** | **24.1%** |

Overall, forest cover is good in SNC's jurisdiction at 29.5%. Large forest blocks including the Larose Forest, Warwick Forest Tract and Edwardsburg Land Assembly contribute to good forest interior habitat. Large forest blocks are typically found in areas that have lower land capability classes for agriculture. This includes physiographic units that are associated with shallow soils such as Smith's Falls limestone plain, or soils that are affected by water and wind erosion such as the Russell and Prescott sand plains and Edwardsburg sand plains.

Forest cover and forest interior habitat is lowest in areas with high land capability classes for agriculture. This includes physiographic units that are associated with clay soils such as the Winchester Clay Plains (located partly in the Castor River, and Middle and Lower South Nation River subwatersheds), and the Ottawa Valley Clay Plains (located partly in the Bear Brook and Lower South Nation River Subwatersheds), as well as the North Gower Drumlin Field (Castor River subwatershed). Forested riparian cover is low throughout SNC's jurisdiction, with 24.1% of 30-m buffers on either side of streams in forest cover. This parameter trends with physiographic unit, similar to forest cover and forest interior.

[1] It should be noted that forest cover values differ slightly than what's presented in the 2014 Forest Cover and Trends Analysis Report. The same data was used to compute these values, however the State of the Nation reports on SNC Jurisdiction (inclusion of St. Lawrence River subwatersheds), while Forest Cover and Trends Analysis reports on SNC's watershed boundary.

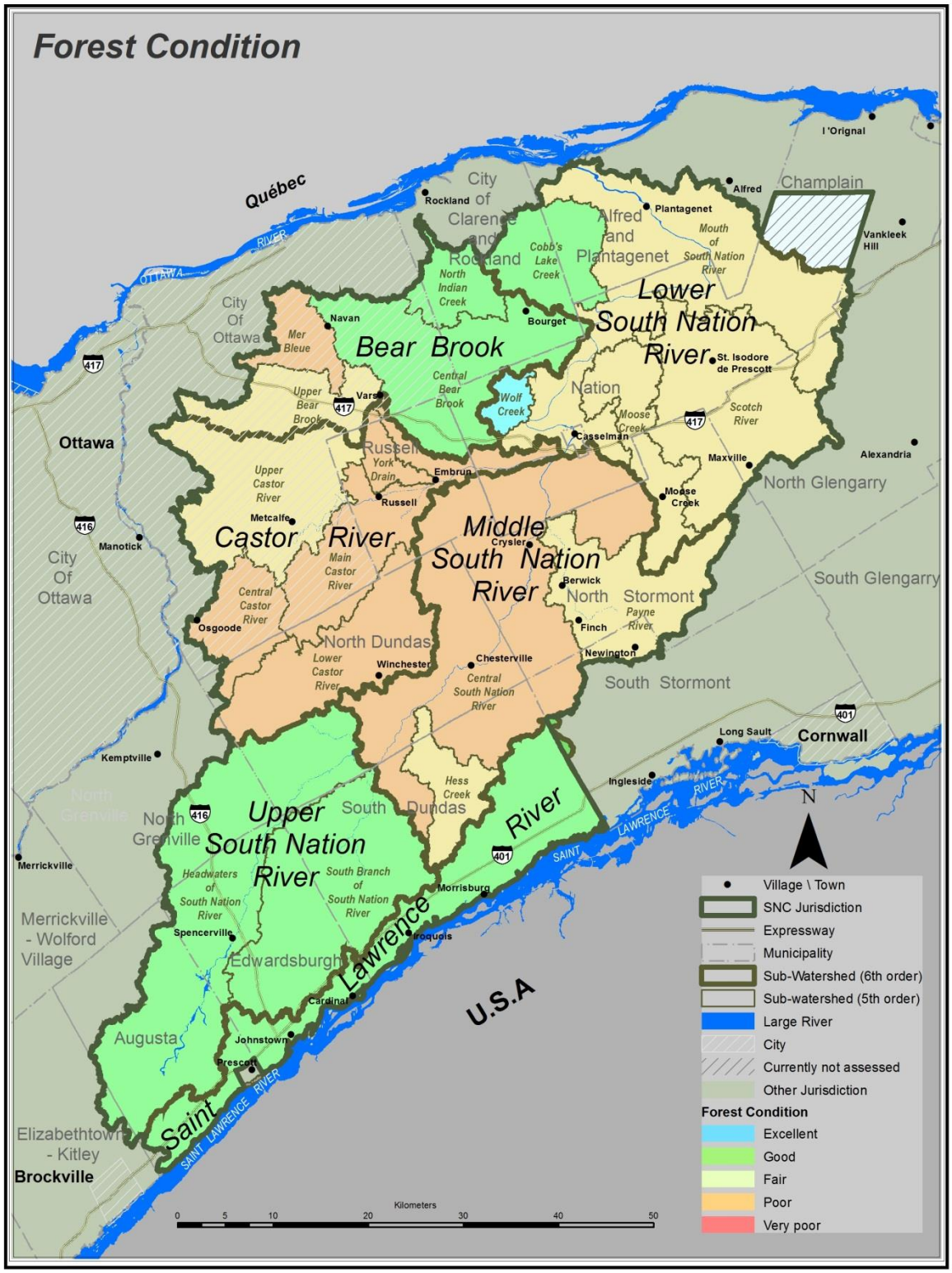


*Figure 8: Forest Conditions in the South Nation Conservation Jurisdiction*

### 3.1.1 St. Lawrence River

Forest cover and forest interior is excellent in the St. Lawrence River subwatersheds (Table 5). The forested riparian zone is higher than most other subwatersheds across SNC's jurisdiction, but still requires improvement.

*Table 5: Forest Resources Results for St. Lawrence River*

| Subwatershed | % Forest Cover | | % Forest Interior | | % Riparian Zone Forested (30-m widths) | | Overall Forest Conditions | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Final Points | Final Grade |
| St. Lawrence River | 36.5 | A | 15.7 | A | 36.5 | C | 4.3 | B |

### 3.1.2 Bear Brook

Forest Cover in the Bear Brook watershed is excellent at 37.3%. There is excellent forest interior across most of the watershed, with the exception of the Mer Bleue subwatershed (a subwatershed that is comprised largely of wetland habitat), as well as the Upper Bear Brook subwatershed. Although Upper Bear Brook is located in a physiographic unit that typically observes the preservation of forest cover (i.e., Russell and Prescott sand plain), it is located within a rapidly urbanizing area in the City of Ottawa; the landscape is becoming increasingly fragmented, reducing the possibility of forest interior habitat. Overall, forested riparian cover is low across the entire subwatershed and needs improvement.

*Table 6: Forest Resources Results for Bear Brook*

| Subwatershed | % Forest Cover | | % Forest Interior | | % Riparian Zone Forested (30-m widths) | | Overall Forest Conditions | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Final Points | Final Grade |
| Upper Bear Brook | 5.6 | A | 8.6 | C | 22.9 | D | 3.3 | C |
| Mer Bleue | 5.4 | C | 2.3 | F | 9.1 | F | 1.7 | D |
| North Indian Creek | 4.9 | A | 14.6 | A | 34.2 | C | 4.3 | B |
| Central Bear Brook | 0.9 | A | 12.2 | A | 30.9 | C | 4.3 | B |
| **BEAR BROOK** | 7.3 | A | 10.5 | B | 27.2 | D | **3.7** | **B** |

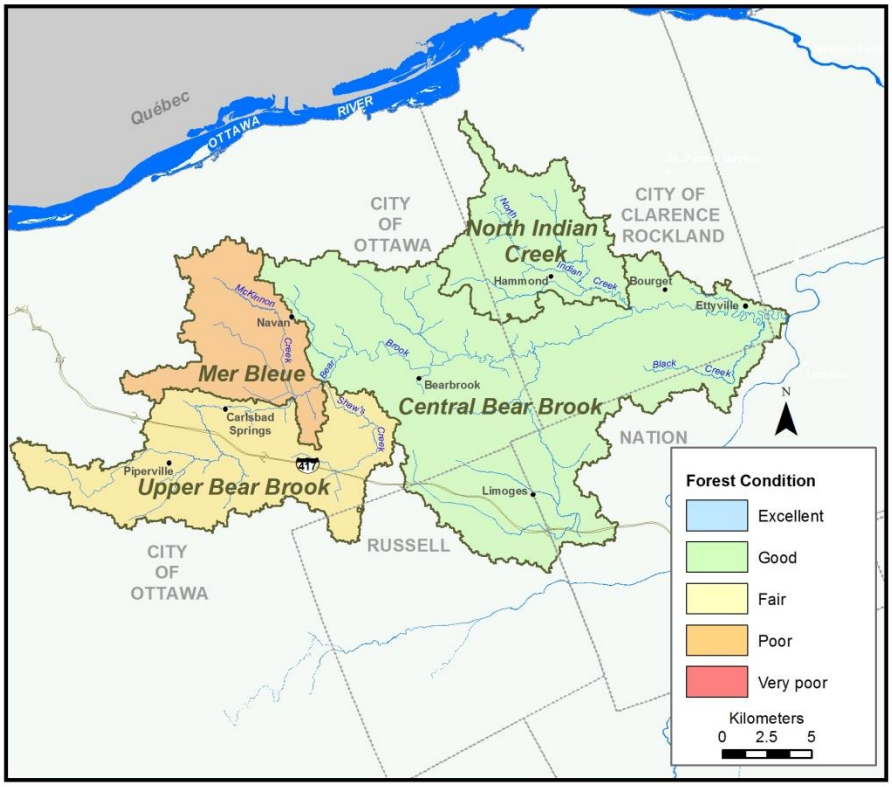


*Figure 9: Forest Conditions in Bear Brook Watershed*

### 3.1.3 Upper South Nation Watershed

The upper reaches of the South Nation River is located primarily in Edwardsburg sand plain (63%), and Smiths Falls limestone plain (17%). The physiography of this area has aided in the preservation of high forest cover and forest interior, especially in the Main Branch subwatershed. Similarly, the South Branch subwatershed has good forest cover and forest interior habitat in the upper reaches. As the lower reaches of this subwatershed flow through Winchester clay plain, lower forest cover is observed.

*Table 7: Forest resource results for Upper South Nation River*

| Subwatershed | % Forest Cover | | % Forest Interior | | % Riparian Zone Forested (30-m widths) | | Overall Forest Conditions | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Final Points | Final Grade |
| Main Branch SNR | 42.7 | A | 13.3 | A | 34.13 | C | 4.3 | B |
| South Branch SNR | 35.9 | A | 13.8 | A | 25.87 | D | 4 | B |
| **Upper SNR** | 40.0 | A | 13.5 | A | 30.5 | C | **4.3** | **B** |

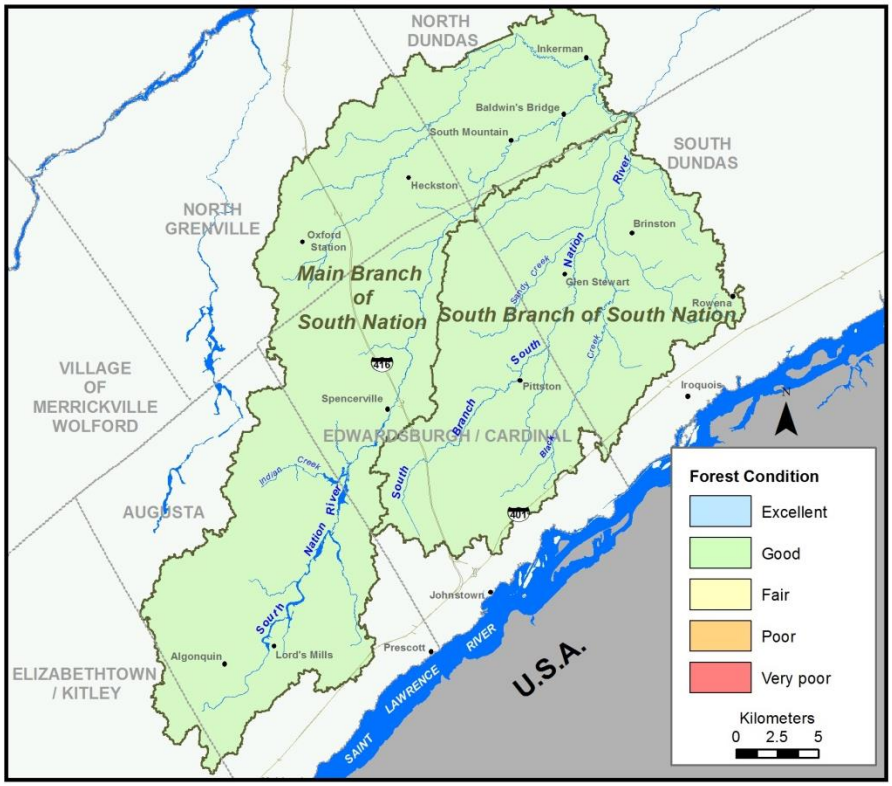


*Figure 10: Forest Conditions in Upper South Nation Watershed*

### 3.1.4 Castor Watershed

Most of the Castor River watershed is located in physiographic units that yield high land capability classes for agriculture, including Winchester clay plain (24%) and North Gower drumlin field (34%). Consequently, low forest cover, and forest interior is observed across most of the watershed. The Upper Castor subwatershed is located primarily in Russell and Prescott sand plain, resulting in the highest forest cover in the watershed at 28.8%. This subwatershed has low forest interior habitat, a result of several quickly urbanizing communities, including Findlay Creek, Greely, and Metcalfe. Forested riparian cover remains low across the entire subwatershed.

*Table 8: Forest resource results for Castor River*

| Subwatershed | % Forest Cover | | % Forest Interior | | % Riparian Zone Forested (30-m widths) | | Overall Forest Conditions | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Final Points | Final Grade |
| Central Castor River | 24.0 | C | 4.6 | D | 13.7 | D | 2.3 | D |
| Lower Castor River | 14.4 | D | 3.5 | D | 0.5 | F | 1.7 | D |
| Main Castor River | 13.9 | D | 1.4 | F | 18.0 | D | 1.7 | D |
| Upper Castor River | 28.8 | B | 4.3 | D | 25.2 | D | 2.7 | C |
| York Drain | 15.5 | C | 2.3 | F | 18.5 | D | 2.0 | D |
| **CASTOR RIVER** | 19.9 | C | 3.3 | D | 18.0 | D | **2.3** | **D** |

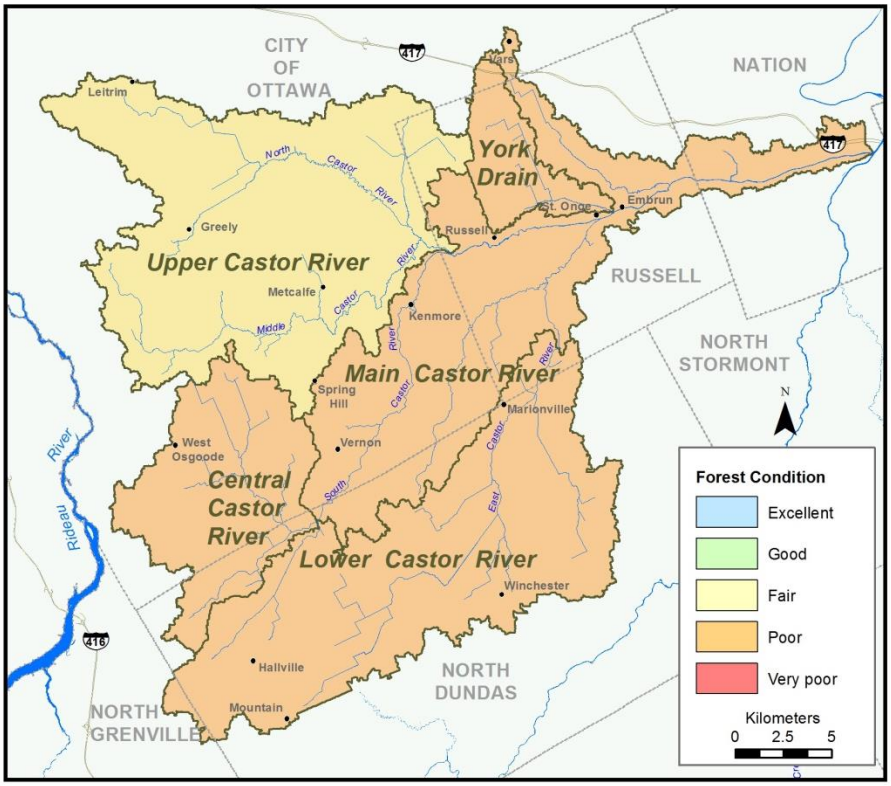


*Figure 11: Forest Conditions in Castor River Watershed*

### 3.1.5 Middle South Nation Watershed

The Middle South Nation watershed is comprised of three subwatersheds – Hess Creek, Payne River and the central reaches of the South Nation River. The Central South Nation subwatershed is located in the Winchester clay plain (71%), where low forest cover and low forest interior is observed. Hess Creek and Payne River subwatersheds observe similar trends in their lower reaches; the headwaters of these two systems are located in Glengarry till plain, where good to fair forest cover and forest interior are observed. Forested riparian cover trends with physiographic unit, similar to forest cover and forest interior. Over-all riparian cover is low within the Middle South Nation watershed.

*Table 9: Forest resource results for Middle South Nation River*

| Subwatershed | % Forest Cover | | % Forest Interior | | % Riparian Zone Forested (30-m widths) | | Overall Forest Conditions | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Final Points | Final Grade |
| Central South Nation River | 13.5 | D | 3.5 | D | 13.2 | D | 2.0 | D |
| Hess Creek | 22.6 | C | 6.9 | C | 20.1 | D | 2.7 | C |
| Payne River | 30.4 | B | 9.2 | B | 27.5 | D | 3.3 | C |
| **MIDDLE SNR** | 17.9 | C | 5.0 | D | 17.2 | D | **2.3** | **D** |

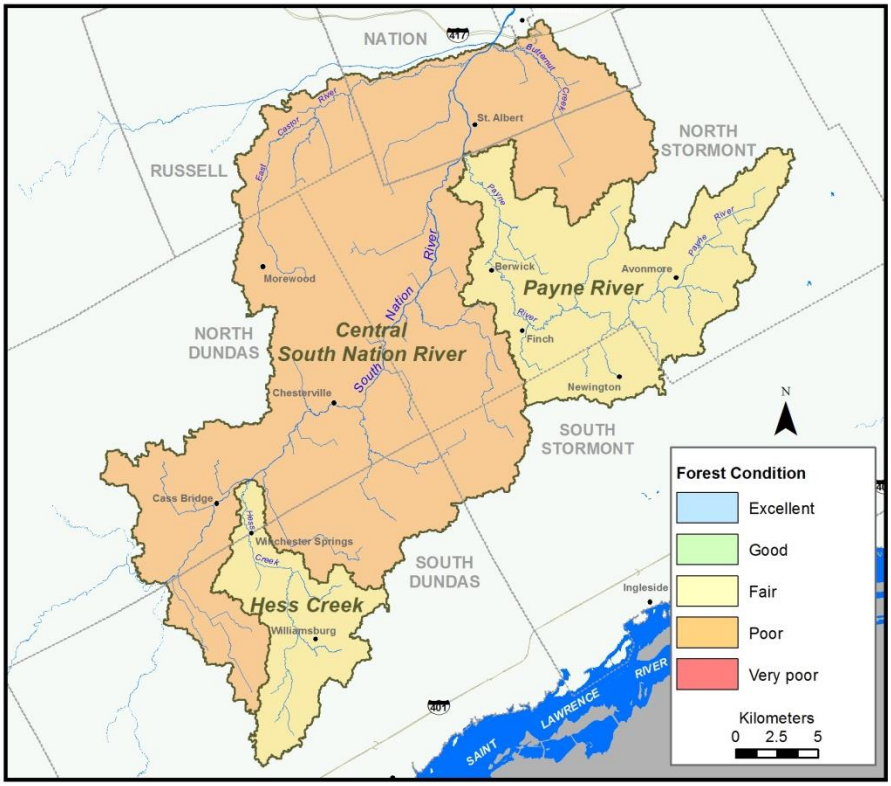


*Figure 12: Forest Conditions in Middle South Nation Watershed*

### 3.1.6 Lower South Nation Watershed

Overall, forest cover and forest interior are good within the Lower South Nation watershed. Large tracks of forest exist within the Russell and Prescott sand plains located in Wolf Creek (Larose Forest), and the headwaters of Cobb's Lake Creek subwatersheds. Additional forest cover is located within several forested wetlands and forests situated along the Glengarry Till plains in the headwaters of the Moose Creek, and Scotch River subwatersheds. Similar to other watersheds, lower forest cover and forest interior is observed on land located within Winchester clay plains, and Ottawa Valley clay flats. Riparian cover is low throughout this watershed and requires improvement.

*Table 10: Forest Resource Results for Lower South Nation River*

| Subwatershed | % Forest Cover | | % Forest Interior | | % Riparian Zone Forested (30-m widths) | | Overall Forest Conditions | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Final Points | Final Grade |
| Cobb's Lake Creek | 9.9 | A | 13.7 | A | 29.4 | C | 4.3 | B |
| Moose Creek | 9.8 | B | 11.4 | B | 24.0 | D | 3.3 | C |
| Mouth of South Nation River | 6.5 | B | 8.1 | C | 22.8 | D | 3.0 | C |
| Scotch River | 3.6 | C | 5.8 | C | 21.0 | D | 2.7 | C |
| Wolf Creek | 1.7 | A | 32.0 | A | 52.7 | B | 4.7 | A |
| **LOWER SNR** | 8.8 | B | 9.1 | B | 24.2 | D | **3.3** | **C** |

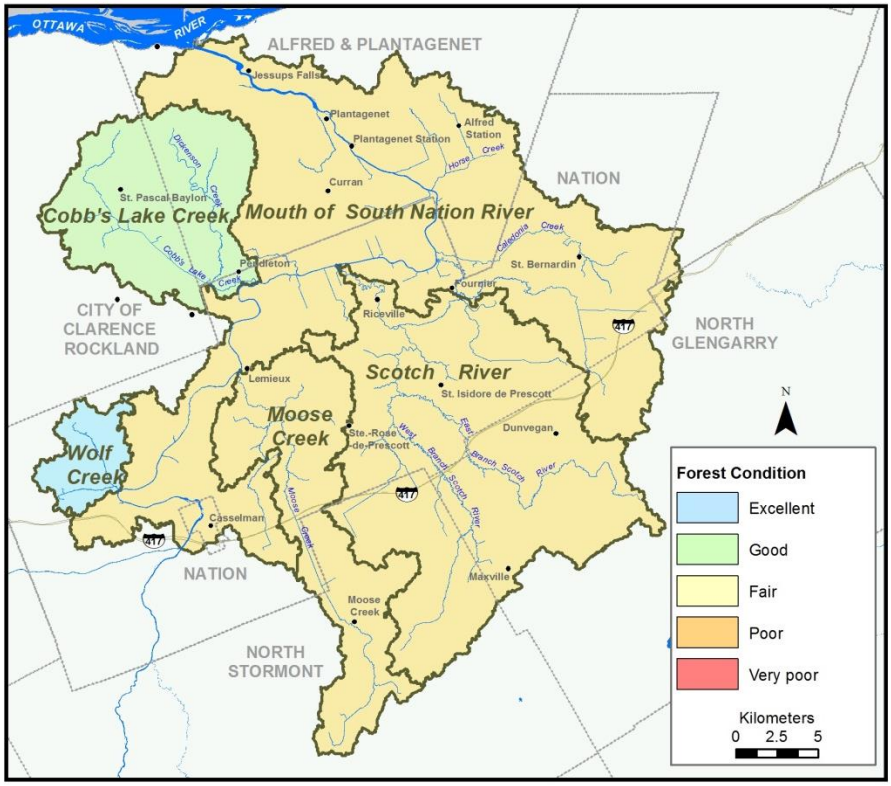


*Figure 13: Forest Conditions in Lower South Nation Watershed*

### *3.2 Wetland Resources*

Wetland cover results are excellent within SNC's jurisdiction, with 17% of the area in wetland cover (see Figure 14). The large proportion of wetland habitat can be attributed to the physiography of the area, and several large wetland complexes. Table 11 provides a summary of the wetland cover results across SNC's jurisdiction. Tables 12 to 16 and Figures 15 to 19 provide results for the St. Lawrence River subwatersheds, as well as the 5$^{th}$ order subwatershed results for the South Nation watershed. Grading according to Conservation Ontario Guidelines is also presented.

*Table 11: Wetland Resources results for 6$^{th}$ order subwatersheds*

| Subwatershed | Total Wetland Cover % |
|---|---|
| Recommended Minimum Value | 10% |
| Bear Brook | 19.0 |
| Upper South Nation River | 25.2 |
| Castor River | 14.6 |
| Middle South Nation River | 10.8 |
| Lower South Nation River | 11.7 |
| St. Lawrence River | 33.7 |
| **SNC Jurisdiction** | **17.1** |

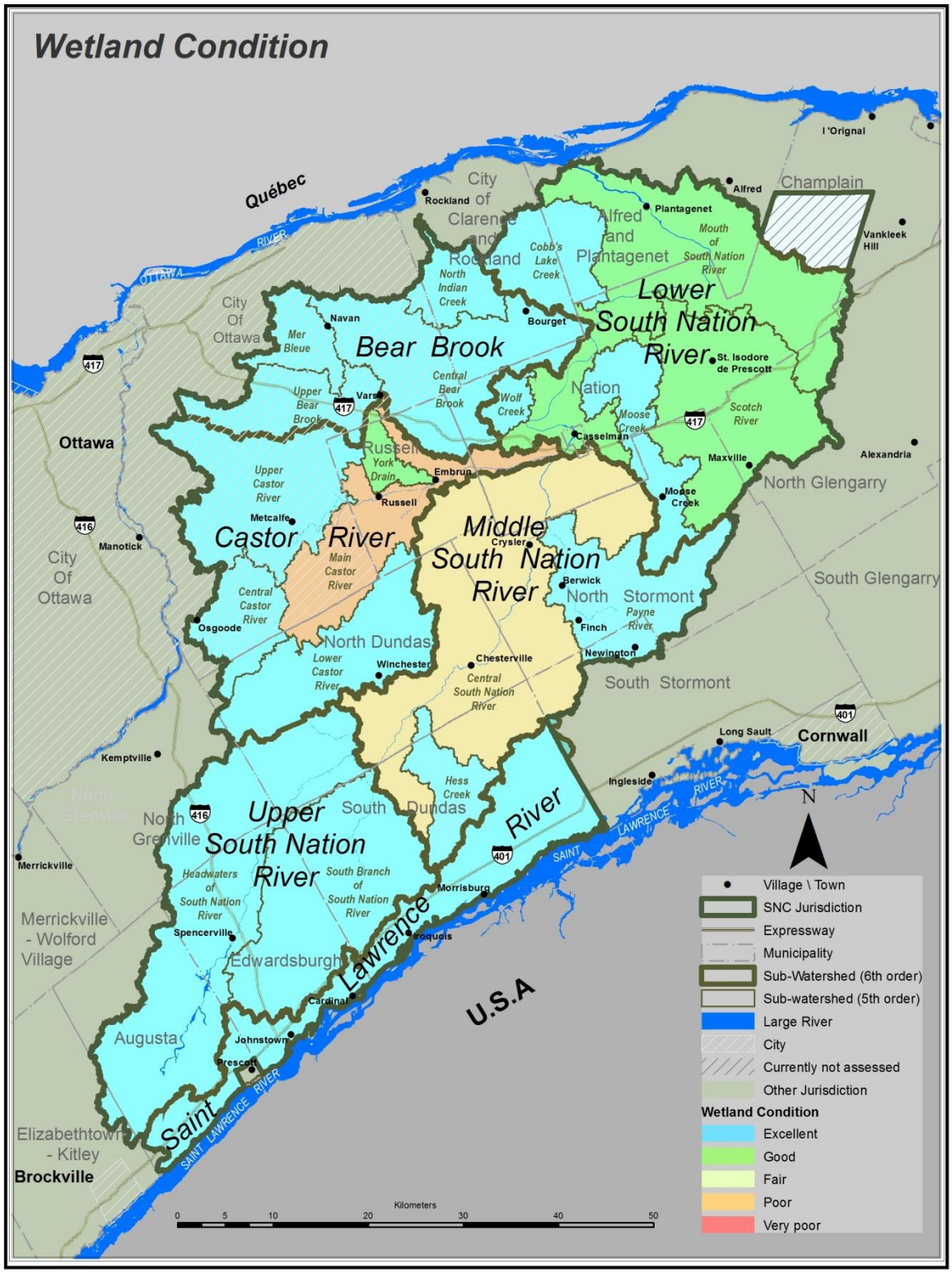


*Figure 14: Wetland Conditions within the South Nation Jurisdiction*

### 3.2.1 St. Lawrence River

A relatively large proportion of the St. Lawrence River subwatersheds comprise of wetland habitat (i.e., 33.7%, Table 11, A Grade). Some provincially significant wetland complexes include the following:

- Hoasic Wetland
- Glen Becker Swamp

### 3.2.2 Bear Brook

A relatively large proportion of Bear Brook comprises of wetland habitat (i.e., 19%, Table 12). Some provincially significant wetland complexes include the following:

- Mer Bleu Wetland Complex (23.6 $km^2$)
- Hammond Swamp (2.8 $km^2$)
- Limoges Wetland (2.9 $km^2$)

*Table 12: Wetland cover in Bear Brook*

| Subwatershed | Wetland Cover % | Grade |
|---|---|---|
| Upper Bear Brook | 21.0 | A |
| Mer Bleue | 32.7 | A |
| North Indian Creek | 16.6 | A |
| Central Bear Brook | 15.8 | A |
| **BEAR BROOK** | **19.0** | **A** |

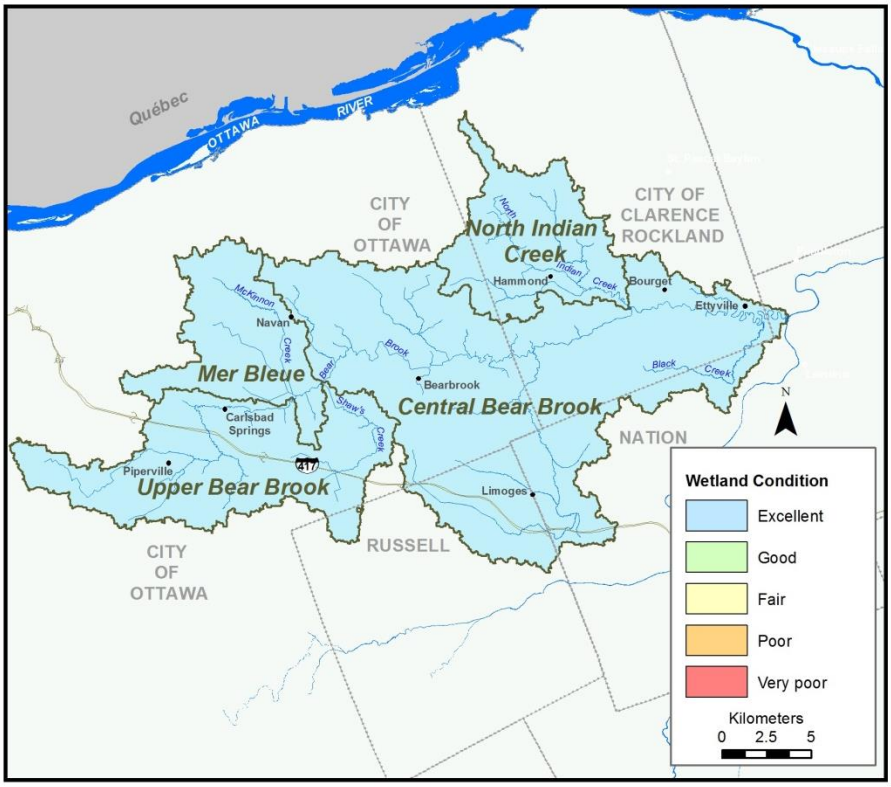


*Figure 15: Wetland Conditions in Bear Brook Watershed*

### 3.2.3 Upper South Nation Watershed

A large proportion of the Upper South Nation watershed comprises of wetland habitat (i.e., 25.2%, Table 13); especially in the Main Branch of the South Nation watershed, where Smith's Falls limestone plain is located. The Smith's Falls limestone plains comprise of shallow soil over limestone; due to gentle gradients, drainage is poor and wetlands are numerous. Some locally and provincially significant wetland complexes include the following:

- Long Swamp Fen (Area of Natural and Scientific Interest - 2.5 $km^2$)
- Charleville Creek Wetland (16.7 $km^2$)
- Limerick Wetland (27.4 $km^2$)
- Edwardsburg Marsh (4.5 $km^2$)

*Table 13: Wetland cover results for Upper South Nation River*

| Subwatershed | Wetland Cover % | Grade |
|---|---|---|
| Main Branch SNR | 28.9 | **A** |
| South Branch SNR | 19.4 | **A** |
| **Upper SNR** | **25.2** | **A** |

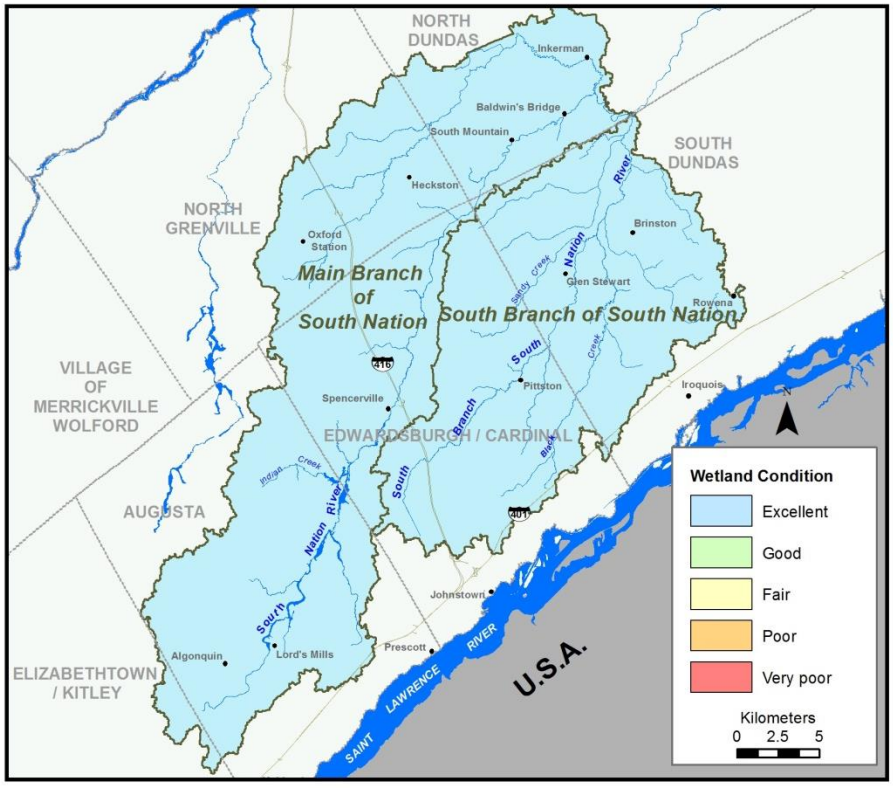


*Figure 16: Wetland Conditions in Upper South Nation Watershed*

### 3.2.4 Castor Watershed

The Castor watershed comprises of 14.6% wetland habitat, with excellent cover in the upper reaches, and reduced cover in the lower reaches. Some provincially significant wetland complexes include the following:

- Albion Wetland (8.7 $km^2$)
- Leitrim Wetland (2.5 $km^2$)
- Osgoode Complex (15.8 $km^2$)
- Winchester Swamp (22.7 $km^2$)

*Table 14: Wetland cover results for Castor River*

| Subwatershed | Wetland Cover % | Grade |
|---|---|---|
| Central Castor River | 17.5 | A |
| Lower Castor River | 17.15 | A |
| Main Castor River | 5.35 | D |
| Upper Castor River | 19.6 | A |
| York Drain | 10.8 | B |
| **CASTOR RIVER** | **14.6** | **A** |

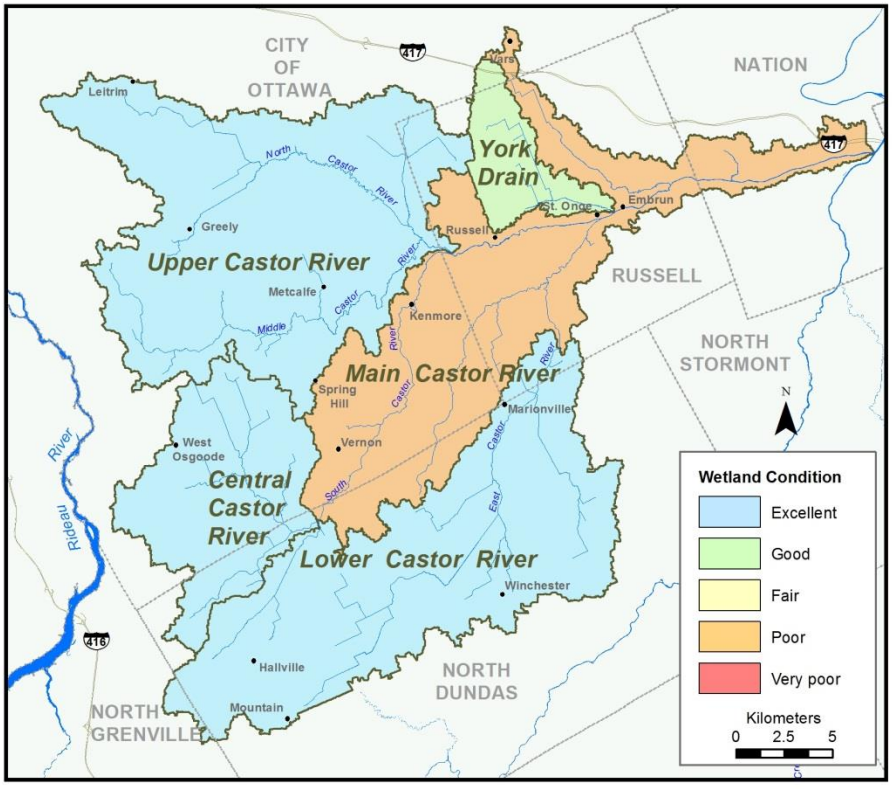


*Figure 17: Wetland Conditions in Castor River Watershed*

### 3.2.5 Middle South Nation Watershed

The Middle South Nation watershed comprises of 10.8% wetland habitat. Wetland cover is excellent to fair, with higher cover in the Payne River and Hess Creek subwatersheds, especially in the headwaters located in Glengarry till plain. Some provincially significant wetland complexes include the following:

- Newington Bog (5.6 $km^2$)
- Morewood Bog (5.5 $km^2$)
- Hoasic Wetland (8.9 $km^2$)
- Glen Becker Swamp (4.6 $km^2$)

*Table 15: Wetland cover results for Middle South Nation River*

| Subwatershed | % Wetland Cover | Grade |
|---|---|---|
| Central South Nation River | 7.9 | C |
| Hess Creek | 15.3 | A |
| Payne River | 18.1 | A |
| **MIDDLE SOUTH NATION RIVER** | **10.8** | **B** |

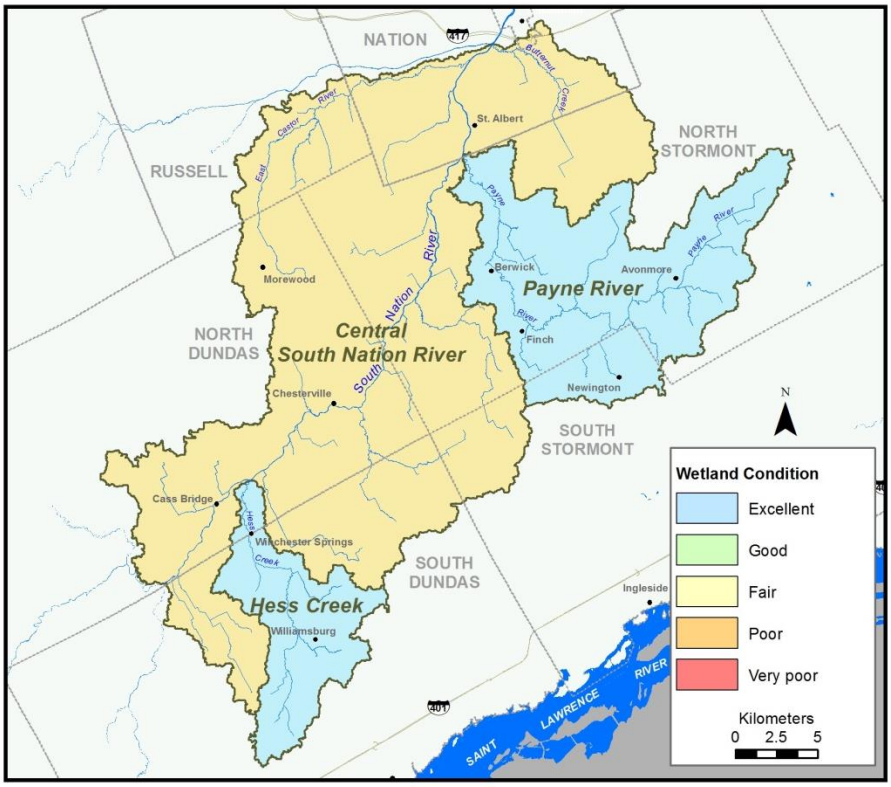


*Figure 18: Wetland Conditions in Middle South Nation Watershed*

### 3.2.6 Lower South Nation Watershed

The Lower South Nation watershed comprises of 11.7% wetland habitat. Wetland cover is excellent to good, with higher cover in the Wolf Creek subwatershed, as well as the headwaters of Cobb's Lake Creek and Moose Creek subwatersheds. Some locally and provincially significant wetland complexes include the following:

- Moose Creek Bog (10.4 $km^2$)
- Alfred Bog (17.2 $km^2$)
- Pendleton Swamp (2.1 $km^2$)
- Wolf Creek Swamp (8.7 $km^2$)

*Table 16: Wetland cover results for Lower South Nation River*

| Subwatershed | Wetland Cover % | Grade |
|---|---|---|
| Cobb's Lake Creek | 14.26 | A |
| Moose Creek | 13.8 | A |
| Mouth of South Nation River | 11.26 | B |
| Scotch River | 9.34 | B |
| Wolf Creek | 24.29 | A |
| **LOWER SOUTH NATION RIVER** | **11.7** | **A** |

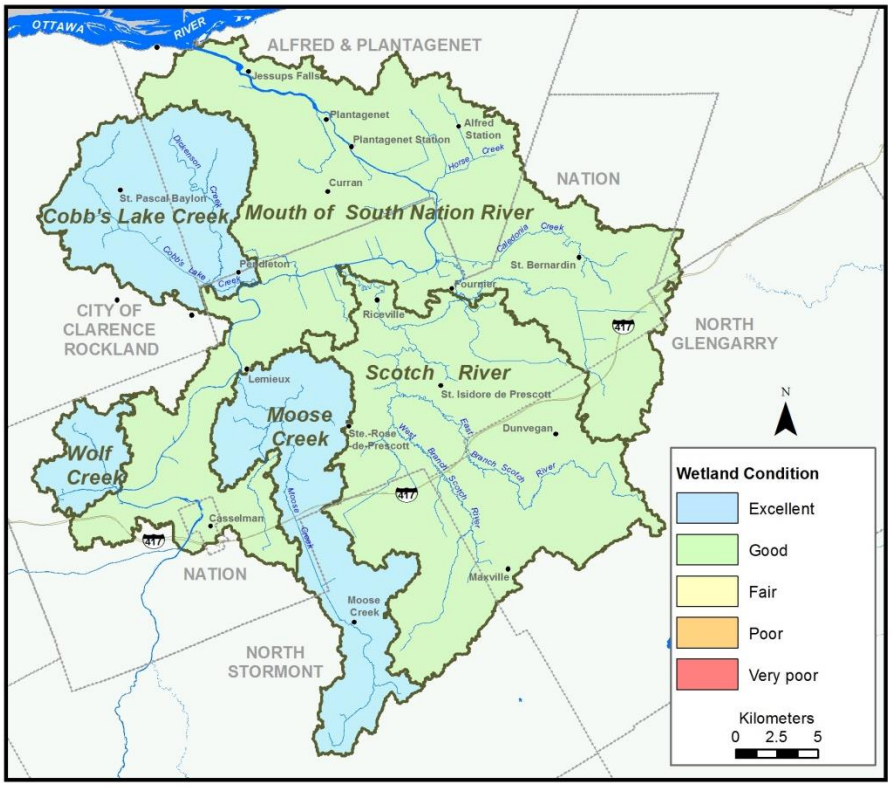


*Figure 19: Wetland Conditions in Lower South Nation Watershed*

### *3.3 Surface Water Quality*

SNC's jurisdiction covers a large and diverse landscape; the biological condition of streams is variable across the study area. 37% percent of the test sites assessed are in good condition, while 40% are in fair condition, and 23% are in poor condition. Table 17 provides a summary of the bioassessment results across SNC's jurisdiction; Figure 20 illustrates the water quality at the 5$^{th}$ order subwatershed scale, and Figure 21 depicts the water quality results at each sampling site. Tables 18 to 23 and Figures 22 to 26 provide St. Lawrence River subwatershed, and 5$^{th}$ order South Nation River subwatershed results.

*Table 17: Bioassessment results for 6$^{th}$ order subwatersheds*

| Subwatershed | # Sites in Good Condition | # Sites in Fair Condition | # Sites in Poor Condition |
|---|---|---|---|
| Bear Brook | 7 | 10 | 1 |
| Upper South Nation River | 5 | 7 | 6 |
| Castor River | 6 | 6 | 7 |
| Middle South Nation River | 5 | 3 | 2 |
| Lower South Nation River | 5 | 6 | 1 |
| St. Lawrence River | 3 | 2 | 2 |
| **SNC Jurisdiction** | **37%** | **40%** | **23%** |

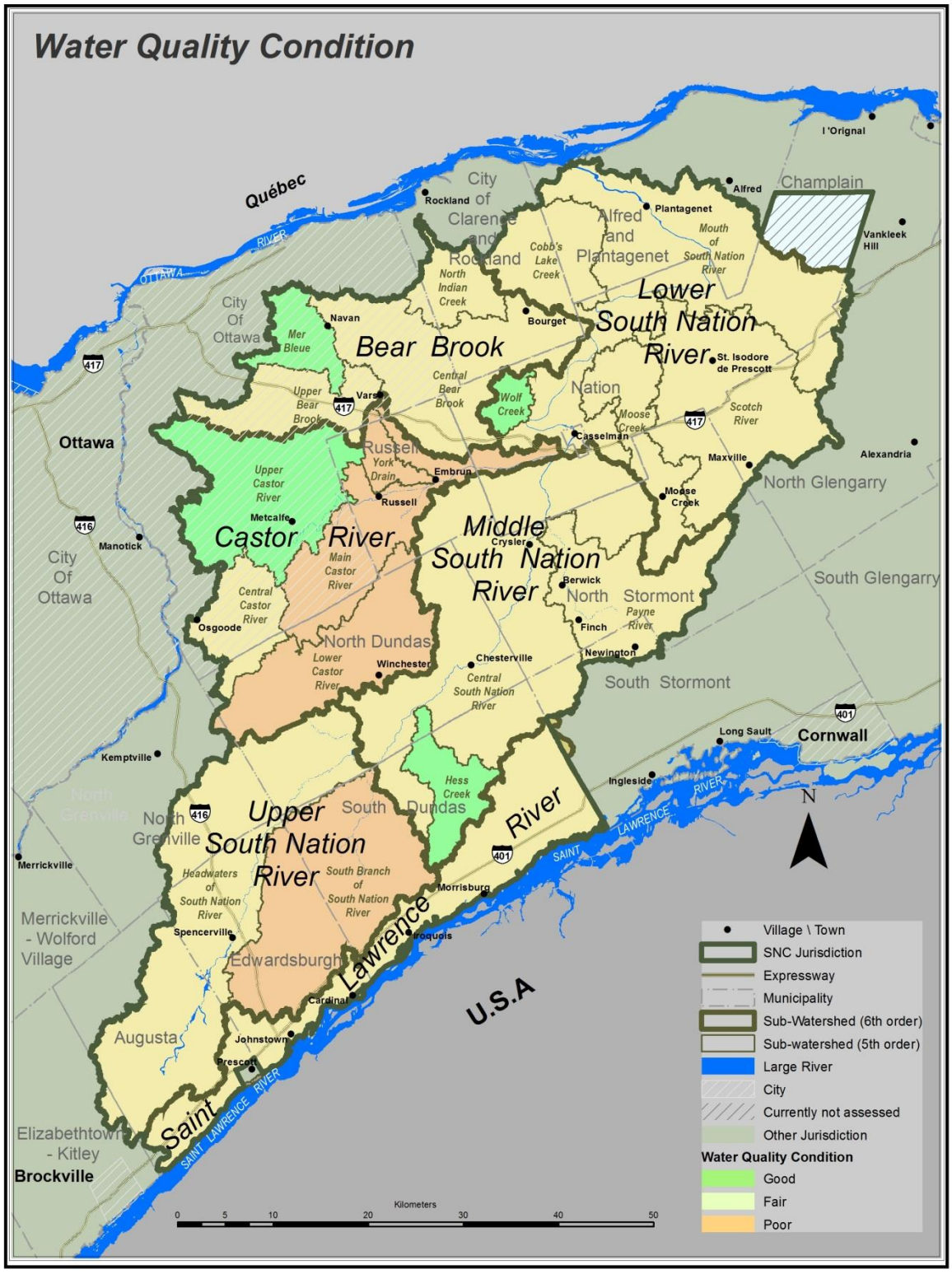


*Figure 20: Water Quality conditions at the 5th order subwatershed scale*

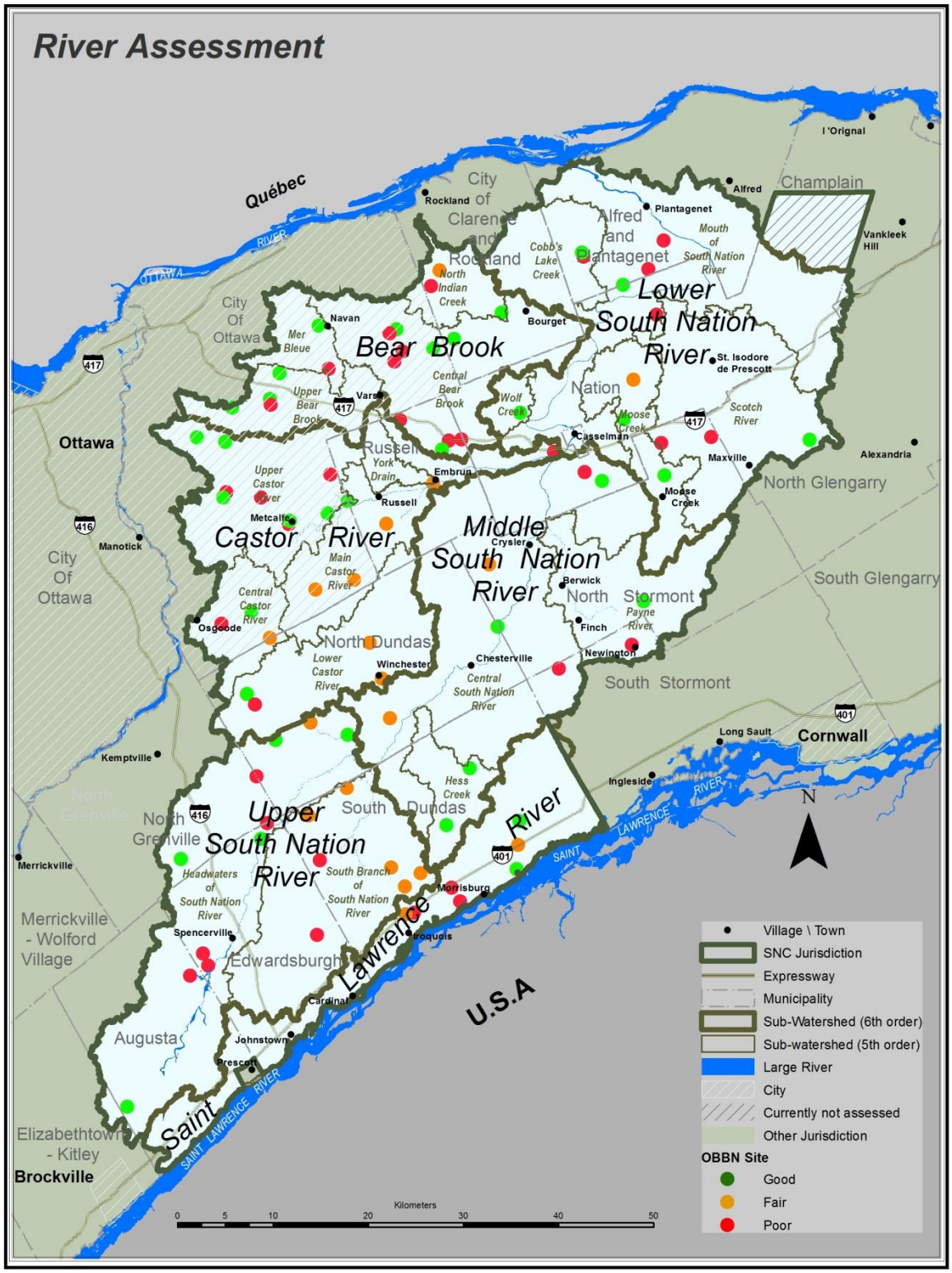


*Figure 21: River Water Quality assessment sites within South Nation Conservation*

### 3.3.1 St. Lawrence River

Bioassessments

St. Lawrence River bioassessments are variable, with 3 sites in good condition, 2 sites in fair condition, and 2 sites needing improvement (Table 18). There are no surface water sampling stations located within the St. Lawrence River subwatersheds.

### 3.3.2 Bear Brook

*Bioassessments*

The condition of test sites in the Bear Brook watershed range from good (7 sites, 39%) to fair (10 sites, 56%). One site was assessed as poor. Figure 22 depicts average subwatershed conditions. Sites observed in good condition, are located in areas with good forest cover, especially along the banks of the river (riparian buffer). The site that was assessed as poor, had very little riparian cover, and noticeable sedimentation issues within the watercourse.

*Table 18: Bioassessment results for Bear Brook Watershed*

| Subwatershed | # Sites in Good Condition | # Sites in Fair Condition | # Sites in Poor Condition |
|---|---|---|---|
| Upper Bear Brook | 1 | 2 | 0 |
| Mer Bleue | 1 | 1 | 0 |
| North Indian Creek | 1 | 1 | 1 |
| Central Bear Brook | 4 | 6 | 0 |
| **BEAR BROOK** | **39%** | **56%** | **5%** |

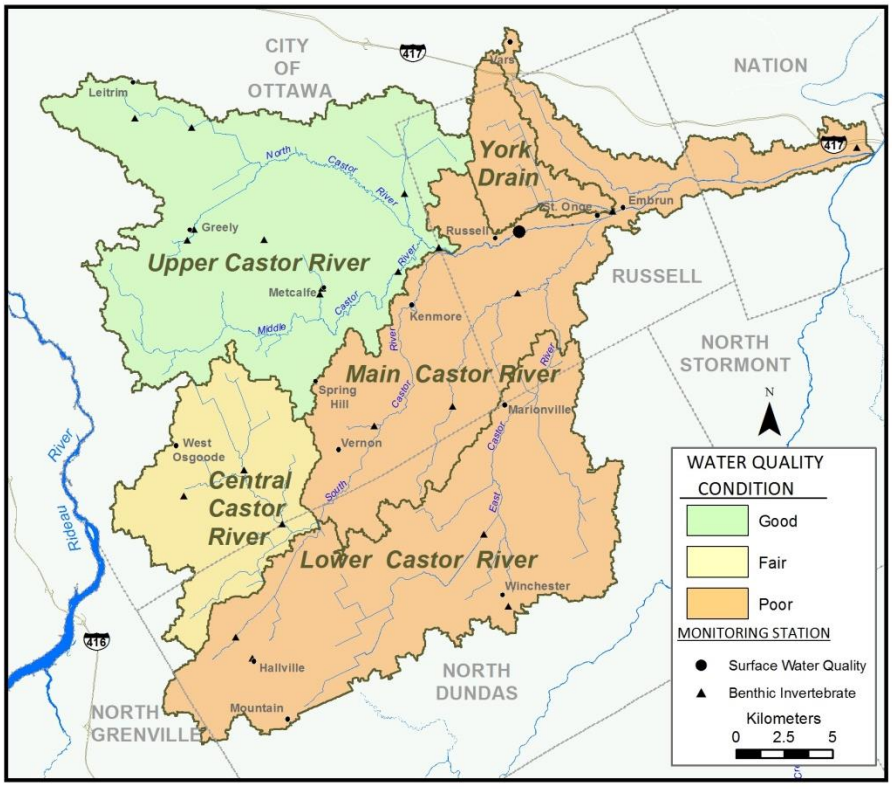


*Figure 22: Water Quality Conditions in Bear Brook Watershed*

*Water Chemistry*

Total phosphorus concentrations in the Bear Brook watershed is high (75$^{th}$ percentile: 0.126 mg/L, 100% exceedence), while nitrate (75$^{th}$ percentile: 1.23 mg/L, 3% exceedence) and zinc (75$^{th}$ percentile: 0.008 mg/L, 3% exceedence) concentrations are relatively low. Chloride results are not available for Bear Brook.

*Table 19: Surface Water Quality Results for Bear Brook*

| Bear Brook Ettyville | Total Phosphorus | Nitrate | Chloride | Zinc |
|---|---|---|---|---|
| Guideline Value (mg/L) | 0.03 | 3.0 | 120 | 0.02 |
| # Observations | 34 | 34 | N/A | 34 |
| 75$^{th}$ Percentile | 0.126 | 1.23 | N/A | 0.008 |
| # Exceedences | 34 | 1 | N/A | 1 |
| %Exceedences | 100% | 3% | N/A | 3% |

### 3.3.3 Upper South Nation Watershed

*Bioassessments*

The condition of test sites in the Upper South Nation watershed are variable, with 5 sites in good condition (28% of sites), 7 sites in fair condition (39%), and 6 sites in poor condition (33%). All sites assessed as healthy are located in the Main Branch subwatershed. Sites assessed in poor condition are located in the South Branch subwatershed.

*Table 20: Bioassessment results for Upper South Nation Watershed*

| Subwatershed | # Sites in Good Condition | # Sites in Fair Condition | # Sites in Poor Condition |
|---|---|---|---|
| Main Branch SNR | 5 | 5 | 1 |
| South Branch SNR | 0 | 2 | 5 |
| **UPPER SNR** | **28%** | **39%** | **33%** |

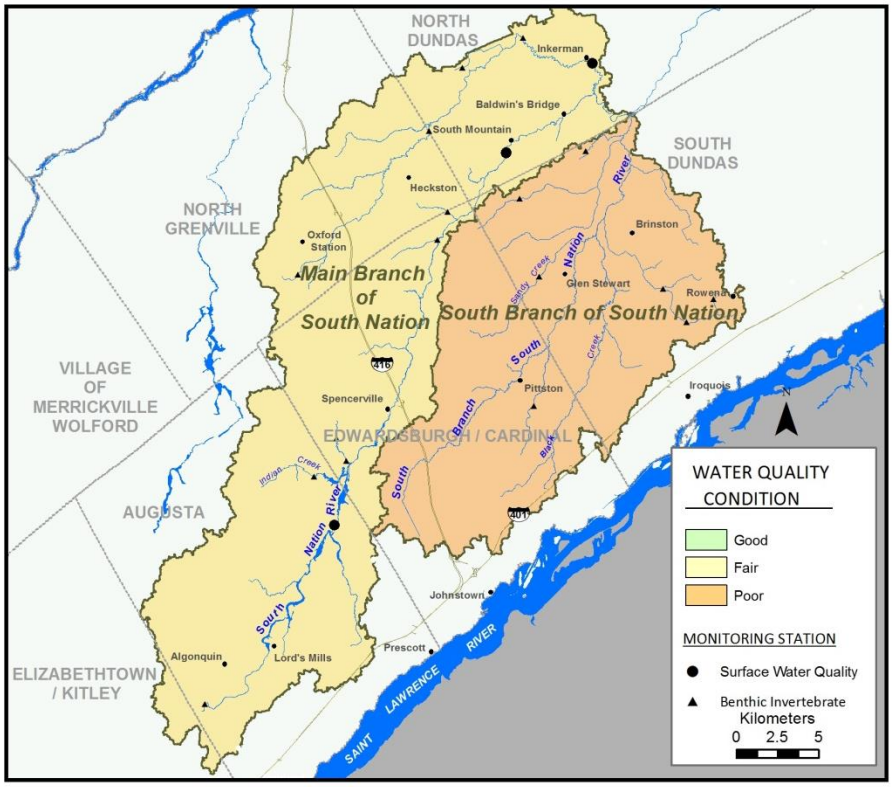


*Figure 23: Water Quality Conditions in Upper South Nation Watershed*

*Water Chemistry*

Water chemistry results are available for three sites along the South Nation River within the Upper South Nation watershed. Total phosphorus is relatively low at Roebuck (75$^{th}$ percentile: 0.048 mg/L, 53% exceedence). Phosphorus levels decrease from Roebuck to South Mountain (75$^{th}$ percentile: 0.031 mg/L, 28% exceedence), then rise sharply from South Mountain to Inkerman (75$^{th}$ percentile: 0.073 mg/L, 83% exceedence). Nitrate, chloride and zinc levels are low with no exceedences (Table_). Nitrate and zinc levels rise longitudinally through the system, from Roebuck (75$^{th}$ percentile: nitrate 0.06 mg/L, zinc 0.002 mg/L) to Inkerman (75$^{th}$ percentile: nitrate 1.25 mg/L, zinc 0.005 mg/L).

Although no water quality results are available for the South Branch subwatershed, it is likely that this system observes higher concentrations of nutrients, and metals given the increases in these parameters within a short distance in the Main Branch from South Mountain to Inkerman (the South Branch flows to the Main Branch just upstream of Inkerman).

*Table 21: Surface Water Quality Results in the Upper South Nation Watershed*

| Upper SNR | Total Phosphorus | Nitrate | Chloride | Zinc |
|---|---|---|---|---|
| Guideline Value (mg/L) | 0.03 | 3.0 | 120 | 0.02 |
| South Nation River at Roebuck | | | | |
| # Observations | 32 | 29 | 41 | 27 |
| 75$^{th}$ Percentile | 0.048 | 0.06 | 25.8 | 0.002 |
| # Exceedences | 17 | 0 | 0 | 0 |
| %Exceedences | 53% | 0 | 0 | 0 |
| South Nation River at South Mountain | | | | |
| # Observations | 36 | 36 | N/A | 36 |
| 75$^{th}$ Percentile | 0.031 | 0.35 | N/A | 0.003 |
| # Exceedences | 10 | 0 | N/A | 0 |
| %Exceedences | 28% | 0 | N/A | 0 |
| South Nation River at Inkerman, downstream of South Branch confluence | | | | |
| # Observations | 35 | 35 | N/A | 35 |
| 75$^{th}$ Percentile | 0.073 | 1.25 | N/A | 0.005 |
| # Exceedences | 29 | 0 | N/A | 0 |
| %Exceedences | 83% | 0 | N/A | 0 |

### 3.3.4 Castor Watershed

*Bioassessments*

River condition results in the Castor watershed are variable, with 32% of the watershed in good condition, 32% in fair condition, and 36% in poor condition. Most sites observed in good condition occur in the Upper Castor subwatershed. This subwatershed is located primarily in Russell and Prescott sand plains, and observes high forest cover. This subwatershed is under development pressure; future bioassessments will be important for monitoring potential impacts within this minimally impacted subwatershed.

Most sites observed in poor condition are located in the Main Castor and Lower Castor subwatersheds. These systems are located in physiographic units that yield high land capability classes for agriculture. Forest cover and riparian cover are low, limiting in-stream habitat features.

*Table 22: Bioassessment results for Castor River Watershed*

| Subwatershed | # Sites in Good Condition | # Sites in Fair Condition | # Sites in Poor Condition |
|---|---|---|---|
| Central Castor River | 1 | 1 | 1 |
| Lower Castor River | 0 | 0 | 2 |
| Main Castor River | 1 | 1 | 3 |
| Upper Castor River | 4 | 4 | 0 |
| York Drain | 0 | 0 | 1 |
| **CASTOR RIVER** | **32%** | **32%** | **36%** |

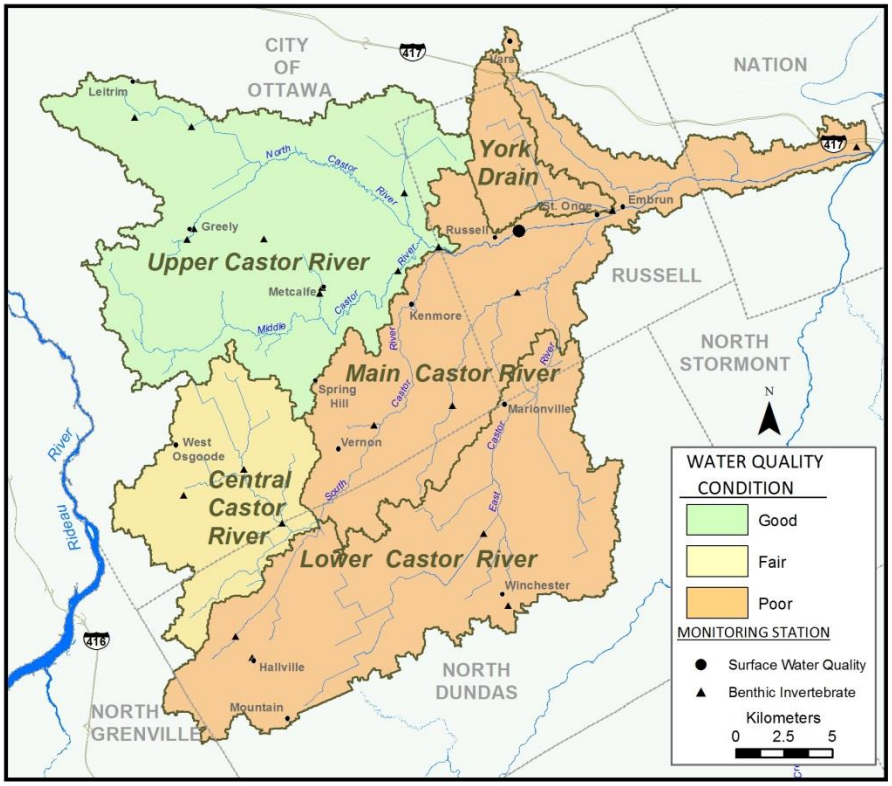


*Figure 24: Water Quality Conditions in Castor River Watershed*

*Water Chemistry*

Total phosphorus levels in the Castor River are moderate (75$^{th}$ percentile: 0.066 mg/L, 77% exceedence), while nitrate levels are low (75$^{th}$ percentile: 1.7 mg/L, 5% exceedence). Although no exceedences were observed, chloride levels in the Castor River are high compared to other sites monitored in SNC's jurisdiction.

*Table 23: Surface Water Quality Results in the Castor River*

| Castor Russell | Total Phosphorus | Nitrate | Chloride | Zinc |
|---|---|---|---|---|
| Guideline Value (mg/L) | 0.03 | 3.0 | 120 | 0.02 |
| # Observations | 35 | 42 | 40 | N/A |
| 75$^{th}$ Percentile | 0.066 | 1.7 | 77.8 | N/A |
| # Exceedences | 27 | 2 | 0 | N/A |
| %Exceedences | 77% | 5% | 0 | N/A |

### 3.3.5 Middle South Nation Watershed

*Bioassessments*

River conditions in the Middle South Nation watershed are variable, with 50% of the watershed in good condition, 30% in fair condition, and 20% in poor condition. Sites observed in good condition are located in the headwaters of the Hess subwatershed and Payne subwatershed. These sites are located in Glengarry till plain, where good to fair forest cover and forest interior are observed.

Sites in fair to poor condition are located in physiographic units that yield high land capability classes for agriculture. Forest cover and riparian cover are low, limiting in-stream habitat features.

*Table 24: Bioassessment Results for Middle South Nation Watershed*

| Subwatershed | # Sites in Good Condition | # Sites in Fair Condition | # Sites in Poor Condition |
|---|---|---|---|
| Central South Nation River | 2 | 2 | 2 |
| Hess Creek | 2 | 0 | 0 |
| Payne River | 1 | 1 | 0 |
| **MIDDLE SNR** | **50%** | **30%** | **20%** |


*Figure 25: Water Quality Conditions in Middle South Nation Watershed*

*Water Chemistry*

Table 25 presents surface water quality results for the South Nation River at Chesterville. There are no increases in total phosphorus concentrations in the South Nation River from Inkerman (75$^{th}$ percentile: 0.0730 mg/L) to Chesterville (75$^{th}$ percentile: 0.0730 mg/L, 89% exceedence). Nitrate concentrations (75$^{th}$ percentile: 2.44 mg/L) are elevated at this location compared to upstream concentrations (75$^{th}$ percentile at Inkerman: 1.25 mg/L), and are in exceedence 15% of the time. Chloride levels at Chesterville (75$^{th}$ percentile: 26.1 mg/L) remain low compared to upstream levels (75$^{th}$ percentile at Roebuck: 25.8 mg/L).

*Table 25: Surface Water Quality Results for the South Nation River at Chesterville*

| SNR Chesterville | Total Phosphorus | Nitrate | Chloride | Zinc |
|---|---|---|---|---|
| Guideline Value (mg/L) | 0.03 | 3.0 | 120 | 0.02 |
| # Observations | 36 | 39 | 40 | N/A |
| 75$^{th}$ Percentile | 0.073 | 2.44 | 26.1 | N/A |
| # Exceedences | 32 | 6 | 0 | N/A |
| %Exceedences | 89% | 15% | 0 | N/A |

Table 26 presents surface water quality results for the Payne River east of the Village of Crysler. Relative to the rest of the watershed, total phosphorus levels are low (75$^{th}$ percentile: 0.055 mg/L, 67% exceedences), while nitrate levels are high (75$^{th}$ percentile: 2.63 mg/L, 21% exceedences). Zinc concentrations are low (75$^{th}$ percentile: 0.005 mg/L, 3% exceedences), with 1 exceedence observed.

*Table 26: Surface Water Quality Results for the Payne River east of Chrysler*

| Payne R Crysler | Total Phosphorus | Nitrate | Chloride | Zinc |
|---|---|---|---|---|
| Guideline Value (mg/L) | 0.03 | 3.0 | 120 | 0.02 |
| # Observations | 33 | 33 | N/A | 33 |
| 75$^{th}$ Percentile | 0.055 | 2.63 | N/A | 0.005 |
| # Exceedences | 22 | 7 | N/A | 1 |
| %Exceedences | 67% | 21% | N/A | 3% |

### 3.3.6 Lower South Nation Watershed

*Bioassessments*

River conditions in the Lower South Nation watershed are variable, with 42% of the watershed in good condition, 50% in fair condition, and 8% in poor condition (Table 27 and Figure 25). The Wolf Creek subwatershed remains one of the least disturbed subwatersheds in SNC's jurisdiction, resulting in healthy river conditions. Additional sites observed in good condition are located in the headwaters of the Moose Creek, and Scotch River subwatersheds. These sites are located in Glengarry till plain, where good to fair forest cover and forest interior are observed.

Sites in fair to poor condition are located in physiographic units that yield high land capability classes for agriculture. Forest cover and riparian cover are low, limiting in-stream habitat features.

*Table 27: Bioassessment Results for Lower South Nation Watershed*

| Subwatershed | # Sites in Good Condition | # Sites in Fair Condition | # Sites in Poor Condition |
|---|---|---|---|
| Cobb's Lake Creek | 0 | 1 | 0 |
| Moose Creek | 2 | | 1 |
| Mouth of South Nation River | 1 | 3 | 0 |
| Scotch River | 1 | 2 | |
| Wolf Creek | 1 | 0 | 0 |
| **LOWER SNR** | **42%** | **50%** | **8%** |

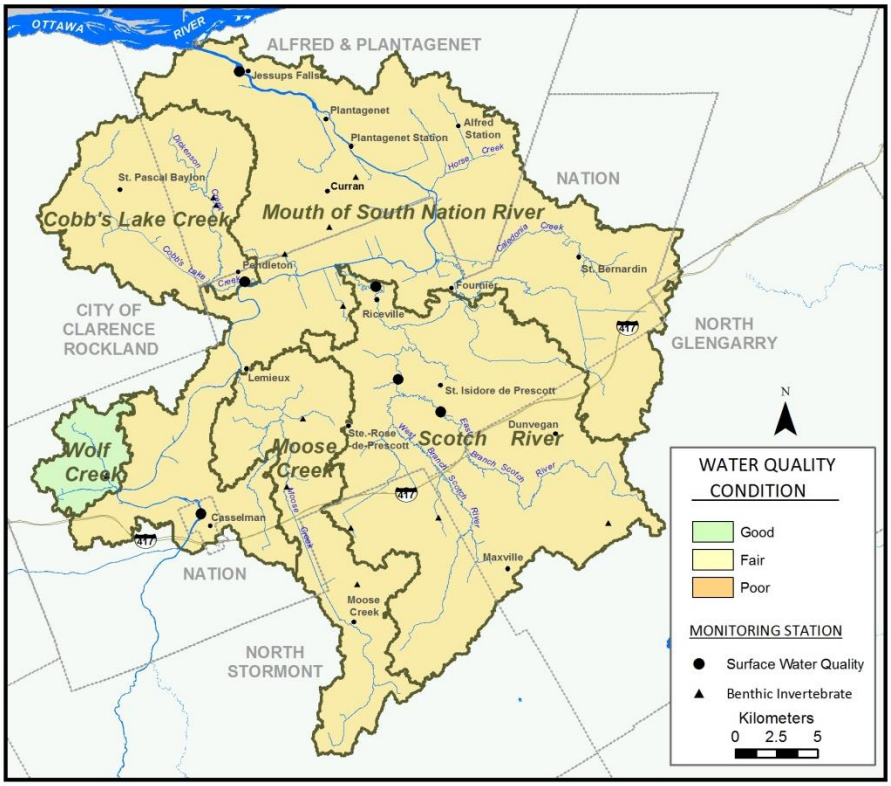


*Figure 26: Water Quality Conditions in Lower South Nation Watershed*

*Water Chemistry*

Table 28 presents surface water quality results for the South Nation River at Casselman and Plantagenet. Total phosphorus concentrations increase in the SNR from Chesterville (75$^{th}$ percentile: 0.0730 mg/L, 89% exceedence) to Casselman (75$^{th}$ percentile: 0.096 mg/L, 97% exceedence) to Plantagenet (75$^{th}$ percentile: 0.119 mg/L, 98% exceedence). Nitrate concentrations remain similar at Casselman (75$^{th}$ percentile: 2.2 mg/L, 18% exceedence) and Plantagenet (75$^{th}$ percentile: 2.45 mg/L, 10% exceedences) when compared to nitrate levels recorded upstream at Chesterville (75$^{th}$ percentile: 2.44 mg/L, 15% exceedence). Chloride levels remain low at Chesterville (75$^{th}$ percentile: 43.8 mg/L) and Plantagenet (75$^{th}$ percentile: 50.7 mg/L), with no exceedence observed. Zinc concentrations (75$^{th}$ percentile: 0.006 mg/L) are low with 1 exceedence observed.

*Table 28: Surface Water Quality Results for South Nation River at Casselman and Plantagenet*

| Lower SNR | Total Phosphorus | Nitrate | Chloride | Zinc |
|---|---|---|---|---|
| Guideline Value (mg/L) | 0.03 | 3.0 | 120 | 0.02 |
| South Nation River at Casselman | | | | |
| # Observations | 35 | 40 | 40 | N/A |
| 75$^{th}$ Percentile | 0.096 | 2.2 | 43.8 | N/A |
| # Exceedences | 34 | 7 | 0 | N/A |
| %Exceedences | 97% | 18% | 0 | N/A |
| South Nation River at Plantagenet | | | | |
| # Observations | 40 | 39 | 39 | 29 |
| 75$^{th}$ Percentile | 0.119 | 2.45 | 50.7 | 0.006 |
| # Exceedences | 39 | 4 | 0 | 1 |
| %Exceedences | 98% | 10% | 0 | 3% |

Water chemistry results are available at three sites along the Scotch River (Table 29). Total phosphorus is elevated at all three sites: East Branch (75$^{th}$ percentile: 0.098 mg/L, 79% exceedence), West Branch (75$^{th}$ percentile: 0.102, 95% exceedence), and the Mouth of the Scotch River (75$^{th}$ percentile: 0.100, 100% exceedence). Nitrate levels are low in the East Brach (75$^{th}$ percentile: 0.415, 3% exceedence), and high in the West Branch (75$^{th}$ percentile: 3.45, 35% exceedence). Nitrate levels remain high at the mouth (75$^{th}$ percentile: 3.68, 34% exceedence). Chloride and zinc levels are low with 1 exceedence in zinc. Water quality in the East Branch of the Scotch River is in better condition than the West Branch.

*Table 29: Surface Water Quality Results for the Scotch River*

| Scotch River | Total Phosphorus | Nitrate | Chloride | Zinc |
|---|---|---|---|---|
| Guideline Value (mg/L) | 0.03 | 3.0 | 120 | 0.02 |
| Scotch River – East Branch at St. Elmo | | | | |
| # Observations | 34 | 39 | 35 | N/A |
| 75$^{th}$ Percentile | 0.098 | 0.415 | 13.1 | N/A |
| # Exceedences | 27 | 1 | 0 | N/A |
| %Exceedences | 79% | 3% | 0 | N/A |
| Scotch River – West Branch at County Road 3 (west of St. Isidore) | | | | |
| # Observations | 39 | 37 | 40 | N/A |
| 75$^{th}$ Percentile | 0.102 | 3.45 | 40.9 | N/A |
| # Exceedences | 37 | 13 | 0 | N/A |
| %Exceedences | 95% | 35% | 0 | N/A |
| Scotch River Mouth at Riceville (u/s of confluence with SNR) | | | | |
| # Observations | 32 | 32 | N/A | 33 |
| 75$^{th}$ Percentile | 0.100 | 3.68 | N/A | 0.005 |
| # Exceedences | 32 | 11 | N/A | 1 |
| %Exceedences | 100% | 34% | N/A | 3% |

Cobb's Lake Creek has the poorest water quality of all sites monitored in SNC's jurisdiction, with total phosphorus levels almost twice as high as any other site (75$^{th}$ percentile: 0.225 mg/L, 100% exceedence) (Table 30). Nitrate, chloride and zinc levels are relatively low (8%, 3%, and 3% exceedences respectively), however chloride and zinc levels in Cobb's Lake Creek are the highest recorded concentrations in SNC's jurisdiction.

*Table 30: Surface Water Quality Results for Cobb's Lake Creek*

| Cobb's Lake Creek | Total Phosphorus | Nitrate | Chloride | Zinc |
|---|---|---|---|---|
| Guideline Value (mg/L) | 0.03 | 3.0 | 120 | 0.02 |
| # Observations | 39 | 38 | 39 | 30 |
| 75$^{th}$ Percentile | 0.225 | 1.65 | 84.4 | 0.013 |
| # Exceedences | 39 | 3 | 1 | 1 |
| %Exceedences | 100% | 8% | 3% | 3% |

### *3.4 Total Phosphorus Levels over Time*

Total phosphorus levels have been decreasing over time (Figure 27). Trends show a dramatic decrease in total phosphorus concentrations from the first 15-year period (1968-1982) to the second 15-year period (1983-1997). This decrease can be attributed to the construction or improvement of sewage treatment lagoons in Embrun, Casselman and Winchester, as well as the decision to restrict phosphate concentrations in detergents.

A decrease is observed from the second 15-year period (1983 – 1997) to the third 15-year period as well (1998-2012). This is likely due to improvements in agricultural land management, Programs implemented by South Nation Conservation, such as the Total Phosphorus Management Plan, and the Clean Water Program, as well as the increase of forest cover on the landscape.

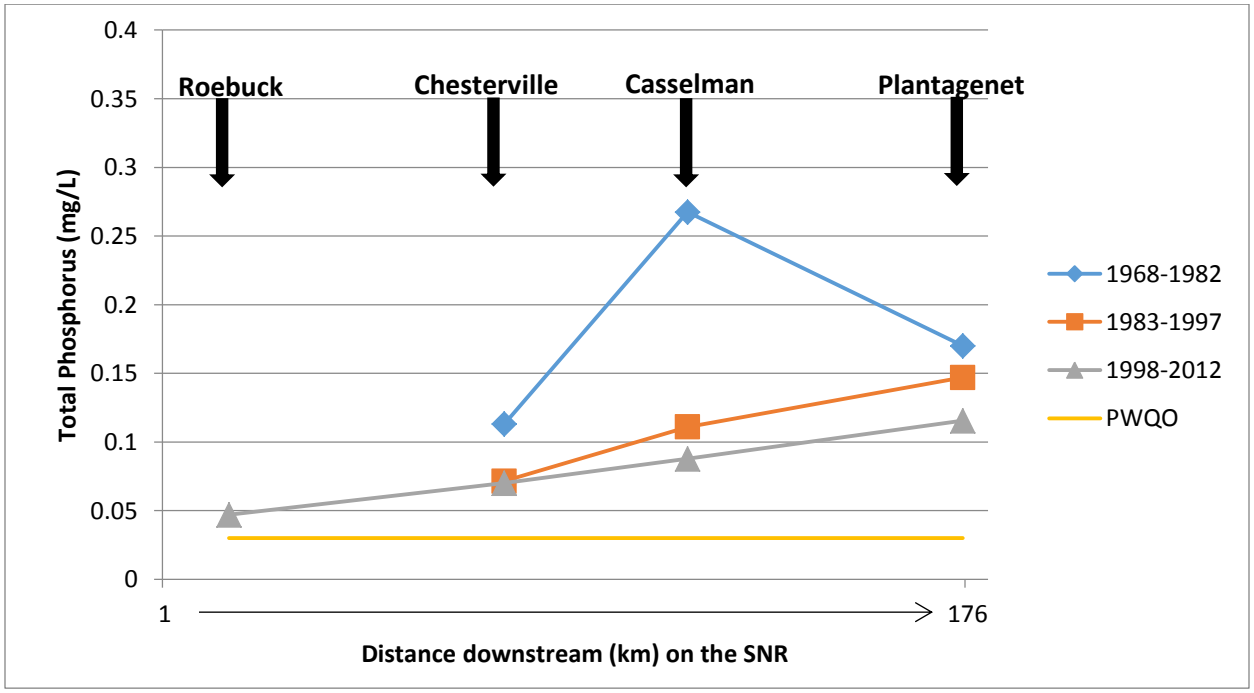


*Figure 27: Total Phosphorus Results in the South Nation River*

# 4 Conclusions

This document summarizes information that has been collected on forests, wetlands, and rivers within the SNC jurisdiction, in order to provide context of the health of the watershed, and highlight areas that are faring well, and those which may need improvement. The following is a summary of report findings:

*Forest Conditions*

Overall, forest cover is good in SNC's jurisdiction at 29.5%. Although total forest cover and percent forest interior fell slightly below the recommended value, they were well represented throughout the SNC jurisdiction. Percent riparian forested cover requires improvement across the entire study area.

*Wetland Conditions*

Wetland cover results are excellent within SNC's jurisdiction, with 17% of the study area in wetland cover. All 5$^{th}$ order subwatersheds exceeded the wetland cover objective of 10%.

*Water Quality Conditions*

The biological condition of streams varies across the study area. 77% of streams monitored were observed in good to fair condition, while 23% require improvement. A correlation exists between the amount of natural cover on the landscape, particularly forest cover, and the condition of surface water resources. Sites that are located in areas with high forest cover result in good to fair assessments, while sites that are located in areas of low forest cover require improvement.

Generally, surface water quality in the SNC jurisdiction is considered fair. Nitrate, chloride and zinc levels are low (with minor exceedences), while total phosphorus levels exceed the Provincial Water Quality Objective at every water quality station across the watershed. Total Phosphorus exceedences are minor in the headwaters of the SNR; as the river flows downstream, it accumulates additional inputs. Total phosphorus levels increase the most as the south branch of the SNR flows to the main branch, as well as between the Chesterville and Casselman surface water quality stations. This emphasizes the importance of continuing to implement phosphorous reducing programs within these areas.

Total phosphorus levels are decreasing over time. Initial declines observed in the 1980's and 1990's can be attributed to the construction or improvement of sewage treatment lagoons, as well as the decision to restrict phosphate concentrations in detergents. Declines in total phosphorus continue to be observed – the result of improvements in agricultural land management, projects implemented through the Clean Water Program, as well as the increase of forest cover on the landscape.

Results indicate that there has been an overall improvement in the condition of water resources within SNC's jurisdiction and that the projects and outreach initiatives, such as the Clean Water Program, and the tree planting Program are having a positive effect.

# 5 Recommendations

Results and Conclusions support the continuation of SNC programs, which have been effective at improving the condition of the SNC jurisdiction. SNC needs to develop strategic objectives within these programs to enhance uptake, especially in areas that need improvement. The next step is to share the information contained within this report with program managers to develop targeted programs. To achieve success and uptake of programs, it is important to explore opportunities for partnerships and ways to leverage projects. This report supports the following recommendations:

*Forest Conditions*

- Continue programs that increase forest cover
- Continue forest education and outreach
- Use Land Securement Strategy to assist with protecting forest cover and forest interior across SNC jurisdiction
- Increase riparian cover through stream naturalization projects, tree planting programs, and stewardship programs (e.g. Clean Water Program)
- Adapt programs to increase uptake in areas that need improvement

*Wetland Conditions*

- Continue regulating Provincially Significant Wetlands
- Enhance education and outreach on wetland habitat and wetland biodiversity
- Continue wetland enhancement and creation work
- Use Land Securement Strategy to assist with protecting locally significant wetlands
- Continue with involvement in annual workshops and training events (e.g. Water Management & Wetland Restoration Training course offered through University of Guelph)

*Water Quality Conditions*

- Continue environmental monitoring program to understand water quality condition in SNC jurisdiction and to track changes over time
- Continue working with existing partners, programs and Committees to promote and facilitate uptake of environmental projects in SNC jurisdiction
- Explore opportunities for understanding effectiveness of projects at improving water quality – before-after, control-impact monitoring
- Adapt programs to increase uptake in areas that need improvement

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# 7 Appendix A

Methodology on how to summarize the biological condition of test sites, using the reference condition approach, and testing the bioassessment null hypotheses

*Summarizing the Biological Condition of Test Sites*

Biomonitoring studies generate complicated rows and columns of numbers that correspond to the counts or relative abundances of animals collected at different sites. These data matrices are extremely difficult to comprehend without reducing the information down to a more manageable level. Summarizing composition with indices is a way to do this. Different indices have been developed to summarize the biological condition of benthic communities in an effort to determine stream health status. Different indices summarize and emphasis different aspects of community composition, though some are correlated. The following were used to summarize test sites sampled in the Middle South Nation River Subwatershed.

*% Isopoda, Gastropoda, Hirudinea(CIGH)*

This metric measures the proportion of water boatmen (Corixidae),aquatic peracarid crustaceans (Isopoda), snails (Gastropoda), and leaches (Hirudinae) within each sample. These orders are often associated with impaired conditions related to agricultural impacts.

*% Ephemeroptera, Plecoptera, Trichoptera (%EPT)*

This metric measures the proportion of mayflies (Ephemeroptera), stoneflies (Plecoptera) and caddisflies (Trichoptera) within each sample. These orders are often associated with unimpaired conditions because they are generally considered sensitive to most human-induced stressors.

*Principal Coordinates Analysis (PCoA)*

Principal Coordintaes Analysis is a method to explore and visualize similarities or dissimilarities of data. Ordination permits a 2- (or more-) dimensional graph to be generated based on how closely different sites are associated according to their counts of collected taxa. Points (sites) that are closer together on the graph are more similar in composition than sites that are farther apart. Axis scores are thus a community-scale summary of composition, and they exhibit a normal distribution, making them well-suited to use in statistical tests of hypotheses.

*Reference Condition Approach*

The Ontario Benthos Biomonitoring Network (OBBN) recommends using the Reference Condition Approach (RCA) for assessing stream health. The RCA compares the biological community at potentially impacted test sites to communities found in minimally impacted reference sites (Bowman and Somers, 2005).

Candidate reference reaches are screened to ensure that the sites have been minimally-exposed to anthropogenic disturbances (e.g., point-source contamination, impoundments and dams, lack of riparian habitat, etc.) and therefore reflect best-available conditions. In addition, they must have similar natural habitat as that of the test site (e.g. similar geographic location,

climate, geology, topography, and similar waterbody size and morphology) and they should be sampled in the same season

If reference stations are accurately chosen, it is assumed that they represent normal, expected, or acceptable biotic conditions. Deviation from this condition is considered to reflect biotic responses to stress, and is therefore a measure of impairment (Bowman et al. 2005).

*Testing the Bioassessment Null Hypotheses*

A critical step in the RCA approach is the test of the bioassessment null hypothesis (i.e. that the test site is normal). Test Site Analysis (TSA; Bowman and Somers 2005) is a multivariate approach to this task. It allows several indices to be used, and considers correlations or redundancies between indices. There are two main results or statistics that are provided by this test: (1) a measure of statistical distance between the test site and the reference sites' mean (i.e., a multivariate Mahalanobis or generalized distance, D), and (2) A measure of a probability that a distance of this magnitude could have arisen by chance.

TSA is normally calculated as a non-central test; rather than testing the hypothesis of no difference (as in a central test), we are testing the null hypothesis that the test site falls outside the normal range of variation. The test calculates two distances: (1) between the reference sites and the test site (i.e. from the reference site mean, or multivariate centroid, to the test site) and (2) among the reference sites. The site fails if it's distance from the reference site mean is greater than the 95th percentile of the distances among reference sites (i.e. greater than 95% of the distribution of all pair-wise distances within the selected reference-site group.

If the test site falls outside of the normal range of variability, and is considered impaired, the analysis is re-run iteratively, each time leaving out a different index. This allows us to characterize the effect sizes (or magnitude of biological responses) reported by each index. In doing so, we are describing a "response signature"; over time these patterns of incriminating index contributions can help us establish causes of the biological impairments (Bowman et al. 2003).

The methodology explaining how calculations are derived can be viewed in "A simple method to evaluate whether a biological community has been influenced by anthropogenic activity" (Bowman et al. 2003, Appendix A).