Photo: Terry Sprague

STOCO LAKE STEWARDSHIP PLAN

JUNE 15, 2017

Quinte CONSERVATION

Friends of Stoco Lake

MUNICIPALITY OF TWEED OUR BACKYARD

Acknowledgements

The Stoco Lake Stewardship Plan Steering Committee would like to recognize the many citizens that gave time, ideas, expertise, and feedback to make this plan happen.

Friends of Stoco Lake (FOSL): Vicki McCulloch, Chair of the Stoco Lake Plan Steering Committee and FOSL Chair; Ruth James-Morrow, FOSL Board Member and Steering Committee Member. Visit www.friendsofstocolake.ca

Municipality of Tweed: Don DeGenova, Municipality of Tweed Councilor; Rachelle Hardesty, Manager of Community Development. Visit www.twp.tweed.on.ca

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EXECUTIVE SUMMARY

This stewardship plan for Stoco Lake marks the completion of more than two years of work by Friends of Stoco Lake, Quinte Conservation, and the Municipality of Tweed. Most importantly, the plan reflects the concerns and aspirations of the community around Stoco Lake expressed at a series of workshops and through survey responses.

The plan provides the community with a suite of stewardship recommendations that will provide guidance for the preservation and protection of Stoco Lake.

Stoco Lake is influenced by its history (from its physical formation, to past land uses and cultural history), and its physical and natural environment. The Health of Stoco Lake has been studied numerous times and has shown improvement over time. Overall, Stoco Lake has a healthy natural environment with high forest cover and wetlands and a rich diversity of species. Stoco Lake is considered to be a healthy lake with moderate nutrient levels (mesotrophic). Significant reductions in lake phosphorus have occurred over time and can be attributed to the reforestation efforts throughout the watershed, the modernizing of sewage treatment systems, and improved agricultural practices. The water quality of the Lake is greatly affected by the small size of the Lake, shallow depth, surface area, volume, shoreline length, and hydrological characteristics. The Lake has a very high drainage ratio with a watershed of 2,230 square kilometers (the area of land drained by rivers, creeks, and streams to a waterbody) resulting in the majority of nutrients entering the Lake from inflowing rivers. High levels of nutrients promote excess aquatic weed growth and algal blooms. The shallow depth of the Lake allows for wind-induced mixing of the lake bottom (determined to be nutrient rich), releasing further nutrients into the water column promoting aquatic plant growth and algae growth. Caution

should be taken to avoid any additional amounts of phosphorus from entering the Lake in order to maintain nutrient levels within a healthy range. To help maintain healthy nutrient levels in the Lake, efforts should be taken to:

- naturalize shorelines to aid in removing excess nutrients from entering watercourses and the Lake;
- ensure septic tanks are pumped regularly and maintained;
- and work alongside farmers, especially along watercourses, to implement best management strategies for reducing excess phosphorus loading into the water systems.

A 2016 lake study by Quinte Conservation determined a richness of native fish species, 17 species were identified. Abundant wetland areas and natural habitats around Stoco Lake and its watershed are in a good natural state and harbor healthy populations of diverse animal species, including sensitive species. Invasive species were noted on the Lake in 2016. Efforts should be taken to reduce the risk of new non-native species from establishing in the Lake and to slow the spread of the ones that are present.

Through a series of workshops and online surveys, the community was provided with opportunities to review background information and to identify their values, issues, and potential actions to be considered. The *"Health of the Lake*" sections of this report document current information on land use, water quality, water levels, natural habitats and features, wetlands, species at risk, invasive species, forest cover, and fish and wildlife. Together with the results of the community meetings and the health of the Stoco Lake studies (past and recent), a series of goals, objectives, and recommendations are provided in this plan with the aim of protecting the health and character of Stoco Lake.

The preparation of this Plan is just the first step. The important work of implementation has yet to be undertaken and we encourage everyone to engage in its recommended actions.

TABLE OF CONTENTS

List of Tables

List of Figures

List of Maps

LIST OF ACRONYMS

Acronym	Definition
ANSI	Area of Natural and Scientific Interest
AOC	Areas of Concern
BOD	Biological Oxygen Demand
BQRAP	Bay of Quinte Remedial Action Plan
CA	Conservation Authority
COD	Chemical Oxygen Demand
DU	Ducks Unlimited
E. Coli	*Escherichia coli*
LEL	Lowest Effect Level
HPECHU	Hastings and Prince Edward Counties Health Unit
MNR	Ministry of Natural Resources
MNRF	Ministry of Natural Resources and Forestry
MOE	Ministry of Environment
MOEE	Ministry of Environment and Energy
MOECC	Ministry of Environment and Climate Change
MRW	Moira River Watershed
NEL	No Effect Level
OBBN	Ontario Benthos Biomonitoring Network
OFAH	Ontario Federation of Anglers and Hunters
PGQMN	Provincial Groundwater Quality Monitoring Network
PSQG	Provincial Sediment Quality Guidelines
PWQO	Provincial Water Quality Objective
PSW	Provincially Significant Wetland
SEL	Severe Effect Level
SAV	Submerged Aquatic Vegetation
TKN	Total Kjeldahl Nitrogen
TP	Total Phosphorus

1.0 STOCO LAKE STEWARDSHIP PLAN

The purpose of the Stoco Lake Stewardship Plan ('the Plan') is to identify, protect, preserve, and enhance the unique environmental and social features of Stoco Lake for present and future generations.

The Plan was developed through a community-based process that considered the interests of all stakeholders on Stoco Lake and throughout the immediate watershed, including permanent and seasonal residents, commercial operators, farmers, and recreationalists (e.g. anglers, boaters). The purpose of the process was to engage members of the community and help them to identify their values and issues; then to develop stewardship actions to address their identified issues and protect the health and character of Stoco Lake.

The Plan contains a series of recommendations that address the goals and objectives of the Plan and strive to meet a stated vision for the future of Stoco Lake. These actions include stewardship activities that are designed to protect, preserve, and enhance the environmental and social features of the Lake. The plan reflects and builds upon background material collected, the results of a Lake Study conducted by Quinte Conservation in 2016, and community interests identified through public consultations and an on-line survey. This document contains information currently available on Stoco Lake, including information on the history of the area and the Lake, natural features of the watershed, wetlands, water quality, water quantity, species at risk, invasive species, and fish and wildlife.

The Plan has been prepared by Quinte Conservation, in partnership with Friends of Stoco Lake and the Municipality of Tweed. A record of all reports, public consultations, and the details of the planning process (e.g., workshop summaries, meeting summaries, Steering Committee minutes, and community survey results) can be found on the Friends of Stoco Lake website, www.friendsofstocolake.ca .

1.1 Preparing the Plan

The process to develop the Stoco Lake Stewardship Plan took place over two years, starting in the spring of 2015 and completed in the summer of 2017. A Steering Committee with representation from Friends of Stoco Lake, Municipality of Tweed, and Quinte Conservation led the process. The Committee held regular meetings, coordinated the process, and made decisions about the Stewardship Plan contents and recommended actions.

The Friends of Stoco Lake chaired the Steering Committee and guided the two-year process. Friends of Stoco Lake coordinated community outreach activities and logistical needs for open houses, meetings, and workshops. The organization also administered an on-line public survey. Quinte Conservation collected and collated data, performed a lake survey in 2016, prepared the "*The Stewardship Plan*" report, and provided technical expertise and advice. The Municipality of Tweed was actively involved on the Steering Committee, financially funded aspects of the project, coordinated with municipal staff and Council, and assisted with community outreach.

A variety of approaches were used to engage members of the community. Friends of Stoco Lake maintained a website with postings of all relevant information and documents (www.friendsofstocolake.ca) including meeting minutes and workshop summaries and presentations.

Three public workshops were held at key decision points in the process: Identifying Values, Issues, and Actions, facilitated by French Planning Services (September 26, 2015); The Health of Lake Report and Preliminary Discussions around Actions (October 1, 2016); and Reviewing and Confirming the Draft Plan (June 3, 2017).

An online survey was developed to provide an opportunity for those that could not attend a public workshop to voice their ideas and opinions; 150 people participated.

Quinte Conservation collected existing information and studies on the Lake, identified gaps in data and then conducted field work in the summer of 2016. The results of the field work are found in this document and were presented to the public on October 1st, 2016. The draft plan was prepared during the winter of 2016 and presented to the Municipality of Tweed Council, Friends of Stoco Lake, and the Stoco Lake community in the spring of 2017.

1.2 Community Values

Natural, social, physical, and economic values are important to the enjoyment and connection with Stoco Lake. These values are linked to the reasons why people live, work, and play in the Stoco Lake region. From the workshops, meetings, and surveys, feedback was broken down into the following values identified as important to the Stoco Lake community:

Water Quality - Many people desire cleaner water and confirmed that good water quality is one of the most important priorities for the Lake. Specific concerns noted included: residential septic systems and sewage/waste treatment; excessive aquatic "weed" growth and algae; runoff from roads, lawns, and farms; upstream impacts; and bacterial levels leading to beach closures.

Water Levels – Water levels fluctuate on Stoco Lake with specific concern around high levels and potential for flooding, with the 2014 flood of specific concern.

Natural Environment - The community recognizes and values the healthy natural features (wetlands, forests, and shorelines) and the rich biodiversity, an abundance of plant and animal species. There is a desire to protect the natural environment. Specific concerns were raised and included excessive aquatic "weed" growth, controlling current invasive species and avoiding the introduction of new ones, improved knowledge of the Lake, more natural shorelines, and the continued preservation of wetlands.

Social and Recreational - Stoco Lake is valued for its year-round recreational opportunities. Many value the quietness and natural beauty, wildlife viewing, and "*relaxing at the lakeshore*". It was noted by some that the Lake is a hub of economic activity and has potential for more tourism. Specific concerns were noted around the potential for larger and louder boats, increased noise and light pollution, and regarding nuisance species, e.g., Canada Geese and Cormorants. Participants would like to see more focus on responsible boating practices, more trails/greenspace, and improved boat launches.

Development - Stoco Lake is valued for its beauty and peaceful rural landscape alongside its year-round recreational opportunities within a mix of land use including residential (permanent and seasonal), commercial, and agricultural. Community members noted that preserving a healthy ecosystem was of value to them. Many had concerns related to wastewater management (municipal, residential, and commercial), shoreline health, and species richness.

1.3 Vision and Goals

The following vision and goal statements were developed by the Steering Committee and provide guidance for the preservation and protection of Stoco Lake. The vision provides a general description of the desired characteristics for Stoco Lake over the long term. The five goals, derived from feedback received during public consultations, provide specific direction for each of the key aspects important in maintaining the health and character of Stoco Lake.

A list of objectives and recommendations, as they pertain to these goals, can be found in Section 1.4. Additional information on the health of the Stoco Lake is provided in Section 2.0.

VISION FOR STOCO LAKE

A healthy and sustainable lake boasting a wealth of recreational opportunities, rich species diversity, and an active community of passionate lake stewards.

GOALS FOR STOCO LAKE

Water Quality

Water quality in Stoco Lake and its inflowing rivers will be monitored, with a focus on nutrient reduction to aid in reducing excessive aquatic weed growth and algal blooms.

Water Levels

Water levels will continue to be monitored in order to best understand impacts on ecosystems and shoreline development.

Natural Environment

Healthy and diverse ecosystems with rich native species diversity and populations will be protected.

Social and Recreational

Active lake stewardship and ethical lake behaviour will be encouraged.

Development

Future development / redevelopment around Stoco Lake will strive to enhance the quality and maintain the tranquility of the Lake.

1.4 Recommendations

The actions will require volunteers, organizations, and expert staff time, and may require funding for implementation. The expectation is for Friends of Stoco Lake, The Municipality of Tweed, and Quinte Conservation to partner with other agencies and community groups, organizations, and potential funders to implement the actions.

Water Quality Water quality in Stoco Lake and its inflowing rivers will be monitored, with a focus on nutrient reduction to aid in reducing excessive aquatic weed growth and algal blooms.

Monitor water quality and lake characteristics.

1. Continue to monitor phosphorus and turbidity on the Lake through the Lake Partner Program on an annual basis. Generally, phosphorus concentrations less than 20 ug/l are non-problematic, concentrations greater than 30 ug/l often lead to nuisance algae.

2. Perform broad-based water quality analyses of Stoco Lake and its tributaries every 3-5 years with the objective of no net increase in levels over time. Seek expert advice and take appropriate actions should there be any consistently poor water quality results.

3. Consider developing a Stormwater - Pollution Control Plan to review the existing outfalls and discharge water quality; recommend actions to assist in improving water quality.

4. Invite Ministry of Environment and Climate Change to speak to the community on the history of mining in the area and specifically the cleanup effort in the old Deloro mine site.

5. Find appropriate locations, with expert advice, to perform benthic surveys on inlets and at set locations in Stoco Lake. Seek expert advice should there be any significant changes to benthic communities.

6. In light of sediment quality (due to past mining activities) in Stoco Lake, caution must be taken for any activities that may result in a disturbance to the sediment in Stoco Lake.

7. Seek funding to perform sediment testing in the Lake for heavy metals and then repeat it every 5 years.

8. Seek funding to study the effectiveness and impacts of the aquatic weed harvesting practices.

Reduce input of nutrients to the Lake to assist in controlling nuisance algae and excessive aquatic plant growth.

9. Consider the establishment of a septic inspection program for waterfront lots, with an associated educational program. Septic systems should be pumped every 3-5 years. Seek funding to provide financial assistance to waterfront landowners for repair or upgrades to their

systems. In those cases where system requires replacement, all efforts should be made to relocate the new system a minimum of 30 metres from the Lake to protect water quality.

10. Work with farmers along the water, through education and connections to incentive programs, to encourage livestock fencing from waterways, waterway plantings (minimum 30 m buffer), cover crop planting, and soil health testing programs to reduce excess nutrient runoff into waterways. Promote related grant programs.

11. Agricultural landowners can inquire about compensation for establishing a buffer/riparian zone between agricultural land and watercourses. Contact Quinte Conservation and/or ALUS Canada. (www.alus.ca).

12. Hardening of waterfront lots by driveways, concrete ramps, and lawns should be kept to a minimum to reduce storm water runoff and erosion of the shoreline.

13. Encourage commercial and residential development/re-development to use sewage treatment systems that reduce or eliminate phosphorus to the greatest extent possible.

14. Where appropriate, consider reforestation/natural regeneration to aid in natural water storage, the slowing of runoff to improve soil quality, and to increase wildlife habitat and improve overall health of the watershed. Promote tree planting programs.

15. Encourage forest management plans to protect the quality of forests within the Stoco Lake watershed (drainage basin) to slow and filter runoff.

Educate the community about the Lake's water quality and how to maintain and improve it.

16. Develop and deliver an awareness program on the impacts of fertilizers, pesticides, gasoline, and other contaminants and substances on water quality.

17. Deliver "Well Aware" and "Septic Aware" programs.

18. Implement a Blue-green algae watch program, with signage at boat launches and information bulletins, including a clear communications protocol amongst various organizations that have a role in monitoring and awareness.

19. Engage youth in watershed education program, including the Yellow Fish Road Program and the Stream of Dreams watershed education program. Contact Quinte Conservation.

Continue to improve upon the municipal waste water management system. ** Municipality of Tweed*

20. Continue efforts to address eaves trough and sump pumps from emptying into the sanitary system and continue to seek funding to address aging infrastructure concerns, all of which contribute to infiltration issues leading to increased flows to the lagoons.

21. Continue to seek funding for a third treatment cell to increase capacity of the municipal treatment system.

Water Levels

Water levels will continue to be monitored in order to best understand impacts on ecosystems and shoreline development.

Monitor high water and low water levels and impacts.

22. Establish a volunteer water level monitoring program to measure water levels throughout the year. Assess associated high and low water levels impacts on shoreline structures and vegetation. Seek funding to install advanced lake level gauges on Stoco Lake for continual monitoring of the Lake levels.

23. Seek funding to study 2-3 low-use wells around Stoco Lake to investigate how lake levels relate to ground water levels and study the ground water quality.

Educate the community about water levels and how to address the effects of high and low water.

24. Report findings of any water level monitoring programs to the community on a regular basis and explain what contributed to the level extreme and how to deal with the effects of the high and low water levels.

25. Promote water conservation methods in the community. Consider a rain barrel program in which rain barrels are sold at reduced cost to private landowners.

26. Quinte Conservation, the Municipality of Tweed, and Friends of Stoco Lake should continue to work together to relay flood information to residents prior to/ during the spring flooding season and during periods of low water drought.

Protect and engage in forests and wetlands protection and creation.

27. Encourage planting of trees on marginal and historically forested and now abandoned agricultural lands. Forests aid in slowing water runoff. Contact Forests Ontario and Quinte Conservation for landowner programs.

28. Provide information to private property owners in order to facilitate contact with landowner programs for wetland creation projects to restore wetlands which aid in capturing and holding water.

29. Encourage and promote forest management planning to woodlot owners across the watershed to retain healthy woodlots for the slowing of water runoff to help decrease severity of flooding events.

Natural Environment

Healthy and diverse ecosystems with rich native species diversity and populations will be protected.

Re-naturalize altered shorelines and encourage the retention of natural shorelines for habitat enhancement. Shorelines are used by 90% of the life in a lake or river.

30. Seek funding and establish a program, or connect property owners to existing programs, to re-naturalization their shorelines. Contact Quinte Conservation for more information on landowner programs.

31. Develop an education program to inform landowners about the value and importance of natural shorelines, including a best management practices guide.

32. Establish, or utilize an existing, shoreline assessment program to provide property owners with an assessment of the condition of their shoreline, and to provide recommendations for improvement. E.g. "Love Your Lake" Program with Watersheds Canada, visit www.loveyourlake.ca

33. Seek champions in the community and use their properties as demonstration projects. Engage youth and community where possible. In 2016, the *Enhanced Natural Shoreline* project was implemented in Tweed Memorial Park. A section of shorelines was planted with St Carthagh students and with assistance from the Kiwanis Club of Tweed. Find out more at www.friendsofstocolake.ca

34. Consider a bylaw regarding the retention of a 30 m buffer of natural vegetation for development or redevelopment on lands which front on a lake or on a major tributary. E.g., Township of Central Frontenac Waterfront Protection Policy - Site Plan Control: 3.6.4

Identify and protect species at risk.

35. Seek funding to conduct surveys of species at risk.

36. Work with conservation partners to develop an education program to inform the lake community of the presence of at risk species and proper protocols for protection.

37. Consider the installation of "Turtle Crossing" Signs in area s where turtles are known to cross roads.

Identify and manage, where possible, invasive species.

38. Conduct an inventory of invasive species currently on, and around, the Lake.

39. Work with an organization (e.g. Ontario Invading Species Awareness Program – Ministry of Natural Resources and Forestry, Ontario Federation of Anglers and Hunters) to establish a program to address known invasive species, consider a boat washing awareness program, and develop a "WATCH OUT FOR" program for potential new invasive species.

40. Develop and deliver an education program about invasive species. E.g., Host a community workshop with the Ontario Invading Species Centre on identification and best management techniques for existing invasive species.

41. Encourage local citizens to monitor and report invasive species.
    Invasive Species Monitoring and Reporting www.invadingspecies.com/report

Maintain and monitor healthy habitat for wildlife in and around Stoco Lake.

42. Conduct a *"bio-blitz"* inviting community members and experts to study and document all species on a property (or series of properties) over a 24-hour period. Visit www.ontariobioblitz.ca for more information.

43. Maintain and update an inventory of species. Base it on existing lists and augment it with additional community input.

44. Continue to identify important habitat and encourage retention and enhancement of these important areas.

45. Monitor the conditions of important natural areas and take action to maintain or improve the natural environment of these areas, as required.

46. Continue 2016 Marsh Monitoring efforts with community volunteers in order to assess any changes to species diversity and habitat quality.

47. Encourage volunteers to engage in citizen science programs to increase species diversity and richness inventories and monitor changes to the environment, including:
    - Bird Studies Canada bird inventories www.birdscanada.org
    - Marsh Monitoring Program www.birdscanada.org
    - Frog, worm, ice and plant monitoring programs www.NatureWatch.ca
    - Turtle monitoring www.torontozoo.com/adoptapond/turtletally.asp
    - Invasive species monitoring and reporting www.invadingspecies.com/report

Maintain healthy and abundant fish habitats and native fish populations.

48. Seek funding to repeat the 2016 fish survey every 3-5 years to monitor changes in fish populations. Continue to monitor water quality and other characteristics of the Lake for changes in the environment that may impact fish populations.

49. Seek resources and expertise for fish habitat protection and enhancement from groups such as Muskies Canada, Ducks Unlimited, and Ontario Federation of Anglers and Hunters.

50. Explore opportunities to work with Ministry of Natural Resources and Forestry, Community Fisheries Improvement and Department of Fisheries and Oceans to undertake spawning bed improvements for Walleye (e.g., washing/vacuuming sediment off beds of round stones at the mouth of the river inlet).

Reduce nuisance species.

51. Work with partners (e.g., MNRF, Canada Wildlife Service) to research and put in place appropriate programs to deter and control nuisance species (e.g., Canada Geese, Cormorants).

52. Educate shoreline residents about best management practices to deal with Canada Geese. E.g., replace mowed shorelines with native flowers and shrubs and continue to discourage the feeding of wildlife, in particular Canada Geese, at Tweed Memorial Park.

Social and Recreation

Active lake stewardship and ethical lake behaviour will be encouraged.

Encourage responsible and respectful boating behavior.

53. Develop and distribute a *"Code of Conduct"* with an associated awareness campaign that includes information on boating courtesy and legal regulations, as well as emphasizing the importance of safe boating and safe swimming. A "*Code of Conduct*" is for lake users that would help residents, visitors, and newcomers to behave in a "lake- friendly" manner

54. Install *"Mind Your Wake"* signs in appropriate areas (e.g., river and environmentally sensitive areas).

55. Meet annually with the local police department to encourage education and enforcement, and to receive and apply their advice on improving boater behaviour.

Promote a dark sky.

56. Promote awareness of the importance of practices that help maintain a dark night sky.

57. Encourage all shoreline property owners to use "dark sky friendly" lighting, and use building permits and site plans to enforce dark sky friendly lighting practices.

58. Request owners of local cell phone towers to install light deflectors to reduce night-time light impacts at local residences.

Educate residents, visitors, and newcomers to encourage and inspire plan implementation.

59. Educate the community around Stoco Lake, including youth, in activities that improve the Lake and its environment. Explore Quinte Conservation youth education programs.

60. Use the Stoco Lake Stewardship Plan and its list of actions as a basis for informing and engaging the community in the watershed.

61. Plan a community and lake celebration event and use the occasion to inspire volunteers to participate in the implementation of the "actions" identified in this Plan.

62. Review progress on the Stewardship Plan on an annual basis.

Development

Future development / redevelopment around Stoco Lake will strive to enhance the quality and maintain the tranquility of the lake.

Encourage lake friendly options for any new development and redevelopment.

63. A greater setback for buildings from the shore may encourage more lake-friendly landscaping with natural vegetation kept on the property and a natural buffer along the water. The current minimum is 15 metres from the 1:100 year floodplain, or 30 metres from a Provincially Significant Wetland. A wider setback to the lake (for buildings and lot hardening, such as driveways, decks, and patio areas) would assist in protecting lake water quality and would also complement fisheries management objectives by minimizing impacts from shoreline activities to the littoral, near-shore, zone. Greater setbacks are strongly recommended on lots with steep slopes, fractured bedrock, and thin soils.

64. Encourage new commercial and residential development and redevelopment to use sewage treatment systems that reduce or eliminate phosphorus to the greatest extent possible.

65. All lots should be of sufficient size and lake frontage to accommodate the safe installation and construction of a well, septic system, and dwelling. The topography, native soil depth, and slope of lots should be conducive to development. Development of lands which are bare bedrock, swampy or low lying should be prohibited.

66. Implement strong development policies that control how development takes place and best management practices are recommended for Stoco Lake to maintain and improve water quality conditions in the Lake.

2.0 STOCO LAKE: THE HEALTH OF THE LAKE

2.1 Stoco Lake and Watershed Characteristics

Stoco Lake and its watershed are located within the Moira River Watershed; see Map 1. The term watershed is used to describe an area that is drained by rivers, creeks, and streams. It is also referred to as a drainage basin or drainage area; see Figure 1.

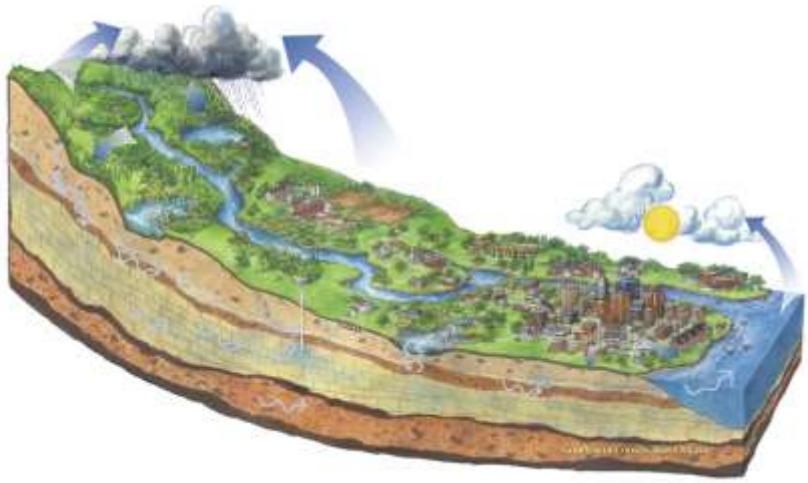


FIGURE 1 WHAT IS A WATERSHED?

A watershed is an area of land drained by a river or stream. Similar to the branch of a tree, creeks empty into streams, which then empty into larger streams, eventually forming one main trunk. Within this system, everything is connected to everything else. Actions which take place at the top of the system can and do affect those downstream.

The Stoco Lake Watershed is made up of several main waterways and their drainage basins. The main inflow to Stoco Lake is the upper Moira, the Black, and the Skootamatta Rivers. These three rivers flow generally south to a point near Actinolite where they meet and flow as one river into Stoco Lake. The Clare River and its drainage basin (303 square kilometres) flow into Stoco Lake on the Northeast side. Sulphide Creek and its drainage basin (157 square kilometers) also drain into Stoco Lake at the north side of the Lake. See Map 2 of the Stoco Lake Watershed for the sub-watershed boundaries of the Upper Moira, Skootamatta, Black, and Clare. Together these make up the Stoco Lake Drainage Basin, an area of 2,230 square kilometers.

The land use in the southern region of the Stoco Lake drainage area (watershed) is mostly agricultural, while the upper Moira River watershed, Skootamatta River, and Black River are primarily forested. The Moira River, due to its sheer size of watershed, carries the most significant flows into Stoco Lake every year. Land use along the Clare River is mainly agricultural; approximately 50% of the drainage basin, with the remainder upper reach compromised of wetlands, low lying areas, and mixed forests. Land use along Sulphide Creek is mainly agricultural in the lower reach at (approximately 30%) and wetlands and forests in the

upper reach (approximately 70%); see Figure 2. Refer to Map 3 for wetlands within the Stoco watershed.

FIGURE 2: AERIAL PHOTOGRAPHY (2013-2014) OVER THE LOWER CLARE RIVER

The Moira River continues to drain to the Bay of Quinte leaving Stoco through two outlets, the East Channel and West Channel. The two channels meet about 3 kilometres downstream to reform the Moira River. Stoco Lake is impacted by activities occurring within the upper sub-watersheds and alternatively what occurs in and on Stoco Lake can affect the lower reach of the Moira system.

For the purposes of this report, due to the sheer size of the Stoco Lake Watershed, much of the focus will be on Stoco Lake and its immediate area.

Stoco Lake characteristics are summarized in Table 1, obtained from the 2012 Ministry of Environment (MOE) report. These lake characteristics are discussed in more detail in the water quality section of this report.

In 2012, an MOE Lake study determined Stoco Lake had approximately 70% developed shoreline. The village of Tweed represented approximately 14% of the shoreline, 11% was zoned commercial, 7% was open space, 44% residential, 21% rural, and 3% zoned Environmentally Sensitive (MOE, 2012). It is not expected to have changed significantly since 2012.

Surface Area	531 ha
Maximum Depth	9.8 m
Mean Depth	4.0 m
Volume	19.93 x 10^6 m^3
Shoreline length	16 km
Drainage Area	2,230 km^2
Annual Inflow/Outflow	993 x 10^6 m^3
Flushing Rate[1]	50 x annually

1 Flushing rate is the number of times that the volume of water contained by the Lake is displaces by inflow in a given period of time.

TABLE 1: STOCO LAKE CHARACTERISTICS (MOE, 2012)

Map 1

Map 2

Map 3 wetlands

Quinte Conservation works in partnership with the MOE and other environmental agencies to implement a series of Watershed Monitoring Programs: The Ontario Provincial Water Quality Monitoring Network (PWQMN), The Ontario Provincial Groundwater Monitoring Network (PGMN), and The Ontario Benthos Biomonitoring Network (OBBN); see Map 4 for the monitoring locations. The information gathered from these water monitoring programs are used to determine the overall conditions that exist throughout the Quinte Conservation watersheds. Quinte Conservation collects and analyzes data for total phosphorus, benthic invertebrates, groundwater, and forest conditions. Forests are essential to the health of our watersheds. Forests provide a variety of benefits to a healthy environment including wildlife habitat, improved air and water quality, sediment and erosion control, reduced flooding, reduced low flow events, and helps to counteract the greenhouse gas effect and global climate change. See Map 5 of forest cover throughout the Stoco Lake watershed.

Quinte Conservation completed watershed health reports in 2008 and 2015 for the main sub-watersheds of the Moira, which make up the drainage basin of Stoco Lake. Total Phosphorus, benthic macroinvertebrates, groundwater, forest cover, forest interior, and riparian zone were analyzed. The sub-watersheds were found to be in a healthy state; see figure 3.

Total Phosphorus is naturally occurring, but can have elevated concentrations due to products such as soaps, detergents, fertilizers, and sewage. Although it is a required nutrient in streams, high concentrations contribute to excessive algae growth and low oxygen levels in streams and lakes. Samples are collected monthly between April and October as part of the PWQMN.

Benthic macroinvertebrates are small creatures without backbones that live in the sediment on the bottom of streams and include aquatic insects, snails, clams, and worms. They are good indicators of water quality and stream health. Samples are collected each spring as part of the OBBN.

Groundwater quality is dependent on many factors including the initial source, the type of soil or rock that the water is flowing through, and impact from human activities. To assign an overall groundwater quality score the following were used as indicators:

- Nitrate & Nitrite: These are forms of nitrogen which can occur naturally. High levels can be associated with leaching of contaminants from excessive amounts of fertilizers and manure or septic systems;

- Chloride: This is naturally occurring and elevated levels can be related to contamination from road salting activities, landfills, septic systems, and water softeners.

Forest cover represents the percentage of the watershed that is forested or wooded, including both upland and wetland forest types. Environment Canada recommends a minimum of 30% forest cover for sustaining plant and animal species within a watershed. See Map 5 for forest cover across the Stoco Watershed (catchment).

Forest interior is the portion of a forest that remains when a 100 metre buffer is removed from the inside perimeter of a woodlot. Forest interior refers to the 'protected core' of the forest. It is recommended that a minimum of 10% forest interior exist.

Riparian zone (or buffer zone) is a band of land, 30 metres wide, along both sides of an open watercourse. This zone is important in maintaining water temperature, ensuring bank stability, and filtering out excess nutrients before they reach the watercourse. It is recommended that at a minimum 50% of the 30 metre wide riparian zone should be forested.

FIGURE 3: SUBWATERSHED CHARACTERISTICS, ACQUIRED USING 2013 DATA

MAP 4 MONITORING SITES

Map 5 forests

2.2 Water Levels

Stoco Lake levels are generally controlled by weather and climate within its 2,230 square kilometre drainage basin. High rain events, snow melts and periods of low precipitation impact levels on Stoco Lake. Four river systems flow into Stoco Lake. The Upper Moira River, Black River, and Skootamatta River merge into the Moira River and drain into Stoco Lake. The Clare River also drains into Stoco Lake. There are no controls in place for spring levels on Stoco Lake. Two weirs at the two outlets, East and West Channels, aim to help regulate summer water levels on the Lake for the purposes of recreation.

i) Control Structures

The Moira River and its tributaries have numerous dams and minor diversions; see Map 1 (above) for locations of dams owned by Quinte Conservation. From its headwaters to Stoco Lake the Moira drops a total of 535 feet (163 metres). From Stoco Lake to the Bay of Quinte the Moira River drops another 220 feet (67 metres) before entering into the Bay of Quinte; see Figure 5 for a river profile from Bay of Quinte to Stoco Lake. Due to the drop in elevation, there were many suitable locations for dams, though none of which have the ability to control spring levels on Stoco Lake.

Quinte Conservation owns, operates, and maintains 39 water control structures; 15 are located within the Moira River Watershed. Numerous other privately-owned dams can be found within the Moira River and its tributaries.

Two water control structures, Caton's and Chapman's weirs, impact water levels on Stoco Lake for summer water levels and are owned by Quinte Conservation, one is operable.

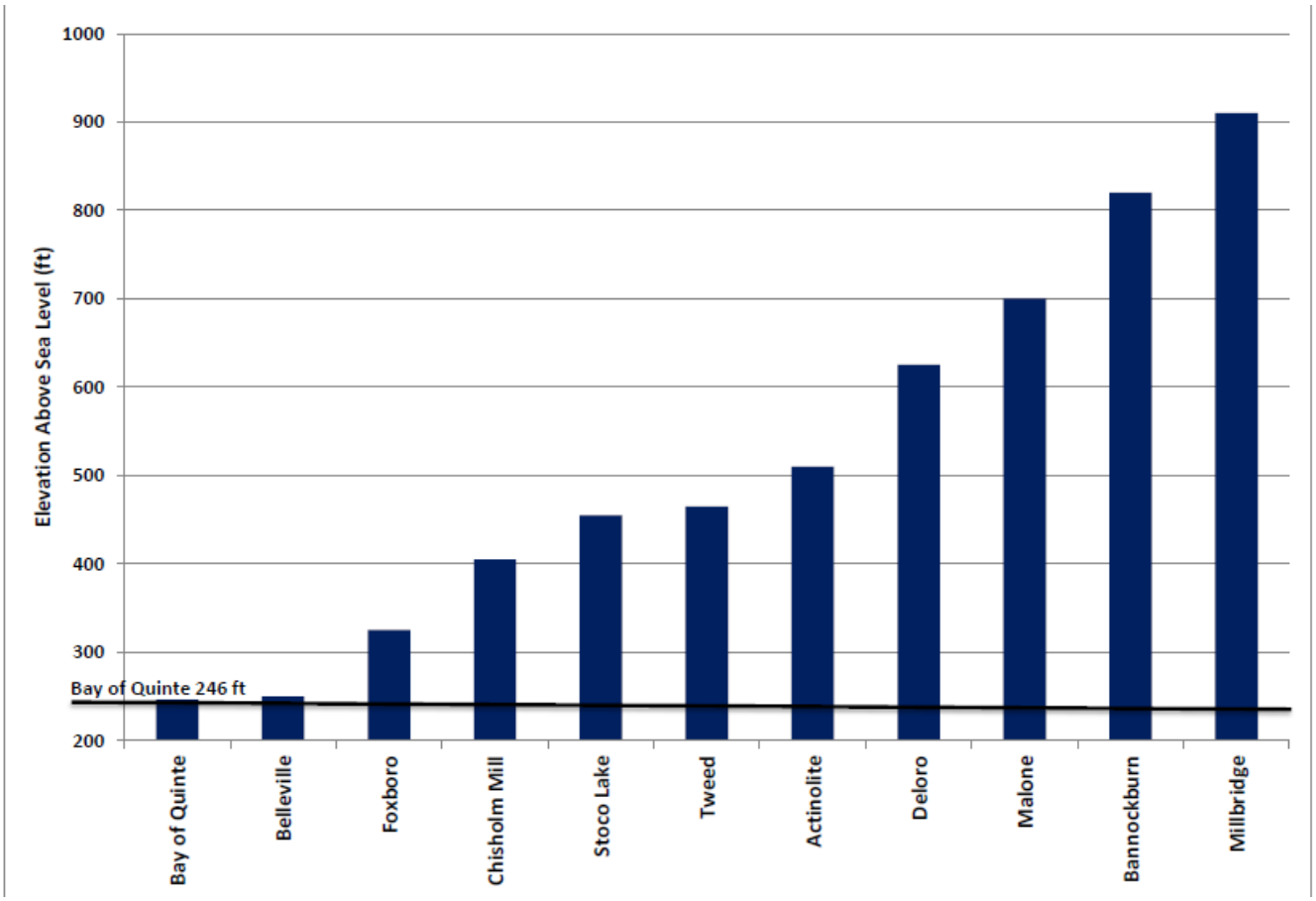
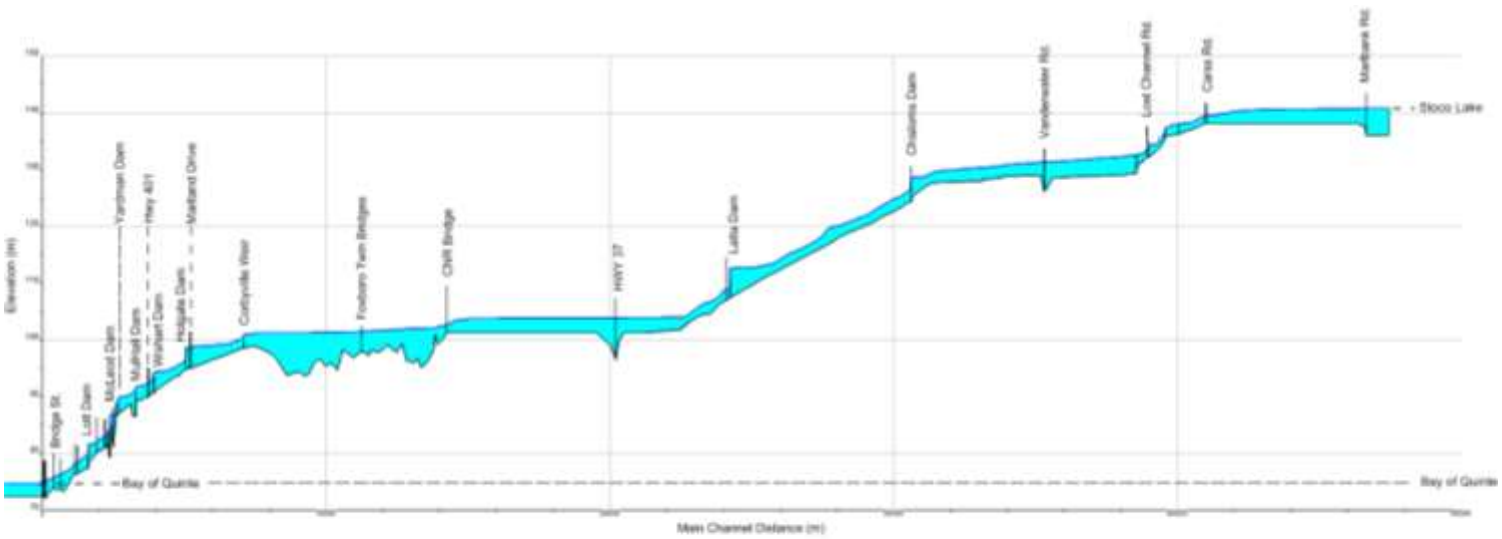


FIGURE 4: MOIRA RIVER ELEVATIONS ABOVE SEA LEVEL



Dam	Top of Dam	Above Bay of Quinte
Lott Dam	80.8 m	6.2 m
McLeod Dam	87.3 m	12.7 m
Yardman Dam	88.7 m	14.1 m
Mulhall Dam	90.7 m	16.1 m
Wishart Dam	93.4 m	18.8 m
Holgate Dam	97.5 m	22.9 m

Bay of Quinte 74.6 m elevation

Foxboro Twin Bridge Deck 103.6 m (29.0 m above Bay of Quinte)

Stoco Lake 141.6 m (67.0 m above Bay of Quinte)

Water Elevations Bankfull Spring Event (2 year Flood)

Quinte CONSERVATION

FIGURE 5: MOIRA RIVER PROFILE FROM BAY OF QUINTE TO STOCO LAKE

Constructed in 1968, **Caton's Weir** is located along the east branch of the Lost Channels of the Moira River immediately upstream of the Caton's Bridge, south of Stoco Lake. It is a seasonal weir that is installed in early summer and removed in late fall. The purpose of the weir is to control summer water levels along the upstream reach and on Stoco Lake.

Chapman's Weir is located along the west branch of the Lost Channels of the Moira River, downstream of the Chapman's Bridge and south of Stoco Lake. This is a permanent concrete weir. The primary purpose is to maintain a constant summer water level along the upstream reach and on Stoco Lake.

Safety Around Dams

- Always exercise caution when boating, hiking, or fishing near dams.
- Stay off the dam structures, unless the area is clearly marked for public travel.
- Be alert to changes in water levels.
- Read and pay attention to warning signs near dams.

ii) Flooding and Low Water History

Prior to settlement much of the region was forested with swamps and wetlands. Early settlers arrived and began to cut and harvest trees and whole forests for lumber, wood products, and fuel. Land was cleared for agriculture and for the construction of roads, buildings, and towns. Numerous villages, homes, and cottages were built along the shorelines of the rivers and lakes as more people came to the area for logging and milling, forestry, mining, and agriculture. The risks of living near waterways and challenges of flooding would quickly have become apparent to those living along the water. Changes to the landscape, including the clearing of forests for agriculture and development, had to a certain extent increase rainwater runoff volumes and the force and speed of freshets (spring rain and snow melt events). Fewer forests meant less to slow the water. The loss of wetlands meant less containment and storage of the runoff. Today, after years of planting efforts across the region, the Stoco Lake watershed is well forested with tributaries and wetlands which may aid in reducing the frequency and severity of floods. The southern part of the watershed (Actinolite and south), remains primarily agricultural mixed with urban centres. Forest and wetland areas will continue to aid in the slowing and capture of runoff, and therefore should be encouraged. Many living along the waterways and lakes continue to feel the impacts of flooding, even more so today as an increasing number of cottages are being converted to year-round homes.

Above: "Breaking a jam - Moira River drive". Men with poles breaking up a log jam. Source: Rathbun Lumber Company

Date: 1 January, 1907, Source: *https://www.flickr.com/photos/deserontoarchives/365626257*

Today, Stoco Lake is considered a high risk flooding area. Stoco Lake has experienced several serious flooding events in recorded history. Notable events occurred on the Moira River system in 1886, 1936, 1981, 2008, and 2014, as described in some detail later in this section.

In the event of flooding and low water events, Quinte Conservation acts in an advisory role, providing continuous monitoring of conditions across the watershed and notifications to the public. Quinte Conservation maintains a network of precipitation gauges, temperature gauges, and stream flow gauges. The Conservation Authority also has a snow and ice program in order to estimate snow depths and water content of snowpack across the watershed. All of this data, combined with long-term and short-term weather forecasting, is used to predict precipitation and melt events on waterways. Predictions are shared with partners and the public. A series of warning messages are used to alert the public.

Flood Warning Messages

Watershed Conditions Statement is a general notice of potential flooding or other conditions that pose a safety risk.

Flood Watch notifies that the potential of flooding exists. Municipalities, emergency services, and individual landowners in flood-prone areas should prepare.

Flood Warning indicates flooding is imminent or already occurring in specific watercourses or municipalities.

Low Water Conditions

Level 1 means the potential for water supply problems has been identified.

Level 2 indicates a potentially serious water supply problem.

Level 3 indicates a failure for the water supply to meet demand.

Municipalities have primary responsibility for the welfare of residents and are responsible for the response to flood forecasting and low water warnings by the Conservation Authority.

Quinte Conservation has six flow stations in the Moira River system continually sending measurements that aid in high and low water forecasting, see Map 6. The stations are located at: 1. Moira River in Deloro; 2. Black River near Actinolite; 3. Skootamatta River near Actinolite; 4. Moira River in Tweed; 5. Clare River just upstream from Stoco Lake; 5. Moira River upstream from Foxboro.

The flow station in Tweed records the drainage from the three upper tributaries which then flow together into Stoco Lake via the Moira River. The Clare River, which also drains into Stoco Lake, has a flow station just upstream from the Lake.

Map 6 of flow monitoring stations

Ice jams causing flooding on the Moira River near Stoco Lake have been noted to occur at the lower Tweed Bridge and the shallow area and island downstream of it, above Highway #37 bridge in Tweed, and in Actinolite at Hawkins Bay Bridge.

A manual count of the Stoco Lake Shoreline, using 2013 air photos, reveals that approximately 97 (seasonal or permanent) residences intersect the 1 in 100 year floodplain boundary, 21 of these are along the East Channel. The floodplain is determined through historical records and modelling by Quinte Conservation.

Spring freshets and ice jams are historically known to cause flooding along the Moira River. Records of the earliest floods are brief and lacking much detail. The Moira Valley Conservation Report (Richardson, 1950) makes reference to notable early flooding events impacting the Moira (particularly Belleville). Flooding events caused by heavy rains and ice jams impacting Belleville along the Moira River are documented in 1864, 1865, and 1868. Another flood event in the Moira system is noted in 1870, in 1883 a reference is made to a bridge in Tweed being damaged by a spring flood and a heavy storm combined with a log jam. Additional flooding events are noted in 1884 and 1885 (Richardson, 1950).

Flood of 1886 - 1886 was one of the most remarkable of the early floods. In Belleville, it was noted to have lasted 57 days with slight intervals of relief. This flood was caused by heavy rains in the late fall throughout the watershed and followed by cold weather and a January thaw with rain (Richardson, 1950).

Considerable flooding is again documented in the lower Moira system (Belleville) in 1904, 1910, 1913, and some flooding in 1907, 1909, 1912, 1914, and 1916 (Richardson, 1950).

Flood of 1936 - March 1936 was noted as the worst flood in 50 years (Richardson, 1950). A thaw began on March 4th while the ice was still solid on the Bay of Quinte. Rains began on the 11th and lasted for 20 hours with flooding beginning that night. On March 12th, severe flooding had been reported in Tweed and Madoc (Richardson, 1950).

Flood of 1981 – Noted by *The Tweed News, Feb 25, 1981*, this flood was brought on by heavy rains and mild weather on February 12th and 13th and by the 16th and 17th homes had been evacuated in Actinolite, Tweed, and down to Belleville. The thaw and rains brought water and heavy ice rushing down the main streets in both Tweed and Belleville *(Tweed News, Feb 25, 1981*). Ice was documented to have jammed at Hawkins Bridge, flooding homes at Actinolite and at the footbridge in Tweed also causing significant flooding.

Ice pack at Tweed Footbridge

Swollen Moira River in Tweed

Source: The Tweed News, Feb 25th, 1981

Top: High waters and heavy ice
Bottom: Flooded backyards on Moira Street
Source: The Tweed News, Feb 25th, 1981

Flood of 2008 - In 2008, a serious flooding event was caused by a significant spring melt and runoff event. A flood advisory was announced indicating the potential for flooding on April 3rd and from April 9th to April 17th the area was in a flood warning and experiencing the impacts of flooding (B. Keene, 2008).

Above: Clare River at Stoco Lane

Above: Tweed Park boat launch

Above left and right: Photos by Quinte Conservation on April 14, 2008

Flood of 2014 – The 2014 flood experienced historical high levels and was a 1 in 100 year spring rain on snow melt flood event. Quinte Conservation began flood forecasting for this event in January when noting the exceptionally cold weather, higher than normal snow fall that remained on the ground, and thick ice cover that persisted throughout the winter. Snow depths exceeded 60 cm with water equivalent at or above 150 mm in most northern monitoring stations. On April 7th and 8th a melt did occur with rain, about 30 mm of rain was received. Another severe but isolated rain event occurred in the upper reaches of the watershed as the peak was occurring further down the watershed extending the flooding (B. Keene, 2014). The Municipality of Tweed declared a State of Emergency on April 15th, 2014.

Top: NE Stoco Lake & East Hungerford Road; Bottom: South Stoco Lake upstream of Marlbank Road Bridge. Quinte Conservation, April 17, 2014

Level 3 Low Water 2016 - On August 4th, 2016, Quinte Conservation and the Low Water Response Team declared their first recorded *Level 3 Low Water Condition* due to lack of rainfall leading to low flows in local rivers and streams. Level 3 indicates a failure for the water supply to meet the demand. Quinte Conservation advised its partnering municipalities to request that businesses and residents reduce water usage by 50%. The Low Water Conditions Bulletin was downgraded to level 2 on December 15th and then the Low Water Condition was ended on January 6th, 2017. Other recent low water events, though not to the declared Level 3 extreme, occurred in 2001, 2007, 2011, and 2012.

Recent flooding and low water events may be attributed to the effects of climate change. A provincial climate change vulnerability study predicted that the Tweed and Stoco Lake region would see a trend towards lower springtime snowmelt peak runoffs, reduced spring runoff volume, earlier and wintertime snowmelt runoff events, greater flows in winter months, and lower average flows during the summer months (Quinte Conservation, 2015).

Photo: Moira River at Rapids Road, September 2016

Above: Moira River in Tweed.
Photo Credit: Vicki McCulloch

2.3 History

i) Natural History

a) Land Formation, Geology, and Soils

Glaciers, large ice sheets over a kilometre thick, once covered 80% of Canada and all of Ontario. Three phases of glaciation account for most of the land features seen today. Over 12,500 years ago the last of these glaciers began to retreat. Glaciers carved the landscape creating depressions and rugged shorelines while depositing and pushing sediments and rock into glacial land forms such as drumlins, eskers, kames, and moraines. This glacial history is responsible for much of the landscape, land formations, and drainage patterns we see today.

Both drumlins and eskers are found in the Tweed and the Stoco Lake region. Drumlins are large teardrop shaped hills, eskers are long winding ridges composed of stratified sand and gravel. The Tweed Esker (or sometimes known as the Thomasburg Esker) is part of the longest esker in Ontario , beginning just east of Stirling with a branch extending to Tweed and another that runs over to the Marlbank and Tamworth area. Eskers are often quarried for sand and gravel, as the material is readily accessible. Kames can be seen along Highway 7 and west of Tweed and are conical hills made up of sand and gravel. They are often used as sources of gravel for road construction.

Much of the Stoco Lake Watershed lies within the Canadian Shield. Through the southern part of the drainage basin pockets of Limestone Plain can be found. This region, where the granitic bedrock of the Canadian Shield meets the Sedimentary Limestone Plain, is known as an ecotone. This region in particular has become known as *"The Land Between",* a major geological feature in North America, for more information visit www.thelandbetween.ca . Both the granitic bedrock and sedimentary limestone can be seen at the surface in some areas of the lower Stoco Lake watershed. The granite bedrock to the north originates from deep within the earth formed by heat and pressure, while the limestone to the south, often seen in layers and containing fossils, is a remnant of the ancient seas. The meeting of these two different landscapes creates the ecotone, a place of high diversity, home to a unique and special environment. A number of rare species adapted to this unique landscape can be found here. See Maps 7 and 8 for surficial geology and bedrock geology.

The region's complex geology contributes to its mineral diversity and richness. Gold, silver, actinolite, sulphides, marl, and marble have been commercially extracted at one time or another from rocks and soils in the area (TCDC, 2009). Today, the major mineral products are aggregate for sand, gravel, and concrete production.

The soils of the region vary; on the Canadian Shield (much of the Stoco Lake drainage basin) the hard bedrock material is resistant to erosion and as a result, marginal soil development has occurred. The soils are poorly developed and are quite often stony from bedrock material that has not been fully broken down; therefore agricultural land use is limited and restricted to isolated pockets of good soil. Significant land uses of the shield region include forestry, mining, and recreation. In the limestone terrain, to the south of the shield, the soils are predominantly comprised of till and developed from the underlying soft limestone bedrock. The soils of this region are favourable for agriculture and much of the region was cleared of forest and cultivated. The soils vary from north to south with higher content of stone and bedrock fragments at the north due to the influence of the Canadian Shield. To the immediate south the soils are of loam and sandy texture and represent the best agriculture soils of this region (Quinte Conservation, 2008). See Map 8 for soil types in the Stoco Lake watershed.

MAP 7 STOCO CATCHMENT SURFICIAL GEOLOGY 1

MAP 8: STOCO CATCHMENT BEDROCK GEOLOGY

MAP 9: STOCO CATCHMENT SOIL TYPES

b) Climate

Quinte Conservation has been working to better understand the effects of a changing climate due to global warming through monitoring and assessment. The assessment of the vulnerability of sub-watersheds to climate change was completed by Quinte Conservation; see Map 10. Following the initial assessment, a provincially significant climate change monitoring station was installed in the Skootamatta watershed near Tweed through a partnership with the Province, four more then followed; see Map 11 for locations. The stations provide useful information over the long-term for determining changes to watershed conditions and potential impacts. The Skootamatta station provides automated continuous measurements for groundwater level and temperature, air temperature, snow depth and temperature, soil moisture and temperature, and precipitation; see Figure 6.

Quinte Conservation determined that the Municipality of Tweed and Stoco Lake reside in an area of low susceptibility to the effects of climate change over the next 25 years. Though the Stoco Lake area was determined to be of low susceptibility to climate change, Quinte Conservation did analyze historical and recent flow patterns of rivers in the Quinte watersheds and the long and short term trends suggest the Stoco Lake area is experiencing some effects of climate change (Quinte Conservation, 2015).

Some local effects of climate change are predicted:

- trend towards lower springtime snowmelt peak runoffs
- reduced spring runoff volume
- earlier and wintertime snowmelt runoff events
- greater flows in winter months
- lower average flows during the summer months

Quinte Conservation will continue to study climate change throughout the watershed based on the five climate monitoring stations established across the Quinte Conservation watershed region.

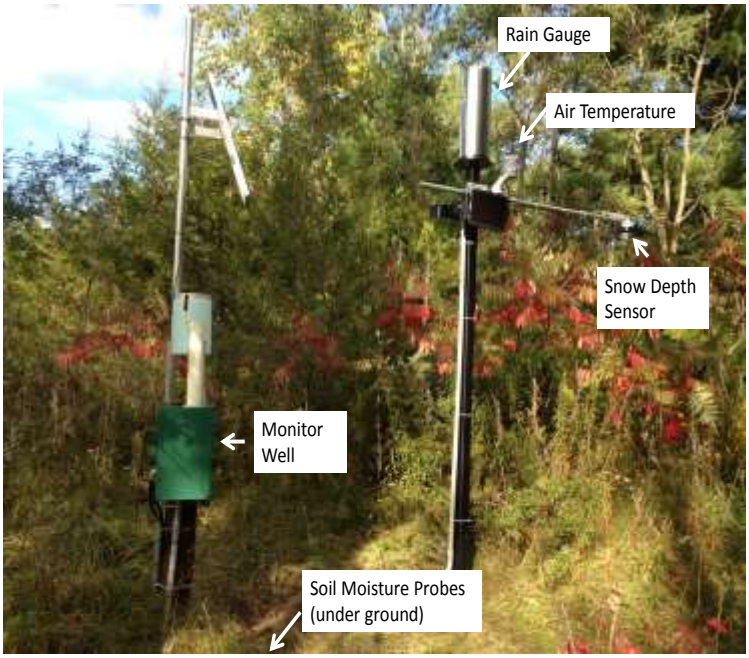


FIGURE 6: CLIMATE CHANGE MONITORING STATION

MAP 10: CLIMATE CHANGE VULNERABILITY WITHIN THE QUINTE CONSERVATION WATERSHEDS

MAP 11: CLIMATE CHANGE MONITORING STATIONS WITHIN THE QUINTE CONSERVATION WATERSHEDS

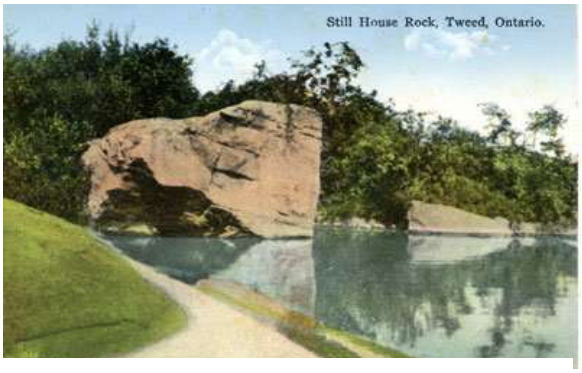
ii) Cultural History

Special thanks to the Tweed and Area Heritage Centre for their assistance with this section.

a) First Inhabitants and Early Settlement

Archaeological findings provide evidence of extensive aboriginal use of the lands surrounding Stoco Lake. The Moira River would have been well used for travel, access to fishing and hunting, and for seasonal (if not larger permanent) villages. The earliest findings identify the Nomadic Laurentian Group people before 1000 BCE. Burial memorial mounds were discovered on Sugar Island in 1976 by the Peabody Museum of Archaeology and Ethnology, Harvard University, and are believed to be from The Point Peninsula culture from over 1000 years ago. The first agriculture in the area is likely to have started in this period. Later residence by Iroquois peoples (now properly known as Kanien'Kahake) up to about 400 years ago come into recorded history. The historical record begins with the defeat of the Mohawk (Iroquois) peoples by the Mississauga Chief Stoucong, apparently on September 30th, 1698. As noted in *Kingston Chronicle and Gazette, 1834 Aug. 30*, his followers named Stoco Lake in his honour. The Mississauga peoples were part of the more northerly Algonquin culture, now known as Anishinaabe or more properly Anishinaabeg. *"Still House Rock"* is a known sacred spot for the Mississaugas and is located where the west branch of the river leaves Stoco Lake.

Hastings County was constituted in 1792 and opened for settlement in 1821. It was first settled by traders and lumberman, with Meyers Trading Post established on Stoco Lake as early as 1797. Captain Meyers established the trading post where furs, venison, maple sugar, etc. were bartered for supplies. It is believed, based on its location description, that it may have been on Sugar Island at the west branch of the Sagonaska (now Moira River),, opposite from "*Still House Rock*". The first settlers arrived in 1826 and located on the south shore of Stoco Lake on Sugar Island. Historical records indicate First Nations peoples gathered there in the spring to make maple syrup from the great sugar maples that grew on the island, hence the name Sugar Island (Richardson, 1950).



Above: Still House Rock, Stoco Lake. Source: Tweed Public Library Digital Collections. 2017.

For some time people had camped and tented on Sugar Island and by 1906 the first permanent cottage was built. Materials were brought across the Lake by boat. Cottages then began to appear on the western shore (pre-1912) and north-eastern shores of the Lake by 1951.

Further historical details can be obtained from the Tweed and Area Heritage Centre and from the Moira Conservation Valley Report, 1950.

b) History of Milling/Logging and Commercial Developments

Many of the pioneers who settled in the Tweed Municipality in the 1800s did so around the rivers and were based around dam and mill sites. By 1843, there were 20 mill sites on the Moira (Richardson, 1950). Many of these dams still exist, including those in the Village of Tweed and the Hamlet of Queensborough. The Lingham Lake dam is the largest water diversion project in the Tweed Municipality. It was originally built by the Rathbun Lumber Company, one of the large timber harvesting and milling operations that harvested the original forests of the area. Logs were floated downstream to their major mill sites. In the 1850s up to 175,000 logs were floated down the Moira River each year. The last log drive on the Moira River was in 1907 and by this time the prime timber had been exhausted all through the area to the north. Rathbun also built its own railways, including the Bay of Quinte Railway which ran from Napanee through Tweed, Actinolite, and Queensborough to Bannockburn. This rail line carried passengers, freight, timber, and minerals and interconnected with other area railways. The Bay of Quinte Railway stopped operations in the 1930s.

Above: "Breaking a jam - Moira River drive". Men with poles breaking up a log jam.
Source: Rathbun Lumber Company
Date 1 January 1907, Source: https://www.flickr.com/photos/deserontoarchives/3656262577/

Locally, the first saw mill was at the dam between the Tweed Mill and the bridge across the Moira River. Logs would be taken there from the log drives and sawn into railway ties and lumber. In 1871, Jordan, Jellyman & Co., with William Wright erected a steam saw mill by the Lake where they sawed lumber and also made cheese boxes. It was later taken over by the Houston Company and relocated to Metcalfe Street.

Early documentation portrays a southern Moira Watershed (from Actinolite and south) to be predominantly hardwood with hard maple being the most abundant species (Richardson, 1950). Settlement led to cutting of the forests for potential development, road construction, and clearing for agriculture or for a town site. Forests were viewed as inexhaustible. This movement and view of the forests didn't change until around the 1950s. As the region was gradually opened up from removal of forests the best lands were acquired first eventually leading to draining of swamplands last. A great extent of original forests across the southern Moira River Watershed was lost between 1850 and 1940. Occupied farmland in 1850 was 40-60% cleared and by 1910 only about 18 % percent remained in woodland (Richardson, 1950).

In the early 1900s, tree planting efforts were encouraged and in 1906 a statute was passed enabling township councils to exempt from tax any part of a farm used for forestry purposes, or if they were considered to be "woodlands". From 1905 to 1948 private plantings across Hastings, Lennox and Addington, and Frontenac counties totaled 3,096,058. Hastings County had 1,435,452 trees planted (Richardson, 1950).

Reforestation of the forest cover on the land would act to slow down and purify run-off from the land, as well as hold water in natural storage areas of swamps. It would also improve the economy of the area, especially by growing timber on otherwise unproductive lands, and provide work for local people.

A dynamite factory, the Ontario Powder Works, was originally situated within the village of Tweed but the plant was relocated due to safety concerns to the north bank of Stoco Lake, just outside of the village. As documented in *The Tweed News, 1903, June 18*, the Ontario Powder Works would build a bridge for vehicle traffic from the old factory to the new one. The plant experienced two major explosions, the first in August of 1903 and the second in February of 1908. Following the second explosion production ceased, however the storage of dynamite continued. By 1910, the dynamite factory had been bought and the Tweed plant closed. Some ruins still remain. Today you can see the ruins and the central pillar of the Ontario Powder Works bridge across the Moira River immediately south of the C.P.R. bridge along the TransCanada Trail.

The Department of Lands & Forestry/Ministry of Natural Resources developed a dock and sea plane base at the eastern end of the park that operated from 1957 until the early 1980s.

The Tweed Memorial Park on Stoco Lake was developed in 1927 to commemorate those who had been killed in World War I. Previously, the shore had been lined with private boat houses. When the Tweed Pavilion was erected in 1929 the boat houses were removed and later the park was extended eastward to provide picnic and camping areas and a ball diamond. Today, the Tweed Memorial Park is a key component of the Tweed community and boast a variety of uses including: a sand beach, playground, picnic shelter, washrooms, a fountain, swimming, boating, waterskiing, fishing, skating, ice-fishing, snowmobiling, and Remembrance Day services, dances, musical events, art exhibits, fundraisers, carnivals, and fireworks. The Pavilion, one of a handful remaining in Ontario, continues to be a popular venue for community events.

c) History of Mining in the Area

The Municipality of Tweed has a rich mining history. Mineral wealth has been important in the history of Tweed and its surrounding area. In the past gold, silver, actinolite (an asbestos like mineral), sulphides, marble and marl (used for cement manufacturing) were staples of the mineral industry in Tweed. Today, many reminders of these mining days remain.

Deloro Mine Site

Gold mining began in Deloro in the late 1860s with the gold rush and by the early 1900s, along with other gold mines in the area, it closed. The site was then used for processing silver and cobalt imported from other Ontario mines. Deloro was the first plant in the world to produce cobalt commercially and lead stellite production. Pesticides were also produced from arsenic-by-products until the late 1950s.

One hundred years of mining and refining at the Deloro Mine site contributed significant amounts of metals to the Moira River system including arsenic, nickel, and cobalt. The Ministry of Environment (MOE) assumed responsibility for the site in 1979 when the last owners abandoned the property (Ministry of Environment, 2011). The MOE have achieved significant reductions in the contamination through various remedial actions.

The MOE commissioned the Moira River Study in 1999 in order to determine the extent of the Deloro Mine Site activities on the Moira River. This involved a comprehensive study of the aquatic environmental effects on the Moira River below the Deloro site including effects on water, sediment, bottom dwelling (benthic) invertebrates, and fish in the Moira River. The study also looked at potential health implications for people living downstream from the Deloro site.

Above: The Moira River flows through the old Deloro mine site and then to Moira Lake and Stoco Lake, then to the Bay of Quinte.

The MOE had determined from their 1999 Moira River Study (MOE, 2001) that:

- *Water quality had greatly improved over the previous 35 years.*
- *There are elevated levels of metals in sediments and the water of the Moira River system.*
- *Sediment quality is slowly improving and will likely continue.*
- *Radioactive materials are not a concern in the Moira River system with levels so low they could not be distinguished from naturally occurring background levels.*
- *Despite the exceedances of PWQOs during low flow and exceedances of PSQGs, no obvious adverse effects were observed in benthic invertebrates and fish populations in the Moira River, Moira Lake or Stoco Lake. There is little to no health concern for residents and cottagers along the Moira River downstream of the site.*
- *It is safe to swim in the Moira River and Stoco Lake (unless otherwise posted by the health unit for bacterial counts).*
- *It is safe to eat fish from the Moira River system, however there is a consumption restriction for sport fish in Moira and Stoco Lakes because of Mercury (this is not related to the Deloro Mine Site).*

Today, an arsenic treatment plant on-site collects and treats arsenic-contaminated groundwater. Water is pumped to the treatment plant where arsenic is removed. The clean water goes back into the Moira River. Prior to the treatment plant 52 kg of arsenic were going into the Moira River daily. In 2015, the plant stopped nearly 2.5 tonnes of arsenic from going into the Moira River in one year. Arsenic released into the Moira River has been reduced by 80% (Ministry of Environment and Climate Change, 2017: *The Deloro Mine Cleanup Project, 2016. Retrieved from www.ontario.ca/page/deloro-mine-cleanup-project).*

The cleanup project continues with a plan that includes:

- the building of 2 large engineered covers and 1 engineered containment cell,
- directing rain and melting snow away from the engineered covers to keep water from getting to the contaminated material,
- ongoing operation of an arsenic treatment plant pumping and treating contaminated groundwater for many years after the engineered covers are built.

At project completion, the MOE states that the site will become a closed and controlled hazardous waste facility that will not accept waste from outside the site (Ministry of Environment and Climate Change, The Deloro Mine Cleanup Project, 2017 *Retrieved from www.ontario.ca/page/deloro-mine-cleanup-project*).

2.4 Water Quality

Historically, Stoco Lake was considered eutrophic (very high levels of nutrients). Through numerous improvements, including upstream reforestation and modern day sewage treatment, on both Moira Lake and Stoco Lake, nutrient levels have been reduced. The Lake is now considered to be mesotrophic, moderately high levels of nutrients.

Stoco Lake water quality is greatly affected by the lake's small size, shallow depth, surface area, volume, shoreline length, and hydrological characteristics. The Lake has a very high drainage ratio (the Moira Watershed) and results in large contributions of natural phosphorus entering the Lake over its 2000 square kilometre watershed. The Lake's shallow depth also allows for wind-induced mixing of the Lake bottom, a lake bottom determined to be rich in nutrients. Higher nutrients in the Lake contribute to aquatic weed growth and algal blooms.

Phosphorus is a common indicator of water quality. Small amounts of phosphorus are required for plant growth; however an excess of phosphorus can cause increased plant growth sometimes seen in the form of algae and algal blooms. Nutrients can make their way into the Lake from urban and farm runoff, sewage treatment plant discharges, sewage disposal systems, lawn fertilizers, fertile rich lake bottoms, soil erosion, and atmospheric deposition. Total phosphorus is the primary nutrient of concern.

Phosphorus can also build up on the bottom of lakes from decaying plant and animal matter. This phosphorus can then be released with the turnover of the lake water. Stoco Lake is particularly susceptible to turnover due to its high flows and relatively shallow depth. During high flows in the spring and summer, it is estimated that the Lake flushes its volume 50 times annually, or completely every 7 days (MOE, 2012).

Ontario Ministry of Environment (MOE) conducted several lake health studies on Stoco Lake:

- 1972: *Report of Water Quality*
- 1984: *Investigation of Nuisance Algae and Water Quality of Stoco Lake*
- 2012: *State of the Lake, Stoco Lake*

Quinte Conservation conducted a health of Stoco Lake study in the spring and summer of 2016 that focused on a fisheries inventory, a plant survey, surface water sampling at two inlets and two outlets, and a benthic survey.

Results from the 1984 study done by the MOE determined from stream flow data that approximately 60% of the annual flow to Stoco Lake occurs in the spring runoff months with less than 5% during July, August, and September (MOE, 2012). It is noted in the 1984 report that *the exchange rate of Stoco Lake is 50 times its volume annually. This extremely high flushing rate confirms that water quality of the lake is dominated by the inflowing waters, primarily the Moira River (MOE, 1985)*

MOE determined that tributary drainage was by far the major contributor of phosphorus to the Lake with the Moira River providing 76% of the inflow and 56% of the phosphorus (MOE, 1985). In 2011, the Ministry of Environment, using the Ontario Lakeshore Capacity Model, confirmed that the largest source of phosphorus input into the Lake remains the tributaries (MOE, 2012).

Aside from nutrient loading from tributaries, it's known through previous MOE studies that Stoco Lake is sensitive to nutrient re-suspension from the nutrient rich lake sediments. Shoreline property owners should adopt best management practices to minimize additional phosphorus loading into the Lake.

i) Phosphorus

Total Phosphorus (TP) results in Stoco Lake are shown below. These results are obtained from regular MOE monitoring from 1972-1975, and then again in 1984, with limited sampling. After 1984, phosphorus data was submitted to MOE by volunteers through the Lake Partner Program. It should be noted phosphorus data that was collected through the Lake Partner Program is an average figure obtained from two samples collected in the spring of each year, on the same day and at the same location. Phosphorus is measured in micrograms per litre (*ug/L*).

In 1972, Stoco Lake phosphorus concentrations ranged from 30 ug/l to 50 ug/l (MOE, 1972).

In 1984, Stoco Lake phosphorus concentrations ranged from 26ug/l to 58 ug/l (MOE, 1985)

From 2008 - 2016, Stoco Lake phosphorus concentrations ranged from 12 ug/L to 24 ug/l; see Figure 7.

The current Provincial Water Quality Objective (MOEE, 1994) does not have a firm water quality objective for phosphorus; however the guideline gives the following advice:

"To avoid nuisance concentrations of algae in lakes, average total phosphorus concentrations for the ice-free period should not exceed 20 micrograms per litre."

Figure 7 depicts a decreasing trend in total phosphorus in Stoco Lake since 1972 (MOE, 2012). The Lake Partner Program with the MOE shows Phosphorus data from 2008 to 2016.

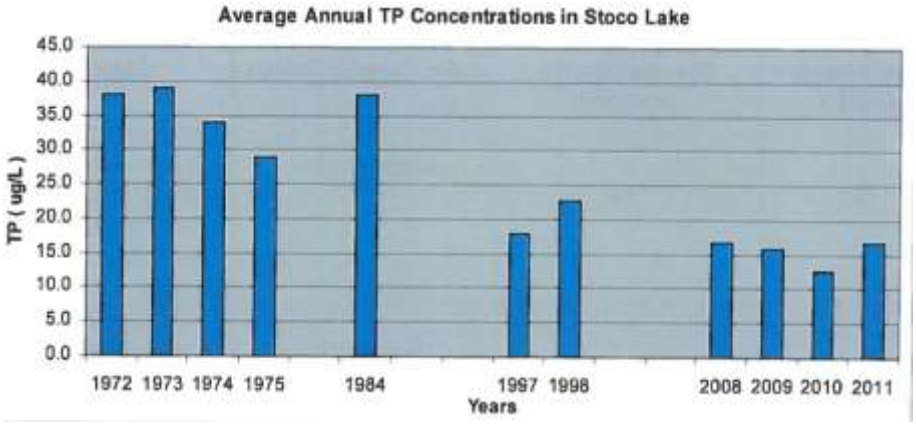


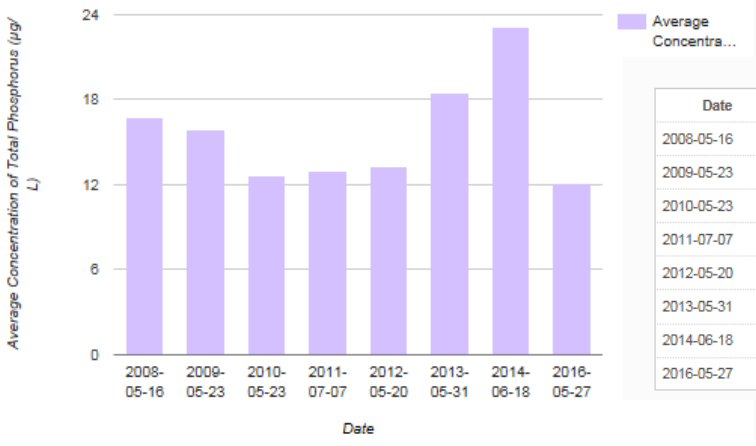
FIGURE 7 : AVERAGE ANNUAL TP CONCENTRATIONS IN STOCO LAKE, OVER TIME.

ABOVE: SOURCE; MOE, 2012. BELOW: SOURCE; LAKE PARTNER PROGRAM WEBSITE (MOECC, 2017)

STOCO LAKE (STN 5170, Site ID 2) Main Lake South – Lake Partner Site

Average Total Phosphorus (ug/L)

https://www.ontario.ca/environment-and-energy/map-lake-partner



Date	Sample 1 (µg/L)	Sample 2 (µg/L)	Average (µg/L)
2008-05-16	16.66	16.73	16.7
2009-05-23	16	15.78	15.89
2010-05-23	13	12.2	12.6
2011-07-07	12.6	13.2	12.9
2012-05-20	13.4	13	13.2
2013-05-31	18.2	18.8	18.5
2014-06-18	24.2	22	23.1
2016-05-27	12	12.2	12.1

a) Phosphorus - Inlets and Outlets

The 2012 study by the MOE applied the Ontario Lakeshore Capacity Model to Stoco Lake to assess relative contributions of phosphorus loadings to the Lake from various sources. A similar investigation was done in a 1984 study. Both studies showed the primary phosphorus input to the Lake was by the tributaries (MOE, 2012). The relatively high flows from the tributaries contribute to a high annual flushing rate of the Lake, noted to be 50 times per year (MOE, 2012); refer to MOE reports from 1984 and 2012.

As depicted in Figure 8, there has been a decrease in TP for both major inlets.

All major inlets and outlets show results below the Provincial Water Quality Objective (PWQM) for rivers and streams; see Table 2.

"Excessive plant growth in rivers and streams should be eliminated at a total phosphorus concentration below 30 micrograms per litre."

At Inlets (PWQMN)	**Total Phosphorus (ug/L) 2007 - 2016 Average**
Clare River	17
Moira River	13
At Outlets	
East Channel	15
West Channel	16

TABLE 2: AVERAGE TOTAL PHOSPHORUS AT MOIRA RIVER AND CLARE RIVER INLETS.

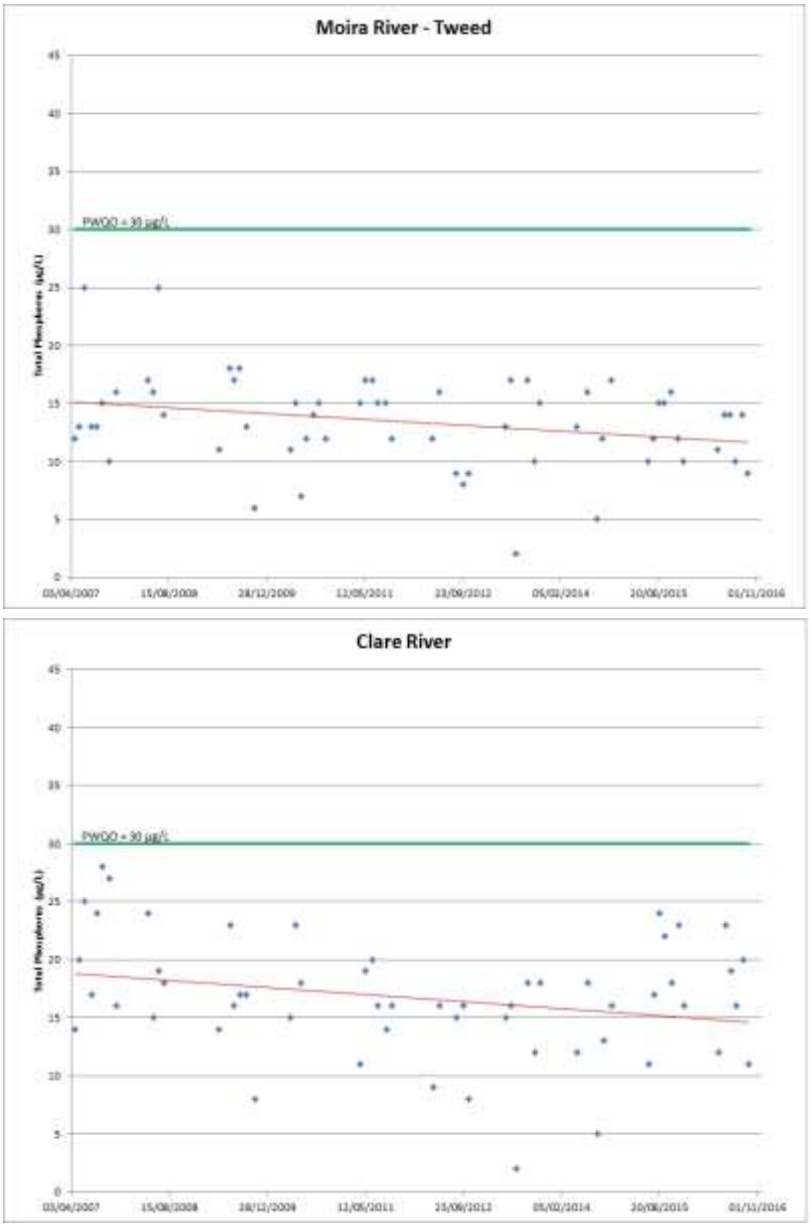


FIGURE 8: TOTAL PHOSPHORUS FOR THE MOIRA RIVER AND CLARE RIVER INLETS OVER TIME (2007-2016)

The outlets, East and West Channels, show a slight increase in average TP concentrations leaving the Lake from data collected between 2007 and 2016. This may be attributed to the high annual flushing rate of the Lake and its nutrient rich lake bottom. The TP levels remain below the Provincial Water Quality Objectives for rivers and streams for both outlets.

MOE noted in the 2012 study that the phosphorus decrease observed on the Moira River may have been attributed to improvements in the sewage treatment, a decrease in intensive agricultural practices across the watershed over the past 45 years, and the agricultural community implementing farm stewardship practices throughout the watershed (MOE, 2012).

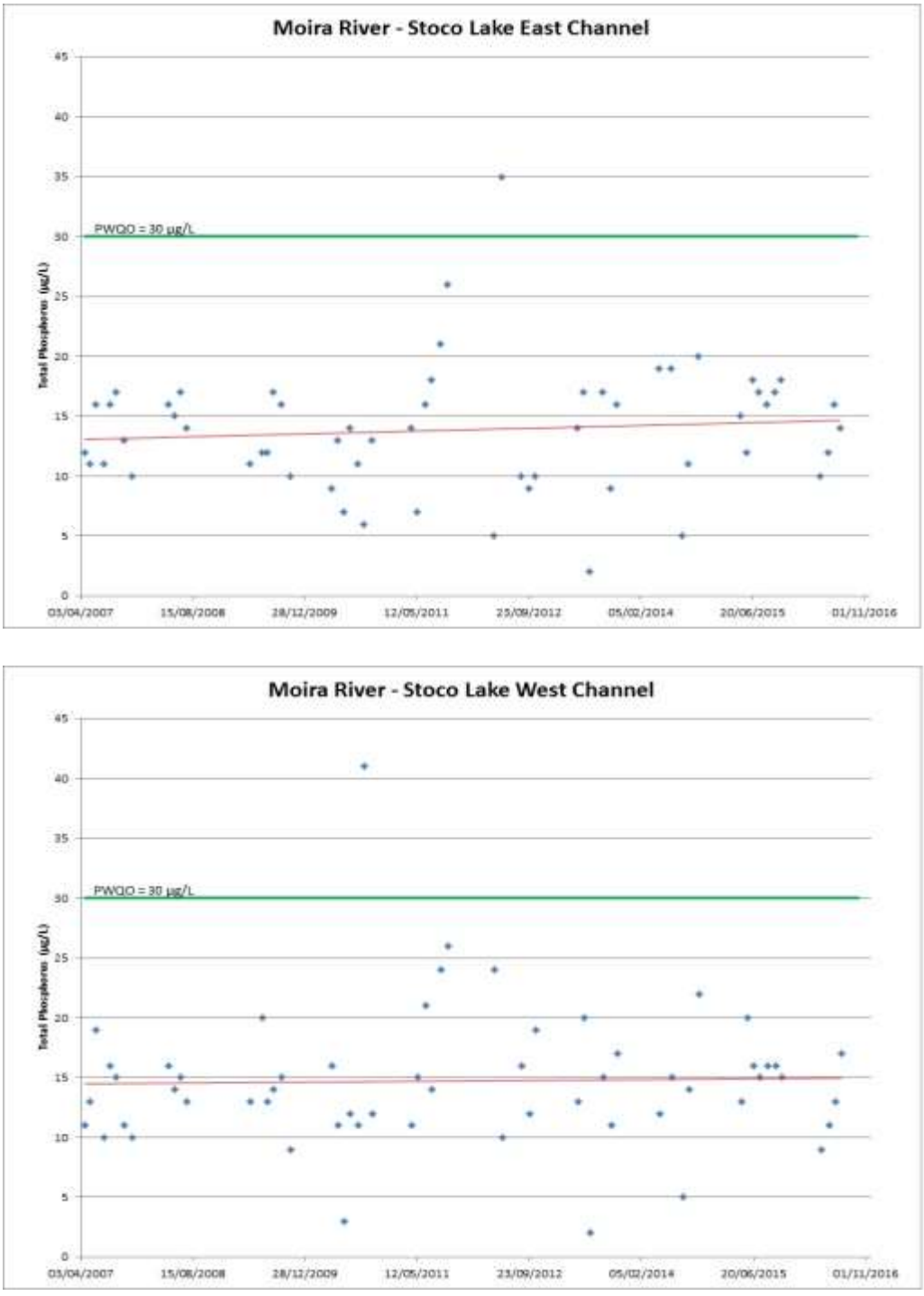


FIGURE 9: TOTAL PHOSPHORUS FOR THE EAST AND WEST CHANNEL OUTLETS OVER TIME (2007-2016) PWQMN DATA, QUINTE CONSERVATION.

Regional farmers have implemented many land stewardship projects that have aided in phosphorus reduction to local rivers and lakes.

Agricultural Land Stewardship

- improved manure storage and land application techniques
- improved on farm fuel and pesticide storage
- improved on farm silage storage
- sealing and capping of abandoned wells to avoid groundwater contamination
- fencing livestock to stop them from accessing streams and lake water directly
- the creation of natural buffers at the shorelines to protect lake and stream water from runoff contamination
- wetland restoration work
- improved erosion control along shorelines
- equipment modifications for more optimal application of fertilizers
- equipment modifications to improve water efficiency during irrigation
- nutrient management planning and alternative livestock watering systems

Numerous regional and provincial programs have assisted farmers in implementing stewardship practices through various programs providing information, expertise, and funding:

- ***Ontario Soil and Crop Improvement Association***: www.ontariosoilcrop.org
  Facilitate responsible economic management of soil, water, air, and crops through development and communication of innovative farming practices.

- ***Ministry of Food Agriculture and Rural Affairs*****:** www.omafra.gov.on.ca

- ***Canada – Ontario Environmental Farm Plan***: www.omafra.gov.on.ca/english/environment
  A voluntary environmental education and awareness program delivered by the Ontario Farm Environmental Coalition.

- ***Bay of Quinte Remedial Action Plan and Quinte Conservation*****:**
  www.bqrap.ca and www.quinteconservation.ca The Bay of Quinte was designated an Area of Concern in 1985 by the International Joint Commission. Areas of Concern are communities, bays, and rivers on the Great Lakes system where human activities have severely damaged the quality of the environment. Environmental concerns in the Bay of Quinte were due to excess nutrients, persistent toxic contamination, bacterial contamination, and the loss or destruction of fish and wildlife habitat.

b) Phosphorus (Nutrient) Rich Lake Bottom

In 2011, MOE obtained samples one metre off the bottom at two deep basins in the Lake to determine internal phosphorus input to the Lake (MOE, 2012). The bottom water samples in 2011 were 52 micrograms per litre (ug/L) of phosphorus in the north basin and 26 ug/L in the south basin confirming a fertile and nutrient rich lake bottom (MOE, 2012). Under anoxic conditions, low or no levels of oxygen, phosphorus is released from nutrient rich sediments. A study of temperature and dissolved oxygen in 2011 showed anoxic conditions below 5.5 metres at the two deepest basins in the Lake (MOE, 2012).

The anoxic conditions and nutrient-rich lake bottom may be explained by the presence and die off of algae in the Lake. Algae is naturally occurring in Stoco Lake. Algae require nutrients, warm temperatures, and available sunlight to flourish, all of which are available in Stoco Lake. Historically, Stoco Lake has been documented by the MOE to experience algae blooms in the summer months. Following the blooms, the algae die off and settle to the lake bottom, contributing to the nutrient-rich lake bottom. This settled algae at the lake bottom is then consumed by bacteria, which use oxygen, presumably contributing to the anoxic conditions seen at the bottom of the lake. When the phosphorus from the bottom is released under anoxic conditions into the upper water column, where water temperatures are warmer and sunlight is available, algal blooms and aquatic plant growth follow.

Stoco Lake is a shallow lake and prone to wind action. The wind action can disturb the water column, mixing the bottom and top layers of the Lake. During this mixing, nutrients can be released from the Lake bottom into the lake water column. This internal source of phosphorus input into the Lake is a critical consideration, as it provides a continued supply of nutrients.

Efforts should be made to reduce any additional phosphorus loading to the Lake from shoreline inputs around the Lake, as well as from the upstream watershed. Any additional phosphorus loading from shoreline runoff can quickly contribute to increased aquatic plant growth and algal blooms off shore.

Above: Blue-green reported to MOE on Stoco Lake on August 4th, 2016 by Quinte Conservation staff.

ii) Algae

Previous water quality surveys (1968, 1972-1975) all present Stoco Lake as a fertile lake with abundant growth of aquatic plants and algae.

The 1984 study by the MOE investigated nuisance algae and water quality of Stoco Lake after numerous reports of severe and prolonged algae on the northeastern shore of the lake. The study determined that elevated phosphorus levels from both overland runoff and the nutrient-rich lake bottom likely contributed to the algae. The MOE determined that the severe and prolonged algae bloom on the northeast lake shore was a result of wind moving the floating algae to the downwind shore (MOE, 1984).

Blue-green Algae (Cyanobacteria) are primitive microscopic plants that live in fresh water. During warm weather, populations rapidly increase to form a large mass called a bloom, often occurring in late summer and early fall.

Blue-green algae often thrive in areas where the water is shallow, slow moving and warm, but can be present in deeper and cooler water.

High levels of nutrients, such as phosphorus and nitrogen, can contribute to blooms.

Some forms of the algae can produce toxins that can be harmful to human health. Symptoms can include itchy, irritated eyes and skin. If swallowed symptoms can include headaches, fever, diarrhea, abdominal pain, nausea, and vomiting.

If you see a bloom and suspect it's Blue-green algae, avoid using the water and call the Ministry of the Environment Spills Action Centre at 1-800-268-6060

In a lake, phosphorus concentrations less than 20 ug/L are non-problematic, while concentrations greater than 30 ug/L often lead to nuisance algae. Stoco Lake has a history of greater then 30 ug/L phosphorus concentrations, though more recently those figures have decreased.

- *In 1972, Phosphorus range was 30 ug/l to 50 ug/L (MOE, 1972).*
- *In 1984, Phosphorus range was 26 ug/l to 58 ug/L (MOE, 1985).*
- *2008 – 2016, Phosphorus range was 12 ug/l to 24.2 ug/L. (MOECC; Lake Partner Program, Online , 2017. https://www.ontario.ca/environment-and-energy/map-lake-partner*

The MOE's Health of Stoco Lake (2012) report states that historic water quality reports (1968, 1972-1975) show Stoco Lake to be extremely productive and that excessive blooms of Blue-green algae occur frequently during the summer months. According to the MOE, Blue-green algae was confirmed on Stoco Lake in both August and September of 2016.

The presence of zebra mussels, an invasive species known to be in Stoco Lake, can further exacerbate the situation. Zebra Mussels over time can help to improve water clarity. This improved clarity can contribute to an increase in depth to which sunlight can penetrate and contribute to warming of the water column to a greater depth. This allows aquatic plants to grow to greater depths, leading to an increase in the amount of aquatic plant growth, and perhaps algae, in the lake.

A Stoco Lake resident has been collecting water clarity data on Stoco Lake through the Lake Partner Program. From 2008 to 2016, an improvement in water clarity could be seen. Lake Partner Program data can be viewed at https://www.ontario.ca/environment-and-energy/map-lake-partner. Temperature data collected also show an increase in average lake temperature from 2008 to 2016. See the appendix for water clarity and temperature readings over time (2008-2016).

iii) Benthic Macroinvertebrates

Benthic macroinvertebrates are small creatures without backbones that live in the sediment on the bottom of streams and include aquatic insects, snails, clams, and worms. They are good indicators of water quality and stream health. Benthic invertebrates were sampled on the lake in 2016 at three lake sites, three times at each site for a total of nine benthic samples. The same areas were surveyed as the Submerged Aquatic Vegetation (SAV) survey: a vegetated area at the Sulphide Creek inlet, and the east and west outlets of the Moira River. The invertebrate communities were examined for differences in the abundance (or number) of invertebrates found at a given location, as well as the overall species composition and the presence or absence of sensitive species.

Above: Benthic sampling by jab and sweep method in August of 2016.

Overall, 45 different varieties of benthic macroinvertebrates were collected. Scuds (*Amphipoda*) were the dominant species in all of the sampling areas. Sow Bugs (*Isopoda asellidae*) were sub-dominant at both the East and West Outlets, whereas Whirligig Beetles (*Coleoptera gyrinidae*) were the dominant species at the Sulphide inlet. The West Outlet had the most diverse population of benthic macroinvertebrates. Dragonfly and Damselfly numbers were considered to be low.

This was a snapshot sample and it would be valuable to repeat the benthic surveys in order to monitor change to benthic population diversity and densities to use as an indicator of improving or declining water quality. The 2016 benthic data can be found in the appendix.

iv) Bacteriological

E. Coli (Escherichia coli) is naturally occurring bacteria found in the intestinal tracts of animals, including humans. High *E. Coli* counts indicate contamination by human or other animal waste. In some cases high *E. Coli* counts are a sign of faulty septic systems. In other cases, high *E. Coli* counts can be attributed to geese grazing and defecating at shorelines. Only a few strains of *E. Coli* can cause illness in humans. Historically, bacteriological contamination within Stoco Lake was attributed to untreated municipal sewage discharge from the Village of Tweed. In 1975, a treatment system was put in place and drastically improved the situation. Regular bacteriological testing does occur at the Stoco Lake beach by the Hastings and Prince Edward Health Unit.

a) Municipality of Tweed Wastewater

Water quality surveys performed by the Ministry of Environment (MOE) on Stoco Lake in 1968 and again in 1972 identified untreated municipal sewage discharge from the Village of Tweed as a source of widespread bacteriological contamination of the lake. The widespread dispersion was a result of the Moira River inflow spreading the discharge throughout the lake (MOE, 1985). In 1975, a new municipal sewage system was placed into operation with a collection works, pumping stations, and the two-cell, seasonal retention, waste stabilization lagoons with a total surface area of 12 hectares.

In 1984, bacteriological sampling for fecal coliform was undertaken by the MOE following complaints that raw sewage was being discharged into Stoco Lake. The sampling showed marked improvement over results from 1968 and 1972 sampling. All sampling showed low counts of fecal coliform bacteria, and levels found were typical of levels present in all surface waters. It was determined that the concern was unfounded (MOE, 1985). The 2011 Ministry of Environment report on Stoco Lake states "*Advanced practices have essentially eliminated the treatment lagoons as a source of bacteria to the Lake (MOE, 2012).*"

The Ontario Clean Water Agency (OCWA) operates and maintains the Tweed Wastewater Treatment Facility (Tweed Lagoons) on behalf of the Municipality of Tweed. The OCWA is a Crown agency of the Province of Ontario that provides operation, maintenance and management services for water and wastewater

treatment facilities in Ontario. The OCWA operates the two-cell seasonal retention waste stabilization ponds system. They operate on a seasonal retention and seasonal discharge, with a discharge in the spring and the fall. Discharge of the lagoons occurs only after tests show compliance. Prior to discharging the lagoons the OCWA collect samples of lagoon contents and test it for Biochemical Oxygen Demand, Total Suspended Solids, Total Phosphorus, Fecal Coliform, Carbonaceous Biochemical Oxygen Demand 5, Total Ammonia Nitrogen, Total Kjeldahl Nitrogen, Nitrate and Nitrite. The MOE is notified prior to discharge and on the day the discharge has ended. An annual report is submitted to the Municipality of Tweed each year by the OCWA. The lagoons cannot be discharged if effluent results are not in compliance (OCWA, 2015). The OCWA also needs to comply with the Wastewater Systems Effluent Regulations (WSER) under the Fisheries Act and submits volumes of effluent to Environment Canada.

Current Condition of the Sewage Collection System

Today, undesired infiltration in the collection system leading to higher flow rates into the lagoons remains a concern. These concerns with the sewage collection system can be largely attributed to age, the pipe used to transport the sewage, and the processes used to construct the system. At the time of construction, the system was built to provincial code and over the years has naturally deteriorated, leading to the undesired infiltration. The deterioration of short pipes and a multiplicity of joints have led to the increased infiltration, which has become the main contributing factor to increased flow levels, creating a strain on the sanitary sewer system.

Today, the sewage collection system includes the following components:

- 12.3 km of sanitary sewer
- 158 manholes
- 700 + service connections
- Jamieson Street Pumping Station and Forcemain
- River Street Pumping Station and Forcemain

Identified Problems

The major structural and infiltration related deficiencies have been identified through camera inspection, with the following determinations made over the last decade:

- pipe joints are a major source of infiltration;
- joints that are not watertight are generally not capable of location without a pressure test;
- many laterals have a steady flow of water, thus source infiltration to the system must

also be considered for rehabilitation;

- extraneous flow from laterals is currently being addressed by the Municipality in the form of:
    - gravity foundation drain connections
    - sump pump connections
    - roof leaders;
- lateral deficiencies (roots, open joints) must also be subject to scrutiny;
- cracks in pipes are a major source of infiltration;
- many of the manholes permit infiltration through joints and cracks in the base and walls.

Adding to these infrastructure deficiencies are changing climate patterns including extreme weather and precipitation, further adding infiltration to an aging infrastructure. This was clearly indicated in the daily flow average for April of 2014, which was nearly 3 three times the flow rate the lagoon can process due to flooding.

Measures Taken to Reduce Infiltration

An evaluation of sewer rehabilitation over the years has demonstrated a reduction of flows following sewer rehabilitation/repairs. The annual average sewage flow in the four years prior to 1994 was 1,710 m^3/day; similar analysis of the last decade shows the average annual flow was 1,100 m^3/day. Although the average flow remains higher than desired, the various rehabilitation measures did produce desired results in maintaining the existing system.

Since 2008, the Municipality of Tweed has invested $3.6 million in village infrastructure rehabilitation in their effort to stem water infiltration into the sewer system (note this also includes some major street repairs).

The Municipality of Tweed will continue to aggressively address the infiltration into the sanitary sewer system. Through the commitment of municipal funds and resources for rehabilitation measures and capital projects, they will ensure the capability of the sewer system and lagoon operations meet present needs. Infiltration into the sanitary sewers will continue to be a primary concern, caused by extreme weather including high volumes of precipitation and unusual long winter months.

The Municipality of Tweed has submitted a number of applications in the hopes of securing funding for the addition of a third cell to the lagoon system. To date, over $350,000 has been spent on land acquisitions and studies. It is anticipated that total construction costs will be approaching $3.5 million.

b) Public Beach Bacteriological Testing

The Hastings and Prince Edward Health Unit perform weekly bacteriological testing at the Municipal Public Beach at Stoco Lake from May to September, as shown in Table 3. The previous five years of data, 2012 to 2016, show a total of 7 beach closures over five years, two in 2013, two in 2014, three in 2015, and no closures in 2016.

Beach closures occur when water is contaminated with bacteria potentially harmful to the health of swimmers. A beach may also be posted because of floating debris, oil, scum, or excessive weed/algae growth (HPECHU, 2017).

Beach Results 2012		
Date of Testing	Geometric Mean	Beach Posted?
29-Aug-12	61	NO
20-Aug-12	13	NO
13-Aug-12	17	NO
08-Aug-12	54	NO
01-Aug-12	13	NO
23-Jul-12	26	NO
16-Jul-12	59	NO
09-Jul-12	10	NO
03-Jul-12	58	NO
25-Jun-12	3	NO
20-Jun-12	2	NO
12-Jun-12	92	NO
05-Jun-12	3	NO
29-May-12	3	NO
23-May-12	5	NO
14-May-12	1	NO

Beach Results 2013		
Date of Testing	Geometric Mean	Beach Posted?
03-Sep-13	28	NO
26-Aug-13	332	YES
19-Aug-13	76	NO
12-Aug-13	24	NO
06-Aug-13	20	NO
29-Jul-13	145	YES
22-Jul-13	91	NO
15-Jul-13	11	NO
08-Jul-13	64	NO
02-Jul-13	19	NO
24-Jun-13	19	NO
18-Jun-13	38	NO
11-Jun-13	87	NO
03-Jun-13	15	NO
27-May-13	10	NO
21-May-13	37	NO
13-May-13	11	NO

Beach Results 2014		
Date of Testing	Geometric Mean	Beach Posted?
25-Aug-14	15	NO
18-Aug-14	11	NO
11-Aug-14	13	NO
05-Aug-14	382	YES
28-Jul-14	23	NO
21-Jul-14	168	YES
14-Jul-14	23	NO
08-Jul-14	30	NO
02-Jul-14	64	NO
23-Jun-14	10	NO
16-Jun-14	49	NO
02-Jun-14	10	NO
26-May-14	20	NO
20-May-14	19	NO
12-May-14	10	NO

Beach Results 2015		
Date of Testing	Geometric Mean	Beach Posted?
31-Aug-15	*Not	Tested
24-Aug-15	44	NO
17-Aug-15	46	NO
10-Aug-15	69	NO
04-Aug-15	*Not	Tested
27-Jul-15	151	YES
20-Jul-15	31	NO
13-Jul-15	10	NO
06-Jul-15	13	NO
29-Jun-15	12	NO
22-Jun-15	45	NO
15-Jun-15	120	YES
08-Jun-15	126	YES
01-Jun-15	75	NO
25-May-15	28	NO
19-May-15	10	NO
13-May-15	13	NO

Courier Delayed more than a day - Lab unable to test

Beach Results 2016		
Date of Testing	Geometric Mean	Beach Posted?
29-Aug-16	36	No
22-Aug-16	42	No
15-Aug-16	10	No
08-Aug-16	20	No
02-Aug-16	21	No
25-Jul-16	14	No
18-Jul-16	12	No
11-Jul-16	10	No
04-Jul-16	10	No
27-Jun-16	64	No
20-Jun-16	15	No
13-Jun-16	11	No
06-Jun-16	30	No
30-May-16	14	No
24-May-16	10	No
16-May-16	12	No

TABLE 3: TWEED PARK - STOCO LAKE BEACH BACTERIOLOGICAL TESTING RESULTS, 2011-2016

(D. Fingland - Hasting Prince Edward Public Health, January 2017).

It is presumed that Canada Geese on the shoreline of the Tweed Park and the Public Beach may contribute to problematic bacterial counts at the beach, particularly following rain events, leading to beach closures. The Municipality of Tweed undertook several initiatives to discourage Canada Geese at the Stoco Lake Beach. In 2016, The Municipality of Tweed installed a *GooseBuster*, which plays geese distress calls, to deter geese. In the spring of 2016, Friends of Stoco Lake with Quinte Conservation, and students from St. Carthagh Catholic School naturalized the shoreline between the beach and the Kiwanis building. Several hundred wildflower and shrub seedlings, sponsored by the neighbouring Kiwanis Club, were planted. The natural shoreline aims to deter geese from coming into the park, as well as slowing and filtering runoff, and enhancing shoreline habitat.

Two lake-based fountains have been installed in the Lake adjacent to the beach in order to increase water circulation for improved water quality.

A stormwater outfall is located adjacent to the public beach. In the spring of 2016, Quinte Conservation with municipal staff and students from the St Carthagh Catholic School planted shrubs and native cattails around the stormwater outfall.

Coping with Canada Geese

At the beginning of the 20th century the Canada Goose had almost disappeared as a result of unregulated hunting. The re-introduction of the Canada Goose has been highly successful. Some of the reasons for increasing populations include increased waste grain availability, loss of predators, decline in hunter numbers, and manicured lawns, parks, and golf courses.

WHAT problems do they cause?

Canada Geese can cause damage to sports fields, shorelines, parks, golf courses, and private property, as well as agricultural fields. Manicured lawns and shorelines, golf courses, and sports fields provide ideal living spaces for Canada Geese. They like short, succulent grass to feed upon because taller grass isn't as palatable to them. These short grasses, besides being a food source, also provide security for the geese. They dislike tall grasses where predators could be hiding.

WHAT can you do?

Change the habitat. You can make your property less attractive to geese by concentrating your efforts on shoreline areas. Creating natural barriers of shrubs and tall grass will reduce goose damage in spring and early summer. Fences can be used alone or along with a natural barrier.

Modify farm practices. Straight-combine cereal grains, whenever possible, rather than swathing. Delaying tillage practices after harvest can provide enough waste grain to attract waterfowl away from vulnerable crops. Establishing a "lure crop" may also help. Plant a 10 meter strip of forage where geese are exiting the wetland, any good hay mix will do. This technique can work well when scare flags are placed between the grass strip and the field.

v) Heavy Metals

Metals are naturally occurring in the environment and are released during weathering of rock and soils. Industrial processes and runoff can alter distributions and increase concentrations. Increased concentrations can be toxic, can cause disruptions to aquatic ecosystems, may decrease the suitability of a waterbody to support aquatic life, and may decrease suitability of supply water meant for domestic uses (MOEE, 1994).

Heavy metals are known to have accumulated in sediments at the bottom of Stoco Lake, and area attributed to past mining activities in the upper watershed; monitoring has been done by Ministry of Environment. Heavy metals are also analyzed in surface waters at two inlets and the two outlets at Stoco Lake; this is performed by Quinte Conservation and submitted to MOE.

a) Sediment

Lake bottom sediment sampling has been conducted historically on Stoco Lake by the Ministry of Environment (MOE). In 2011, the MOE conducted sediment sampling at the deepest points in the north and south basins of Stoco Lake. Results were compared with the Provincial Sediment Quality Guidelines (PSQGs) (MOE, 2012).

- Arsenic elevated above the Severe Effect Level (SEL) at both stations
- Iron, nickel, and zinc were all found to be in concentrations greater than the SEL
- Manganese was above the SEL in the south basin and close to SEL in the north basin
- Phosphorus was at concentrations greater than the SEL in the north basin and close to the SEL in the south basin.
- Aluminum, calcium, magnesium, potassium, and sulphur were elevated as well, however they are lacking PSQG to compare to.

Guidelines for Identifying, Assessing and Managing Contaminated Sediments in Ontario

2.0 Provincial Sediment Quality Guidelines: *The purpose of the Provincial Sediment Quality Guidelines is to protect the aquatic environment by setting safe levels for metals, nutrients (substances which promote the growth of algae) , and organic compounds.*

The No Effect Level (NEL)- indicates a concentration of a chemical in the sediment that does not affect fish or sediment-dwelling organisms. At this level negligible transfer of chemicals through the food chain and no effect on water quality is expected. Sediment meeting the NEL are considered clean.

The Lowest Effect Level (LEL)- indicates a level of contamination that can be tolerated by the majority of sediment-dwelling organisms. Sediments meeting the LEL are considered clean to marginally polluted.

The Severe Effect Level (SEL) - indicates a level of contamination that is expected to be detrimental to the majority of sediment-dwelling organisms. Sediments exceeding the SEL are considered heavily contaminated.

Ministry of Environment and Climate Change, 2008.

The Moira River Study conducted by the MOE in 1999 concluded that no obvious adverse effects were observed in benthic invertebrates and fish population in the Moira River or Stoco Lake (MOE, 2001). MOE states that sediment quality downstream from the Deloro Mine site will continue to improve over long term. Metal concentrations in sediments in the Moira River system, down to and including Stoco Lake, will remain above PSQG for many years to come, aside from cleanup efforts at Deloro. Caution must continue to be taken for any activities that may result in the disturbance to the sediment in Stoco Lake.

b) Surface Water at Inlets and Outlets

For this report, five heavy metals are analyzed using data from 2007 to 2016 and compared to the Provincial Water Quality Objectives (PWQO). The heavy metals analyzed include arsenic, cadmium, copper, lead, and zinc. Provincial Water Quality Monitoring Network (PWQMN) sampling sites are located at the two main inlets and two outlets to Stoco Lake and can be found on Map 3, above.

Water Management: Policies, Guidelines, Provincial Water Quality Objectives. 1994.

This publication contains the Ministry of Environment and Energy policies and guidelines for the management of the province's water resources. It gives direction on how to manage the quality and quantity of both surface and group waters. The **Provincial Water Quality Objectives** (PWQO's) goal is to ensure that water quality is satisfactory for aquatic life and recreation.

Ministry of Environment and Energy, 1994. Available Online: https://www.ontario.ca/document/water-management-policies-guidelines-provincial-water-quality-objectives

Arsenic

Sources of arsenic include weathering of rocks and soils, and smelting and refining industries. According to Canadian Council of Ministers of the Environment (CCME), *"The largest natural source of Arsenic entering surface waters is that from weathered rocks and soils. Smelting and refining industries are anthropogenic sources*."

	Arsenic (ug/L) 2007 – 2016 Average	
Clare River	0.964	The Interim PWQO is 5 ug/L (MOEE, 1994)
Moira River – Tweed (Inlet)	5.636	
Moira River - Stoco Lake East Channel	6.203	
Moira River - Stoco Lake West Channel	6.508	

TABLE 4: ARSENIC (AVERAGE UG/L 2007-2016)

Clare River arsenic levels are considered stable and are well below the PWQO. The Moira River Inlet and both Outlets (Channels) have averages above PWQO and increasing trends from 2007 to 2016. This is attributed to both the natural occurring Arsenic in the soils and rock, and the mining upstream of Stoco Lake in the upper Moira, due primarily to the activities that had occurred historically in Deloro.

Cadmium

Cadmium can be found naturally occurring in our environment and also through human sources. The CCME states that "*background concentrations of cadmium in water bodies is determined not only by the mineral composition of the surrounding environment, but also depends on abiotic process such as weathering, climate, soil type, pH, and dilution"*. The PWQO levels are dependent on the hardness of the water.

Anthropogenic sources of cadmium include mining, agriculture, burning of fossil fuels, and nickel cadmium batteries.

The Clare River has an increasing trend from 2007-2016, whereas the other stations have decreasing trends. All sample sites have values above the corresponding interim PWQO.

	Cadmium (ug/L) 2007 - 2016 Average	The interim PWQO for cadmium is: 0.5 ug/L for a Hardness >100 mg/L CaCO3**. *** **OR** 0.1 ug/L for a Hardness <100 mg/L CaCO3 ** (MOEE, 1994)
Clare River	0.423*	
Moira River – Tweed (Inlet)	0.313**	
Moira River - Stoco Lake East Channel	0.292**	
Moira River - Stoco Lake West Channel	0.337**	

TABLE 5: CADMIUM AVERAGE - UG/L 2007-2016

Cobalt

Cobalt is a naturally occurring element. Anthropogenic sources to the environment including burning of fossil fuels, sewage sludge, phosphate fertilizers, mining, and smelting.

	Cobalt (ug/L) 2007 - 2016 Average	PWQO for cobalt is: 0.9 ug/L PWQO
Clare River	0.164	
Moira River – Tweed (Inlet)	0.328	
Moira River - Stoco Lake East Channel	0.245	
Moira River - Stoco Lake West Channel	0.184	

TABLE 6: COBALT AVERAGE UG/L 2007-2016

Since 2009, values have been below the PWQO. All show a decreasing trend from 2007-2016, with the exception of the Moira River Stoco Lake West Outlet.

Copper

Sources include the weathering of copper minerals and numerous sources from human activities (e.g. copper pipe, metal alloys, wiring, fungicides, and insecticides). Anthropogenic sources of copper include textile manufacturing, paints, electrical conductors, plumbing fixtures and pipes, wood preservatives, pesticides, fungicides, and sewage treatment plant effluent (OMOEE, 2003). Copper is a trace metal associated with urbanization.

	Copper (ug/L) 2007 - 2016 Average	PWQO for copper is 5 ug/L (MOEE, 1994)
Clare River	0.654	
Moira River – Tweed (Inlet)	0.757	
Moira River - Stoco Lake East Channel	0.643	
Moira River - Stoco Lake West Channel	0.620	

TABLE 7: COPPER AVERAGE UG/L 2007-2016

Values for all of the four stations are below the PWQO (5 ug/L). All of the sites have decreasing trends, with the exception of the Moira River Stoco Lake West Channel which has a very slight increasing trend. Moira River inlet (Tweed) has the highest average concentration.

Nickel

Sources of nickel include weathering of rocks and soils, the burning of fossil fuels, processing of nickel ores, smelting and electroplating industries. All values of all stations were found to be below the PWQO (25 ug/L) and all have decreasing trends from 2007-2016.

	Nickel (ug/L) 2007 - 2016 Average	PWQO for nickel is 25 ug/L (MOEE, 1994)
Clare River	-0.341	
Moira River – Tweed (Inlet)	0.732	
Moira River - Stoco Lake East Channel	0.595	
Moira River - Stoco Lake West Channel	0.552	

TABLE 8: NICKEL AVERAGE UG/L 2007-2016

2.5 Natural Habitats and Flora/Fauna

The Stoco Lake Watershed lies within an ecotone, where the northern granitic shield overlaps with the southern limestone plains. The watershed contains coniferous and deciduous forests, granite barrens, wetlands ranging from peat bogs and fens to rich marshes and swamps, and agricultural farmlands. Rare landscape features, such as Alvar (thin soil over limestone), are found in the area and are known to be home to very unique and rare species. There are no known intensive species inventories for the Stoco Lake watershed.

Wetland, vegetation, and fish surveys were conducted in 2016 by Quinte Conservation staff. The information collected during the surveys is summarized in the following section. Additional information is sourced from previous studies, partnering agency data, and data collected through citizen science programs.

i) Fish Community

Stoco Lake is known to support a warm water fish community with excellent fishing opportunities. The Lake is home to “giant muskies” (Muskellunge) and has become well known for Bass and Walleye fishing, and more recently the Black Crappie. In the mid to late 1940s Muskellunge were introduced into Stoco Lake and the releases were not considered successful (Richardson, 1950), however the recent surge in popularity and anecdotal information from anglers would suggest that the Muskellunge is having good success in Stoco Lake.

Quinte Conservation conducted a fish netting program in 2016 between May 30 and June 1. The focus of the netting program was to determine some of the community structure within the Lake and collect general observations of the population. The equipment for the survey was designed to collect fish from the nearshore areas in shallow bays and inlets to the Lake. Several locations were identified as potential sites from Quinte Conservation aerial mapping and lake contours. Hoop nets (small and large), Windermere traps, and minnow traps were deployed at selected sites. Fish were collected from the traps/nets typically after being set for 24 hours and placed into large plastic totes equipped with aerators. The fish were identified to species and some general information was collected prior to returning the fish back into the Lake.

A total of 2,351 fish were caught during the 2016 assessment. A representative sample of each fish species had a weight and length taken by Quinte Conservation staff. The survey showed a

richness of native fish species, with 17 species identified. Two fish were collected and noted as a "hybrid" indicating that they exhibited traits of both the Pumpkinseed and Bluegill (this is quite common).

Fish species found in the 2016 sampling (brackets indicate the total number caught):

Banded Killifish (5)
Fundulus diaphanous
Black Crappie (20)
Pomoxis nigromaculatus
Bluegill (1148)
Lepomis macrochirus
Brooke Silverside (3)
Labidesthes sicculus
Brown Bullhead (23)
Ameiurus nebulosus
Golden Shiner (25)
Notemigonus crysoleucas
Greater Redhorse (4)
Moxostoma valenciennesi
Largemouth Bass (19)
Micropterus salmoides
Log Perch (2)
Percina caprodes
Longear Sunfish (67)
Lepomis megalotis
Longnose Gar (14)
Lepisosteus osseus
Muskellunge (1)
Esox masquinongy
Pumpkinseed (779)
Lepomis gibbosus
Rock Bass (109)
Ambloplites rupestris
Smallmouth Bass (26)
Micropterus dolomieu
Walleye (1)
Sander vitreus
Yellow Perch (103)
Perca flavescens

The 2016 survey found a high abundance (92%) of fish from the Sunfish and Bass family (*Centrarchidae*). In general, this family of fishes prefers warm-water of lakes with abundant vegetation (with the exception of rock bass and smallmouth bass that prefer cooler water over rocky bottoms). They are a carnivorous family of fish, with the smaller species and young individuals feeding primarily on small invertebrates (such as insects, crustaceans, and mollusks) while the larger individuals feed more frequently on other fish, crayfish, and amphibians.

Some of the other more abundant families of fish collected during the survey were the *Percidae* (which includes perch and walleye, 4.5 % of catch), *Cyprinidae* (minnows and carps, 1% of catch) and *Ictaluridae* (North American Catfishes – bullheads, 1% of catch).

Muskellunge, 2016 – Stoco Lake

This particular netting program was not designed to capture large - bodied fish, as Quinte Conservation staff targeted the nearshore areas. However, Quinte Conservation staff did collect a few large fish, notably a 97.1 cm (38") long Muskellunge weighing approximately 5 kilograms (11lbs), and a 54.5 cm (21.4") Walleye weighing 1.45 kilograms (3.2 lbs). In addition, staff also collected a total of 14 Longnose Gar ranging in length from 40 – 90 cm (15.7"-35.4").

Walleye, 2016 – Stoco Lake

Longnose Gar, 2016 – Stoco Lake

Longnose Gar, 2016 – Stoco Lake

Greater Redhorse, 2016 – Stoco Lake

One unusual fish was found during the survey, the Greater Redhorse (Moxostoma valenciennesi), a fish species within the sucker family. According to Ontario Freshwater Fishes Life History Database, it is considered uncommon, however known to be in tributaries of Lake Ontario. It is sensitive to turbidity, siltation, and pollution (Retrieved online at www.ontariofishes.ca, 2016).

The Greater Redhorse was once thought to be rare in North America has been found in many more locations as a result of new fisheries methods (Holm, Mandrak and Burridge, 2010). The Greater Redhorse is often mistaken for a white sucker or other members of the Moxostoma family. It is a large sucker with adults averaging 46 cm (18 "). It has a large and long head making up 19-20% of total length (E.B. Scott, E.J. Crossman, 1998). One of the distinguishing features of the greater redhorse pertains to the lips. The lips have distinct ridges that are not broken by transverse grooves, see photos (adjacent and below).

Lips of the greater redhorse - photo credit - http://moxostoma.com/northern-illinois-greater-redhorse/

Below: Lips of the Robust Redhorse, White Sucker, and Shorthead Redhorse.
Photographs by gabriela m. hogue.

The Greater Redhorse feed from the bottom and eat aquatic insects, crustaceans, and aquatic plants. Spawning occurs in late spring to early summer over rocky substrate, often in riffles, when water temperatures reach 13 degrees.

In addition to the 2016 sampling species list, MNRF Fish-ONline website indicates that Burbot, Freshwater Drum, Northern Pike, and White Sucker were also confirmed in the Lake; however, no dates were specified. A historical account of the Moira River watershed fish community based on a 1948 fish survey noted several of the aforementioned species, as well as the American Eel and Northern (Shorthead) Redhorse (Richardson, 1950). Fisheries and Oceans

Canada in 2016 identified a number of fish species at risk and protected under the Species at Risk Act (SARA) to be within the Moira River system and Stoco Lake. Listed SARA fish species and their critical habitat that have been identified in Stoco Lake and the Moira River include Channel Darter, Eastern Sand Darter, Pugnose Shiner, and Spotted Gar (Fisheries and Oceans Canada, 2016). Special provisions and attention is granted to these species in order to protect their populations from being negatively impacted.

Today, Stoco Lake fishing opportunities are enjoyed by residents and attract many visitors seeking a diverse list of fish species. Walleye, Smallmouth Bass, Largemouth Bass, Muskellunge, and Northern Pike are of primary interest. In 2016 and 2017, the Municipality of Tweed hosted a fall and winter Black Crappie fishing tournament. These events are well attended and serve as a valuable method of bringing the spot light to a great area.

Stoco Lake lies within the Fisheries Management Zone 18. One exception for 2017 is listed for Stoco Lake: Muskellunge must be greater than 102 cm (40 in.).

ZONE 18 SEASONS AND LIMITS

• Dates are inclusive; all dates including the first and last dates stated in the summary are open or closed

SPECIES	OPEN SEASONS	LIMITS
Walleye & Sauger *or any combination*	Jan. 1 to Mar. 1 & 2nd Sat. in May to Dec. 31	S - 4; Must be between 40-50 cm - (15.7– 19.7 in) C - 2; Must be between 40-50 cm - (15.7– 19.7 in)
Largemouth & Smallmouth Bass *or any combination*	3rd Sat. in June to Dec. 15	S - 6 C - 2
Northern Pike	Jan. 1 to Mar. 31 & 2nd Sat. in May to Dec. 31	S - 6 C - 2
Muskellunge	1st Sat. in June to Dec. 15	S - 1; must be greater than 91 cm (36 in.) C - 0
Yellow Perch	Open all year	S - 50 C - 25
Crappie	Open all year	S - 30 C - 10
Sunfish	Open all year	S - 300, only 30 may be greater than 18 cm (7.1 in.). C - 15

SPECIES	OPEN SEASONS	LIMITS
Brook Trout*	Open all year	S - 5 C - 2
Brown Trout*	Open all year	S - 5 C - 2
Rainbow Trout*	Open all year	S - 5 C - 2
Lake Trout*	4th Sat. in May to Sept. 8	S - 2 C - 1
Splake*	Open all year	S - 5 C - 2
Pacific Salmon*	Open all year	S - 5 C - 2
Atlantic Salmon*	Closed all year	
Lake Whitefish	Open all year	S - 12 C - 6
Lake Sturgeon	Closed all year	
Channel Catfish	Open all year	S - 12 C - 6

American Eel is a specially protected fish species and may not be caught or possessed under a recreational fishing licence.

*Aggregate limits apply to these species. See page 7 for full details.

Ontario Ministry of Natural Resources and Forestry, 2017. Ontario Recreational Fishing Regulations . Available Online at https://www.ontario.ca/page/fisheries-management-zone-18-fmz-18

ii) Birds and Amphibians

Marsh bird and amphibian surveys were conducted at four sites around Stoco Lake in the spring and summer of 2016 using the methodologies from the Marsh Monitoring Program in accordance with Bird Studies Canada. This provides a snapshot of breeding birds and amphibians around Stoco Lake. Monitoring frog and toad populations is another way to assess and monitor the health of wetland areas. Frogs and toads are vulnerable to changes in the atmosphere, land, or water and so they are often used as indicator species of the health of an area. Monitoring and tracking populations from year to year by listening for their calls during mating season can help to understand changes in the local environment. A healthy population of all expected frog species was noted in the 2016 surveys.

Significant bird species were noted on Stoco Lake during the 2016 lake study, including American Bittern, Bald Eagle, and the Sora. Both the American Bittern and Sora during nesting season require large, diverse, and undisturbed marshes. The American Bald Eagle is a species in recovery after being decimated by agricultural pesticides (DDT) in the Great Lakes Basin. Bald Eagles were observed on Stoco Lake in 2016 by Quinte Conservation staff. Local residents reported observing Bald Eagles on Stoco Lake for the past several years.

Cormorants are noted by lake residents to be present on Stoco Lake in recent years and are perceived by some to be a nuisance, damaging trees. Cormorant populations were in decline from 1950-1970s, largely due to environmental contaminants (e.g., DDT). Today their range is growing, as is their population density. At overabundant levels, their excrement and nest-building behaviour can cause chemical and physical damage to soil and vegetation of terrestrial ecosystems and they may out-compete other colonial nesting birds for nesting sites.



Above from left to right: American Bittern (Botaurus lentiginosus), Sora (Parzana carolina), Bald Eagle (Haliaeetus leucocephalus)

Bird species noted during marsh bird surveys in the spring and summer of 2016:

American Bittern
American Crow
American Robin
Bald Eagle
Belted Kingfisher
Black Capped Chick-a-dee
Blue Jay
Canada Geese
Catbird
Common Loon
Common Yellow Throat
Downy Woodpecker
Great Blue Heron
Herring Gull
Hooded Merganser
Mallard
Mourning Dove
Osprey
Pileated Woodpecker
Ruby-throated Hummingbird
Red-winged Black Bird
Song Sparrow
Sora
Thrasher
Turkey Vultures
Veery

Local residents have observed many other bird species in the Stoco Lake area. Ebirds Canada (www.ebirds.org) noted 270 species of birds sighted and submitted within Hastings County.

Healthy populations of frogs were noted during Amphibian surveys in the spring and summer of 2016.


Spring Peeper


Green Frog


Leopard Frog


Bull Frog


Wood Frog (not noted during surveys, but known to be present)


Chorus Frog


American Toad (not noted in survey, but known to be present)


Gray Tree Frog

**Amphibian surveys were conducted in 2016 by Quinte Conservation through the Marsh Monitoring Program.*

Photos by local photographer, Jason King

iii) Lake Plant Communities

Stoco Lake supports a diverse population of plants with a high abundance and species richness of native species. The 2016 survey of vegetation noted 37 species of plants with a very high percentage being plants native to the region.

The 2016 submerged aquatic vegetation (SAV) survey took place over two days in August when the plants were mature. Three separate areas were surveyed, and included a vegetated area at the Sulphide Creek inlet, and the east and west outlets of the Moira River; see Map 3 (above, pg 22) for the wetland plant community sampling locations.

Above: 1 metre square quadrat used to survey vegetation on Stoco Lake in 2016.

Within those three separate areas, 20 random points were surveyed using a floating 1 by 1 metre square quadrat to identify the vegetation community from the surface to the substrate. The point data within the quadrat consists of total coverage, individual coverage by species, water depth, sediment type, and turbidity. General observations were also noted. The sampling protocol followed the Durham Coastal Wetland Monitoring Protocol. The SAV surveys took place on the same day as the aquatic macro-invertebrate sampling. In total, 31 unique plant species were identified in 2016.

Aquatic vegetation surveys in 1972 found 17 species and in 2011 found 14 species. The MOE attributed the decrease in aquatic species found between 2011 and 1972 to the proliferation and dominance of invasive species, in particular Eurasian Water-milfoil (MOE, 2012). The increase in plant diversity found within this 2016 study may be the result of a different methodology compared to the previous studies. Furthermore, five invasive species were identified in the Lake in 2016. One of the invasive species documented in 2016 was previously

documented in Stoco Lake, Eurasian Water-milfoil (MOE, 2012). Efforts should be made to slow the spread of further invasive species into the Lake. More information can be found in the invasive species section of this report. Submerged and emergent vegetation identified in 2016 as summarized below, non-native invasive species identified in the Lake are found in bold;

Submerged:

- Canada Waterweed *(Elodea Canadensis)*
- Common Bladderwort, Spatterdock (*Utricularia vulgaris)*
- Coontail, Hornwort *(Ceratophyllum demersum)*
- **Curly Pondweed *(Potamogeton crispus)***
- Curly White Water Crowfoot *(Ranunculus longirostris)*
- **Eurasian Water-milfoil *(Myriophyllum spicatum)***
- Fern Pondweed *(Potamogeton robbinsii)*
- Flat-stemmed Pondweed *(Potamogeton zosteriformis)*
- Floating-leaved Pondweed *(Potamogeton natans)*
- Richardson's, Clasping Leaved Pondweed (*Potamogeton richardsonii)*
- Sago Pondweed *(Potamogeton pectinatus)*
- Slender Naiad *(Najas flexilis)*
- Slender Pondweed *(Potamogeton pusillus)*
- Stonewort, Muskgrass Chara sp.
- Tape Grass, Wild Celery, Water Celery *(Vallisneria Americana)*
- Water Star-grass *(Heteranthera dubia)*

Emergent

- Algae *(Algae* sp)
- Blue Flag Iris *(Iris versicolor)*
- Broad-leaved Arrowhead *(Sagittaria latifolia)*
- Cardinal Flower *Lobelia (Cardinalis)*
- Cattail *(Typha sps.)*
- Burreed (*Sparganium sp*.)
- Button bush (*Cephalanthus occidentals)*
- **European Frog-bit *(Hydrocharis morsus-ranae)***
- **Flowering Rush *(Butomus umbellatus)***
- Greater Duckweed *(Spirodela polyrhiza)*
- Hardstem Bulrush *(Schoenoplectus acutus*
- Large-leaved Pondweed *(Potamogeton amplifoliu)*
- Lesser Duckweed *(Lemna minor)*
- Marsh Fern *(Thelypteris palustris)*
- Pickerelweed *(Pontederia cordata)*
- **Purple Loosestrife *(Lythrum salicaria)***
- Softstem Bulrush *(Schoenoplectus tabernaemontani*
- Star Duckweed *(Lemna trisulca)*
- Sensitive Fern *(Onoclea sensibis)*
- Water Shield *(Brasenia schreberi)*
- White Water Lily, Fragrant Water Lily (*Nymphaea odorata)*
- Wild Rice *(Zizania palustris)*
- Yellow Pond Lily, Bullhead Lily, Spatterdock *(Nuphar lutea ssp. Variegate)*

*A **weed harvester*** is owned by Friends of Stoco Lake and the Municipality of Centre Hastings. Every year a permit is obtained from the Ontario Ministry of Natural Resources and Forestry. Harvesting is done on Stoco Lake for members for a two-week period in each of July, August, and September. The other two weeks of each month the harvester is on Moira Lake. The Ontario Ministry of Natural Resources and Forestry regulates weed harvesting activities to ensure protection of fish habitat. *For best management practices on removing native aquatic plants, visit* **www.ontario.ca/page/remove-native-aquatic-plant**

iv) Species at Risk

The populations of more than 190 species in Ontario are in decline. These are species that are at risk of disappearing from the Province. Their populations are in decline due to a number of reasons including habitat loss, pollution, land use, and resource management activities, as well as the spread of invasive species.

There are 31 known species at risk in the Hastings County Region, below are some of those that could reside in the Stoco Lake and its watershed (MNRF, updated June 20 2016, *Retrieved online from www.ontario.ca/environment-and-energy/species-risk-area).*

SAR Species in Hastings County - Status identified by MNRF for 2016

BIRDS
Black Tern (*Chlidonias niger*)- THR
Bobolink (*Dolichonyx oryzivorus*) - THR
Cerulean Warbler (*Dendroica cerulea*) - THR
Eastern Meadowlark (*Sturnella magna*)- THR
Eastern Whip-poor-will (*Antrostomas vociferus*) - THR
Henslow's Sparrow (*Ammodramus henslowii*) – END
King Rail (*Rallus elegans*) – END
Least Bittern (*Ixobrychus exilis*)- THR
Loggerhead Shrike (*Lanius ludovicianus*) – END
Louisiana Waterthrush (*Seiurus motacilla*) – SC
Peregrine Falcon (*Falco peregrinus*) – SC

FISH
Channel Darter (*Percina copelandi*) – THR
River Redhorse (*Moxostoma carinatum*)- SC

INSECTS
Rusty-patched Bumble Bee (*Bombus affinis*)-END

PLANTS AND FUNGI
Butternut (*Juglans cinerea*) – END
Dwarf Hackberry (*Celtis tenuifolia*) – THR
Juniper Sedge (*Carex juniperorum*) – END
Ogden's Pondweed (*Potamogeton ogdenii*) – END
Pale-bellied Frost Lichen (*Physconia subpallida*) – END
Small White Lady's-slipper (*Cypripedium candidum*) – END

SNAKES AND LIZARDS
Common Five-lined Skink (*Plestiodon fasciatus*) – SC
Eastern Ribbonsnake (*Thamnophis sauritus*) – SC

TURTLES
Blanding's Turtle (*Emydoidea blandingii*) – THR
Eastern Musk Turtle (*Sternotherus odoratus*) – SC
Northern Map Turtle (*Graptemys geographica*) – SC
Snapping Turtle (*Chelydra serpentina*)- SC

MNRF Species at Risk Status Descriptions

Extirpated A species that no longer exists in the wild in Ontario but still occurs elsewhere.

Endangered (END) A species facing imminent extinction or extirpation in Ontario.

Threatened (THR) A species that is at risk of becoming endangered in Ontario if limiting factors are not reversed.

Special Concern (SC) A species with characteristics that make it sensitive to human activities or natural events.

Eastern Musk Turtle
Special concern due to mortality of adults and young from recreational boaters and habitat loss due to development and shoreline degradation.

Blanding's Turtle
Threatened due to habitat loss, road mortality (often egg laying females), and predation of eggs.

Common Five-lined Skink
Special concern caused by the flipping of rocks (by humans or Black Bears), and removal of rocks for landscaping shrink habitat areas. Other threats are illegal collection for the pet trade and ATVs. In Canada, the species is limited to two distinct areas, one being the southern margin of the Canadian Shield.

Photos by Jason King

v) Invasive Species

Invasive species, also called "*exotics*", are species from other areas of the world that move outside of their native habitat. Not all exotic species are harmful, but when they threaten the natural environment, economy, and society they become known as invasive**.**
Invasive species, not known to our local ecosystems, can have drastic effects on ecosystem balance and local biodiversity (the variety of plant and animal species) when introduced. Invasive species may disrupt food webs, alter and degrade habitats, introduce parasites and disease, and lead to species at risk by pushing out native species that share the same habitat. Invasive species are the second biggest threat to biodiversity; habitat loss is the first.

In Ontario, the Invasive Species Act came into effect in 2015 and presents rules to prevent and control the spread of invasive species in the natural environment. Under provincial law, invasive species fit into categories of prohibited and restricted. Prohibited species are those that may have been found in Ontario but are not yet established with a goal to keep them from establishing. Restricted species are already established in the province and the goal is to prevent their spread.

Ontario's Invading Species Awareness Program, a partnership between Ontario Federation of Anglers and Hunters and the Ontario Ministry of Natural Resources and Forestry (MNRF), list more than 185 non-native species that have invaded the Great Lakes basin. These exotic species, often starting in the Great Lakes, can disperse very quickly into inland waters. Exotic species are introduced to Ontario's waters and forests through aquarium and garden trades, live food fish trades, packaging material, movement of wood, unauthorized fish introductions, transport on vehicles, mowers, boats, through bait bucket releases, and introductions into gardens and backyard ponds. The active participation of the public boaters, anglers, campers, hikers, and recreationalists is vital to prevent the spread of invading species. The Municipality of Tweed has looked into the feasibility of a boat washing station and found it to be technically, environmentally, and financially prohibitive.

In 2016, Quinte Conservation noted a number of aquatic invasive species while surveying the Lake.

Invasive Species Act, 2015, S.O. 2015, c. 22 - Bill 37 (www.ontario.ca/laws/statute/s15022)

Ontario has prohibited and restricted some invaders. See which invasive species are on the list. Available online: www.ontario.ca/page/stop-spread-invasive-species

Learn about Ontario's invading species, how to identify them, and how to control them through best management practices. Available online through Ontario's Invading Species Awareness Program: http://www.invadingspecies.com/

REPORT A SIGHTING - EDDMapS Ontario is a fast and easy way to map invasive species without any technical expertise. Users simply take a picture with their mobile device and report from where they are standing. Visit www.eddmaps.org/ontario to register and report your sighting.

Identified aquatic invasive species in 2016 included Zebra Mussel, Eurasian Water-milfoil, Curly Pondweed, Flowering Rush, European Frog-bit, and Purple Loosestrife. It should be noted that in an MOE 2011 study of the Lake only one invasive species was noted, Eurasian Water-milfoil. Efforts should be made to slow and stop the spread of new invasive species.

In addition, the Ontario Invasive Plant Council notes aquatic and terrestrial invasive plant species identified in Ontario and may reside in the Stoco Lake Watershed, greater Moira Watershed and Great Lake Basin; see below.

Terrestrial:

Dog Strangling Vine *(Vincetoxicum rossicum)*
Garlic Mustard *(Alliaria petiolata)*
Manitoba Maple *(Acer negundo)*
Norway Maple *(Acer plantanoides)*
European Buckthorn *(Rhamnus cathartica)*
European or Black Alder *(Alnus glutinosa)*
European Spindletree *(Euonymus europaeus)*
Non-native Bush Honeysuckles *(lonicers spp.)*
Goutweed *(Aegopodium podagraria)*
Periwinkle *(Vinca minor)*
Giant Hogweed *(Heracleum mantegazzianum)*
English Ivy *(Hedera helix)*
Japanese Knotweed *(Fallopia japonica)*
Wild Parsnip *(Pastinaca sativa)*
Reed or Giant Manna Grass *(Glyceria maxima)*
Common Reed *(Phragmites australis)*

Aquatic:

Purple Loosestrife *(Lythrum salicaria)*
Eurasian Water-milfoil *(Myr**io**phyllum spicatum)*
EuropeanFrog-bit *(Hydrocharis morus-ranae)*
Yellow Iris *(Iris pseudacorus)*
Flowering Rush *(Butomus umbellatus)*
Phragmites *(Phragmites australis)*
Brazilian Waterweed *(Egeria densa)*
Curly-leavedPondweed *(Potamogeton crispus)*
European Lake Sedge *(Carex acutiformis)*
Fanwort *(Cabomba caroliniana)*
European Water chestnut *(Trapa natans)*
Hydrilla *(Hydrilla verticillata)*
Parrotfeather *(Myriophyllum aquaticum)*
Water Hyacinth *(Eichhornia crassipes)*
Water Lettuce *(Pistia stratiotes)*
Watermoss-salvinia species *(Salvinia molesta, auriculata, S. minima, S, natans)*
Water Soldier *(Stratiotes aloides)*

Phragmites *(Phragmites australis subsp. australis)* is causing damage to Ontario's biodiversity, wetlands, and beaches. It is a perennial grass native to Eurasia. It spreads quickly and outcompetes native species for water and nutrients. It grows in extremely dense stands and can reach heights of five metres. Toxins released from its roots hinder growth of surrounding vegetation. It is often found growing in areas of standing water but can survive in relatively dry areas. It provides poor food supply and habitat for wildlife, increases fire hazards, can affect agriculture, and impact recreational activities, such as swimming. Currently, it has not been identified on Stoco Lake, though it is known to be in the Moira River Watershed.

*Phragmites is **restricted** under the Invasive Species Act. For more information on the Invasive Species Act and Regulations, visit* ***www.ontario.ca/invasionON***

Phragmites (Australis subsp. Australis)

Garlic mustard
(Alliaria petiolate)

European buckthorn
(Rhamnus cathartica)

Wild parsnip
(Pastinaca sativa)

Left: Dog strangling vine *(Cynanchum rossicum and Cynanchum louiseae*)

Right: Japanese knotweed
(Fallopia japonica)

Invasive aquatic plant species in Stoco Lake, observed by Quinte Conservation in 2016

Eurasian Water-milfoil *(Myriophyllum spicatum)* is an invasive aquatic species native to Europe, Asia, and northern Africa. It prefers shallow waters and can form dense underwater mats that can shade other aquatic plants. When the plant dies off, the decaying plants can reduce oxygen levels in the water. Because tiny plant pieces can develop into new plants, Eurasian water-milfoil is easily spread when water currents, boat propellers, trailers or fishing gear carry plant fragments to new areas. Eurasian Water-milfoil looks similar the native Northern Water-milfoil (*Myriophyllum sibiricum*). The native Water-milfoil has leaves with 11 or fewer leaf segments.

How to Identify Eurasian Water-milfoil:

- Grows under the water surface and blooms in July and early August.
- Has feather-like green leaves that circle the stem in groups of 4 or 5 with 12 or more thread-like segments.
- Tiny, reddish flowers grow on spikes five to 20 cm long that rise above the water.

Curlyleaf Pondweed (*Potamogeton crispus)* forms dense mats at the water surface interfering with boating, fishing, and swimming and it displaces native plant communities. Summer die-offs and decomposition of the plants can lead to algal blooms and oxygen depletion impacting fish populations and other aquatic life.

Flowering Rush *(Butomus umbellatus)* flowers from July to September with clusters of white and pink flowers and can grow up to 1 metre high and a depth of 3 metres. It typically invades shorelines, disturbed areas, and road sides, dominates marsh areas, and displaces native vegetation.

European Frog-bit *(Hydrocharis morsus-ranae)* is native to Europe and parts of Asia and Africa. It grows rapidly and forms dense floating mats that crowd out native species. Large areas of frog-bit that die in the fall and decompose may lead to reduced oxygen levels in the water effecting fish and other aquatic life. New plants can grow from stem fragments, seeds, and winter buds and spread to new waters by boats and wildlife. European frog-bit looks similar to other native aquatic plants, including North American Frog-bit, Watershield and White Water Lily.

Purple Loosestrife *(Lythrum salicaria)* is native to Europe and Asia and has become a threat to wetlands, roadsides, and disturbed areas. The best time to remove purple loosestrife from your garden is in June, July, and early August when it is in flower. Small areas can be dug by hand. Cutting the flower stalks before they go to seed ensures the seeds will not produce future plants.

In addition, below are species that have been identified by the Ontario Invading Species Awareness Program as threats in Ontario and could be a threat to Stoco Lake and its watershed. Visit www.invadingspecies.com for more information.

Forest Pests	Pathogens	Invertebrates	Fish
Asian Long-horned Beetle	Beech Bark Disease	Bloody Red Shrimp	Asian Carp
Emerald Ash Borer	Butternut Canker	Spiny and Fish Hook Water Flea	Goldfish
Gypsy Moth	Dutch Elm Disease	Rusty Crayfish	Northern Snakehead
Invasive Earthworms	Oak Witt	Zebra and Quagga Mussels	Rainbow Smelt
Mountain Pine Beetle	Sudden Oak Death		Round Goby
			Rudd
			Sea Lamprey
			Tench
			Tubenose Goby

Emerald Ash Borer was first detected in 2002 in Windsor Ontario and has spread rapidly killing tens of millions of ash trees. In 2014, the Canadian Food Inspection Agency (CFIA) consolidated the regulated areas within Ontario and Quebec into one larger regulated area. Stoco Lake and its entire watershed reside within the regulated area overseen by federal ministerial orders that prohibit movement of potentially infested ash commodities. More information about the regulations and a map of the current regulated areas are available from the CFIA. Trees can be protected from attack by injecting them with a registered insecticide. Federal regulatory controls restrict the transport of infested ash commodities, including firewood, from infested to non-infested areas (MNRF, Updated Oct 5, 2016, www.ontario.ca/page/emerald-ash-borer).

Help stop the spread of invasive species!

- **When gardening, plant native or non-invasive species.**
- **When camping, don't transport firewood – buy it locally and leave what you don't use.**
- **When fishing, don't empty your bait bucket in or near water – it's against the law.**
- **When boating, wash your boat before you move to another lake or river.**
- **After hiking clean mud, plants, and seeds from your boots and other equipment.**
- **Don't release pets into the wild or flush down the toilet.**
- **If you have a pet turtle or other small reptile that is no longer wanted, contact a reptile rescue society for help**
- **When travelling, don't take plants, plant parts, seeds or fruit across borders.**
- **If you find an invasive species, or one you have never seen, report it. Call the Invading Species Hotline at 1-800-563-7711, or report your sighting online at Ontario's online invasive species reporting system.**

2.6 Development

i) Conservation Authority Shoreline and Flood Regulations

Conservation Authorities, created in 1946 by an Act of the Provincial Legislature, are mandated to ensure the conservation, restoration, and responsible management of Ontario's water, land, and natural habitats through programs that balance human, environmental, and economic needs.

Conservation Authority Objectives

- ensure that Ontario's rivers, lakes, and streams are properly safeguarded, managed, and restored;
- protect, manage, and restore Ontario's woodlands, wetlands, and natural habitat;
- develop and maintain programs that will protect life and property from natural hazards, such as flooding and erosion;
- provide opportunities for the public to enjoy, learn from and respect Ontario's natural environment.

All Conservation Authorities have regulations governing development, interference with wetlands, and alteration to shorelines and watercourses. These require Conservation Authorities to regulate development, such as construction, filling, and site grading and other activities in or adjacent to any watercourse, river or stream valleys, Great Lake and inland lake shorelines, wetlands, and other hazardous lands. Hazardous lands include unstable slopes, other flood prone areas, or areas of unstable bedrock. Development taking place on these lands requires permission from the Conservation Authority.

Activities that fall under the review of the Conservation Authority permit application process include:

- the construction, reconstruction, erection or placing of a building or structure of any kind;
- any change to a building or structure that would have the effect of altering the use or potential use of the building or structure,
- increasing the size of the building or structure or increasing the number of dwelling units in the building or structure;
- site grading, or the temporary or permanent placing, dumping or removal of any material, originating on the site or elsewhere; and
- the straightening, changing, diverting or interfering in any way with the existing channel of a river, creek, stream, watercourse or for changing or interfering in any way with a wetland.

There are setbacks from watercourses, wetlands, and shorelines for new development, such as buildings and sewage systems. It is Quinte Conservation Authority policy to require that new development be at least 15 metres from the 1:100 year floodplain, or 30 metres from a Provincially Significant Wetland. Setbacks may be increased for unstable slopes, and Municipalities may require a greater setback than the Authority.

The setback assists in providing a margin of error in the floodplain mapping, to provide access during a flood, to provide for wave uprush and ice push, and to assist in reducing pollution loading of our watercourses.

ii) Hastings County Official Plan

The Hastings County Official Plan provides goals, objectives, and policies to guide the physical development of Hastings County, including the Municipality of Tweed and the Stoco Lake Area, while having regard for relevant social, economic, and environmental matters. The Planning period of the current plan is to 2020, with reviews at least every 5 years to consider the need for revisions.

The goals and objectives of the Hasting County Official Plan form the basis and provide direction that guide the development of detailed policies and programs. The goals and objectives identified in the Official Plan are as follows:

- social
- settlement
- economic
- environmental protection
- agricultural
- water
- historical preservation
- transportation
- community improvement
- extractive (aggregate and mineral)

The full Official Plan can be accessed through the Hasting County office, and an electronic copy can be accessed online through the Hasting County website. The policies and programs in full can be found in the Official Plan document. www.hastingscounty.com/sites/default/files/documents/planning-land-development/official-plan/Official_Plan.pdf

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APPENDIX

Aquatic Benthic Macro-Invertebrate Summary (2016 Sampling on Stoco Lake)

The benthic surveys took place on the same day as the submerged aquatic vegetation (SAV) and water quality sampling following the Durham Coastal Wetland Monitoring Protocol for benthic sampling.

The same areas were surveyed as the SAV: a vegetated area at the Sulphide inlet, and the east and west outlets of the Moira River. At each of these sites included three replicates, totaling 9 benthic samples.

Overall, 45 different varieties of benthic macroinvertebrates were collected. Scuds (*Amphipoda)* were the dominant species in all of the sampling areas. Sow Bugs (*Isopoda asellidae)* were sub-dominant at both the East and West Outlets whereas Whirligig Beetles (*Coleoptera gyrinidae)* were the dominant species at the Sulphide inlet. The West Outlet had the most diverse population of benthic macroinvertebrates.

	Sulphide			West Outlet			East Outlet		
	Taxa	Family	Common Name	Taxa	Family	Common Name	Taxa	Family	Common Name
Dominant	Amphipoda		Scuds	Amphipoda		Scuds	Amphipoda		Scuds
Sub-Dominant	Coleoptera	Gyrinidae	Whirligig Beetles	Isopoda	Asellidae	Sow Bugs	Isopoda	Asellidae	Sow Bugs

Summary of Benthic Sampling

			Sulphide			West Outlet			East Outlet			
Taxa	Family	Common Name	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Total
Amphipoda		Scuds	50	164	140	44	97	16	121	129	106	867
Anisoptera	Aeshnidae	Dragonflies (Darners)	1									1
Anisoptera	Gomphidae	Dragonflies (Clubtails)		1								1
Anisoptera	Libellulidae	Dragonflies (Skimmers or Chasers)	3		1	8	1	6	2	1	3	25
Anisoptera	Petaluridae	Dragonflies (Petaltails)									1	1
Bivalvia		Clams						2				2
Bivalvia	Dreisseniidae	Zebra mussel	6		1	1		1		1		10
Bivalvia	Sphaeriidae	Fingernail or Pea Clams				1				1		2
Coleoptera	Carabaidae	Ground Beetle						1				1
Coleoptera	Dytiscidae	Predacious Diving Beetles			1			1	1		5	8
Coleoptera	Elmidae	Riffle Beetles	1		1			3		2		7
Coleoptera	Gyrinidae	Whirligig Beetles	43				4	1				48
Coleoptera	Haliplidae	Crawling Water Beetles	7					2	2	4	1	16
Coleoptera	Hydrophilidae	Water Scavenger Beetles	1			2		7	2	8		20
Coleoptera	Salpingidae	Narrow-waisted Bark Beetles						3				3
Diptera	Ceratopogonidae	No-see-ums (Punkies or Biting Midges)			1		2			1		4
Diptera	Chironomidae	Midges	7	6		16	10	7	3	6	2	57
Diptera	Culicidae	Mosquitoes					1					1
Diptera		Misc. True Flies				1						1
Ephemeroptera	Caenidae	Small Squaregills Mayflies	4		2	9	16			1	3	35
Ephemeroptera	Isonychiidae	Brush-legged Mayflies			5		5					10
Ephemeroptera	Siphlonuridae	Minnow Mayflies								4		4
Gastropoda	Ancylidae	Ancylid Snails						1				1
Gastropoda	Bithyniidae	Bithyniid Snail				5		17				22
Gastropoda	Lymnaeidae	Lymnaeid Snails	17	8	2	8	9	14	1	5		64
Gastropoda	Physidae	Physid Snails	2	2	8	2	1	31	1	2	1	50
Gastropoda	Planorbidae	Planorbid Snails				7		23	2	2		34
Gastropoda	Viviparidae	Viviparid Snails						5				5
Hemiptera	Belostomatidae	Gaint Water Bugs	1		1	1		1		2	1	7
Hemiptera	Naucoridae	Creeping Water Bugs				6	2	6		4		18
Hemiptera	Nepidae	Water Scorpions								1		1
Hemiptera	Notonectidae	Backswimmers	1			1						2
Hemiptera	Pleidae	Pygmy Backswimmers	4			3		1	6		13	27
Hirudinea		Leeches	1			1		8	3	4	1	18
Isopoda	Asellidae	Sow Bugs	2			24	7	8	27	1	23	92
Megaloptera	Corydalidae	Alderflies					1				1	2
Tricoptera	Hydroptilidae	Purse-case Makers Caddisflies							1			1
Tricoptera	Limnephilidae	Northern Caddisflies							1			1
Tricoptera	Rhyacophilidae	Free-living Caddisflies								1		1
Tricoptera	Polycentropodid	Trumpet-net and Tube-making Caddiesflies						1				1
Oligochaeta		Aquatic Earthworms		1			4	1		2	1	9
Trombiciformes-Hydracarina	Hydracarina	Mites	15	7	1	8	26	1	1	9	1	69
Turbellaria		Flatworm				4		1	3	2	2	12
Zygoptera	Coenagrionidae	Common Damselflies	3			1	8			4	4	20
Zygoptera	Lestidae	Spreadwings Damselflies				4		5				9
Total			**169**	**189**	**164**	**157**	**194**	**174**	**177**	**197**	**169**	**1590**

Quinte Conservation conducted a fish netting program in 2016 between May 30 and June 1. The focus of the netting program was to determine some of the community structure within the Lake and collect general observations of the population. Hoop nets (small and large), Windermere traps, and minnow traps were deployed at selected sites. Fish were collected from the traps/nets typically after being set for 24 hours and placed into large plastic totes equipped with aerators. The fish were identified to species and some general information was collected prior to returning the fish back into the Lake.

Sampling Sites Locations: May 30 - June 1, 2016)

Event Code	Gear Code	Event Start Date	Event End Date	# days set	UTM (NAD 83) Zone #	Easting	Northing	Area Type	Collectors	Gear Type
May-16	SHN1	May 30 2016	June 1 2016	2	18	316990	4927015		B.M, C.J	Small Hoopnet
May-16	SHN2	May 30 2016	June 1 2016	2	18	318979	4928086		B.M, C.J	Small Hoopnet
May-16	SHN3	May 30 2016	June 1 2016	2	18	318870	4926013		B.M, C.J	Small Hoopnet
May-16	SHN4	May 30 2016	June 1 2016	2	18	316889	4927247		B.M, C.J	Small Hoopnet
May-16	LHN1	May 30 2016	June 1 2016	2	18	318235	4927894		B.M, C.J	Large Hoopnet
May-16	LHN2	May 30 2016	June 1 2016	2	18	317145	4927122		B.M, C.J	Large Hoopnet
May-16	LHN3	May 30 2016	June 1 2016	2	18	317038	4925119		B.M, C.J	Large Hoopnet
May-16	EXLHN	May 30 2016	June 1 2016	2	18	318457	4929606		B.M, C.J	Extra Large Hoopnet

Total Fish Caught (May 30 - June 1, 2016)

Event Code	Gear Co	Lift Day	Date Set	Date Lift	Fish Total	Fish Species Common Name	Fish Species Scientific Name	MNR Code
Mar-16	EXLHN	1	May 30 2016	May 31 2016	69	Pumpkin Seed	Lepomis gibbosus	313
Apr-16	EXLHN	1	May 30 2016	May 31 2016	47	Blue Gill	Lepomis macrochirus	314
May-16	EXLHN	Pull	May 31 2016	June 1 2016	178	Pumpkin Seed	Lepomis gibbosus	313
May-16	EXLHN	Pull	May 31 2016	June 1 2016	154	Blue Gill	Lepomis macrochirus	314
May-16	EXLHN	Pull	May 31 2016	June 1 2016	17	Longear Sunfish	Lepomis megalotis	315
May-16	EXLHN	Pull	May 31 2016	June 1 2016	72	Yellow perch	Perca flavescens	331
May-16	EXLHN	Pull	May 31 2016	June 1 2016	18	Golden Shiner	Notemigonus crysoleucas	194
May-16	EXLHN	Pull	May 31 2016	June 1 2016	17	Rock Bass	Ambloplites rupestris	311
May-16	EXLHN	Pull	May 31 2016	June 1 2016	12	Black Crappie	Pomoxis nigromaculatus	319
May-16	EXLHN	Pull	May 31 2016	June 1 2016	12	Smallmouth Bass	Micropterus dolomieu	316
May-16	EXLHN	Pull	May 31 2016	June 1 2016	11	Brown Bullhead	Ameiurus nebulosus	233
May-16	EXLHN	Pull	May 31 2016	June 1 2016	2	Largemouth Bass	Micropterus salmoides	317

Fish Collected: Length and Weight Summary by Species

Species	Length (mm)		Weight (g)		Number	Comments
	min	max	min	max		
Banded Killifish	44	59	-	-	5	not all fish had weights
Black crappie	130	273	35	330	20	not all fish had weights
Blue Gill	37	177	25	78	1158	not all fish had weights
Brooke Silverside	71	75	-	-	3	not all fish had weights
Brown Bullhead	67	265	3	270	23	not all fish had weights
Golden Shiner	93	149	8	15	25	not all fish had weights
Greater redhorse	483	550	1750	2400	4	not all fish had weights
Largemouth Bass	82	372	10	890	19	not all fish had weights
Logperch	76	101	7	9	2	not all fish had weights
Longear Sunfish	11	122	54	700	71	not all fish had weights
Longnose gar						not all fish had weights
Muskellunge						not all fish had weights
Pumpkin Seed						not all fish had weights
Rock Bass						not all fish had weights
Smallmouth Bass						not all fish had weights
Yellow perch						not all fish had weights
Walleye						not all fish had weights

Water Chemistry (May 30, 31, and June 1, 2016)

Event Code	Gear Code	Easting	Northing	Lift Day	Date	Time	Mean Air Temp (°C)	Dissolved Oxygen (mg/L)	pH	Water Temperature (°C)	Conductivity (ms/cm)	Turbidity (NTU)
May-16	SHN1	316990	4927015	Set	May 30 2016	11:45	23	9.95	6.99	24.11	0.191	0.7
May-16	SHN1	316990	4927015	1	May 31 2016	10:30						
May-16	SHN1	316990	4927015	Pull	June 1 2016	10:30	19	10.42	7.66	22.42	0.192	0.7
May-16	SHN2	318979	4928086	Set	May 30 2016	13:30	25	9.2	7.87	24.93	0.242	0.7
May-16	SHN2	318979	4928086	1	May 31 2016	12:30	26					
May-16	SHN2	318979	4928086	Pull	June 1 2016	13:45	20	10.97	7.52	23.74	0.267	1.3
May-16	SHN3	318870	4926013	Set	May 30 2016	14:00	23	9.91	7.82	23.85	0.199	0.7
May-16	SHN3	318870	4926013	1	May 31 2016	13:00						
May-16	SHN3	318870	4926013	Pull	June 1 2016	10:15	20	10.8	7.57	21.68	0.2	1.15
May-16	SHN4	316889	4927247	Set	May 30 2016	11:15	21	8.55	6.76	24.42	0.189	0.9
May-16	SHN4	316889	4927247	1	May 31 2016	9:40	24					
May-16	SHN4	316889	4927247	Pull	June 1 2016	11:00	19	10.76	7.81	22.68	0.19	0.6
May-16	LHN1	318235	4927894	Set	May 30 2016	12:30	23	10.48	7.72	25.07	0.207	0.6
May-16	LHN1	318235	4927894	1	May 31 2016	11:30						
May-16	LHN1	318235	4927894	Pull	June 1 2016	13:15	20	10.7	7.6	22.8	0.207	0.6
May-16	LHN2	317145	4927122	Set	May 30 2016	12:00	23	9.51	7.27	24.46	0.182	0.4
May-16	LHN2	317145	4927122	1	May 31 2016	11:00						
May-16	LHN2	317145	4927122	Pull	June 1 2016	12:40	20	9.7	7.56	22.78	0.19	0.4
May-16	LHN3	317038	4925119	Set	May 30 2016	14:30	25	9.34	7.91	24.67	0.235	0.9
May-16	LHN3	317038	4925119	1	May 31 2016	14:00	26	10.39	7.97	24.32	0.228	0.5
May-16	LHN3	317038	4925119	Pull	June 1 2016	9:30	20	10.88	7.3	20.39	0.211	0.9
May-16	EXLHN	318457	4929606	Set	May 30 2016	13:00	24	11.31	8.13	26.9	0.208	1.2
May-16	EXLHN	318457	4929606	1	May 31 2016	12:00	26					
May-16	EXLHN	318457	4929606	Pull	June 1 2016	14:00	22	10.8	7.67	22.93	0.205	0.8

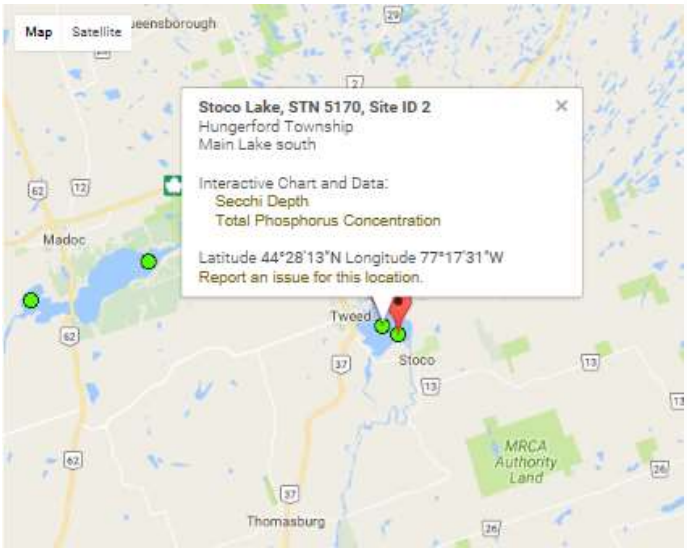
All of the Provincial Water Quality Data can be found on the MOECC website below.
https://www.ontario.ca/data/provincial-stream-water-quality-monitoring-network

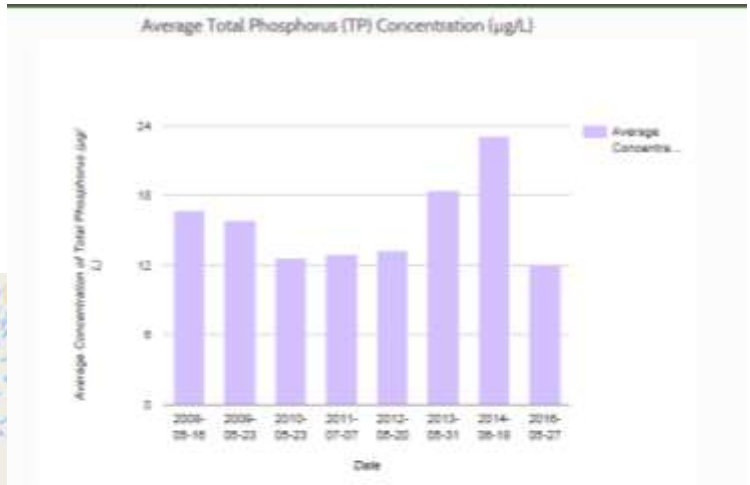
Please contact Quinte Conservation for questions regarding the data above and the data/field sheets from the Marsh Monitoring sites and vegetation surveys (too extensive to include in the appendix) - 613-968-3434.

Total Phosphorus, temperature, and water clarity data collected by a local resident through the Lake Partner Program (2008 - 2016)

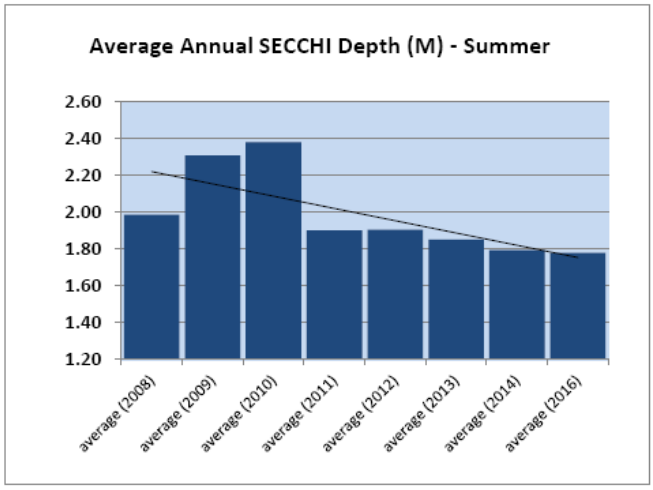
Stn; 5170 Site ID;2 Vol ID; 1158

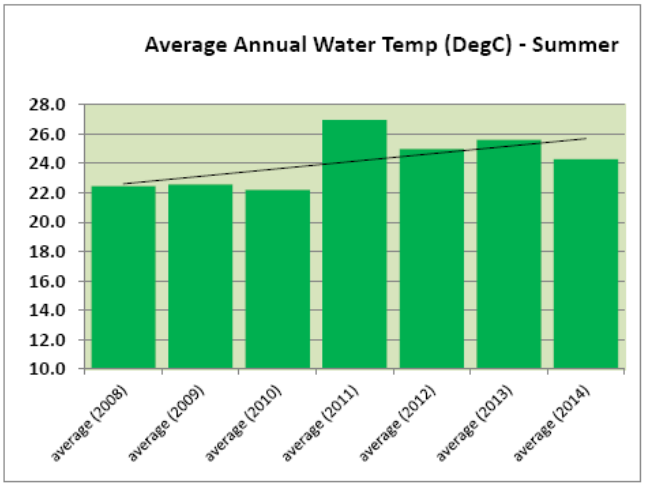
https://www.ontario.ca/environment-and-energy/map-lake-partner

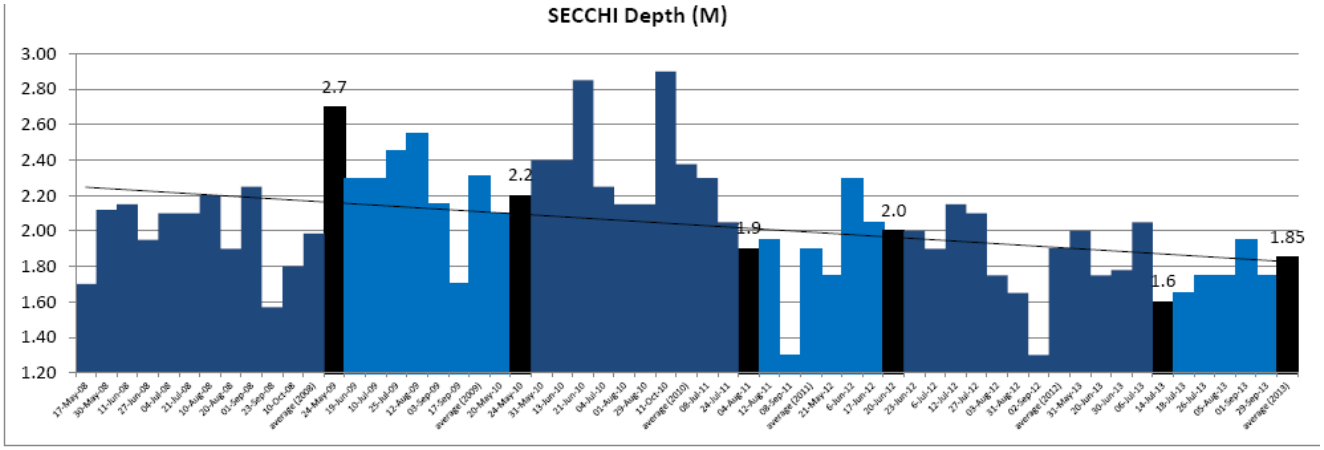


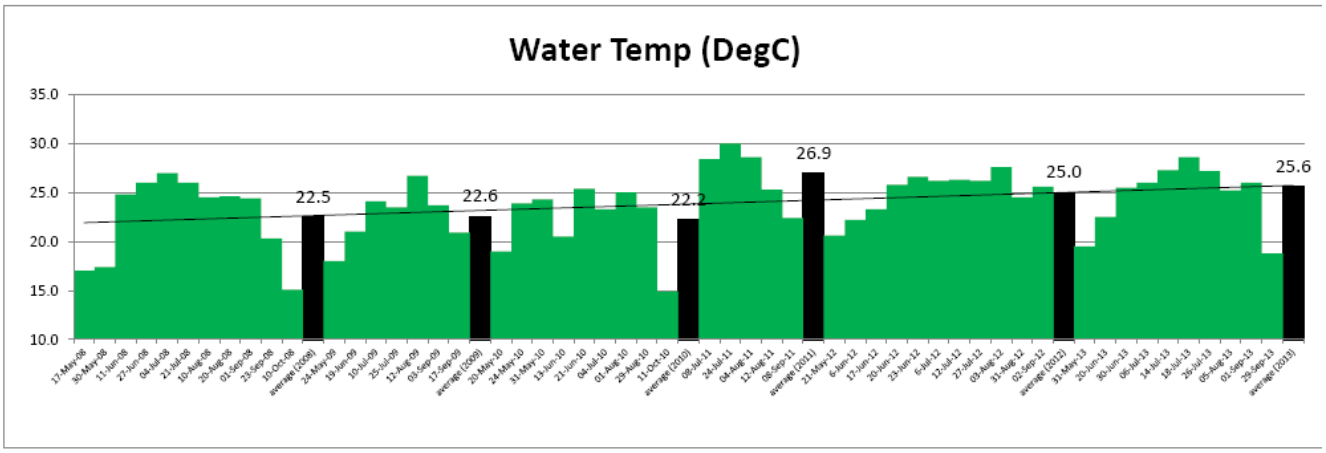


Date	Sample 1 (µg/L)	Sample 2 (µg/L)	Average (µg/L)
2008-05-16	16.66	16.73	16.7
2009-05-23	16	15.78	15.89
2010-05-23	13	12.2	12.6
2011-07-07	12.8	13.2	12.9
2012-05-20	13.4	13	13.2
2013-05-31	18.2	18.8	18.5
2014-06-18	24.2	22	23.1
2016-05-27	12	12.2	12.1


Average Annual SECCHI Depth (M) - Summer
2.60
2.40
2.20
2.00
1.80
1.60
1.40
1.20
average (2008)
average (2009)
average (2010)
average (2011)
average (2012)
average (2013)
average (2014)
average (2016)


Average Annual Water Temp (DegC) - Summer
28.0
26.0
24.0
22.0
20.0
18.0
16.0
14.0
12.0
10.0
average (2008)
average (2009)
average (2010)
average (2011)
average (2012)
average (2013)
average (2014)


SECCHI Depth (M)
3.00
2.80
2.60
2.40
2.20
2.00
1.80
1.60
1.40
1.20
2.7
2.2
1.9
2.0
1.6
1.85


Water Temp (DegC)
35.0
30.0
25.0
20.0
15.0
10.0
22.5
22.6
22.2
26.9
25.0
25.6