# Water Quality Monitoring in the St. Marys River Area of Concern

Environment Canada | Environnement Canada | Ontario | Algoma University

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# Introduction

# St. Marys River

- Freshwater ecosystem connecting Lakes Superior and Huron

# Areas of Concern

- Geographically delineated regions where impairment of beneficial uses has occurred due to human activities [1]

[1] Great Lakes Water Quality Agreement (1972, 1978, **1987**, 2012)

# Remedial Action Plans

- The goal of the Remedial Action Plan process is the restoration of beneficial uses, leading to the recovery of Areas of Concern [2]

[2] St. Marys River Stage 1 Remedial Action Plan (1992)

# Beneficial Use Impairments

1. Restrictions on Fish Consumption
2. Degradation of Fish Populations
3. Fish Tumours and Other Deformities
4. Degradation of Benthos
5. Restrictions on Dredging Activities
6. **Eutrophication and Undesirable Algae**
7. Beach Closings
8. **Degradation of Aesthetics**
9. Loss of Fish and Wildlife Habitat

# Eutrophication & Undesirable Algae

- Eutrophication refers to the nutrient enrichment of a water body, high levels of nutrients can lead to algal blooms [3]

[3] Particularly elevated levels of phosphorus and nitrogen (Smith & Smith 2006)

# Degradation of Aesthetics

- Aesthetics involves the visual appearance of the river ecosystem [4]

[4] Identified due to oil slicks, grease, floating scums, oily fibrous material and woody debris (RAP 1992)

# Project Purpose

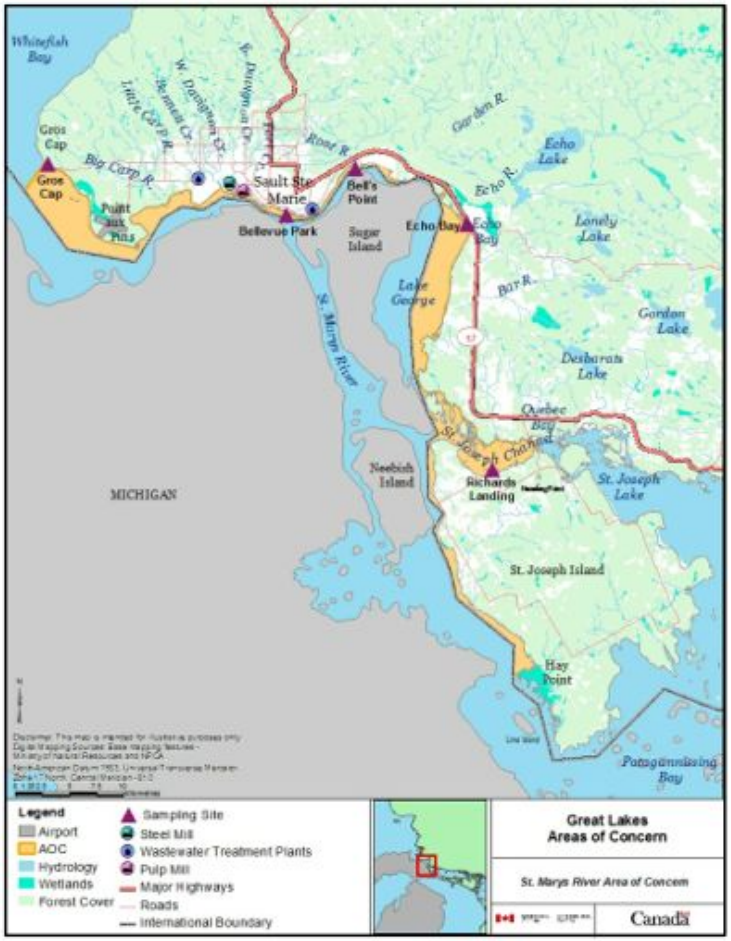
- To provide water quality monitoring data to allow for a reassessment of the beneficial uses of interest [5]

[5] Eutrophication and Undesirable Algae, Degradation of Aesthetics

# Methods

# Monitoring Sites

1. Gros Cap (GCL)
2. Bellevue Park (TSI)
3. Bell's Point (BPC)
4. Echo Bay (EBB)
5. Richards Landing (RLP)



# Workplan

- Monitoring 2013 to 2015
- Collecting field data and water samples at 5 sites

# Site Characteristics

- Date and time
- Air temperature
- Weather
- Substrate type
- Waterfowl
- Human activities
- Photographs
- GPS coordinates

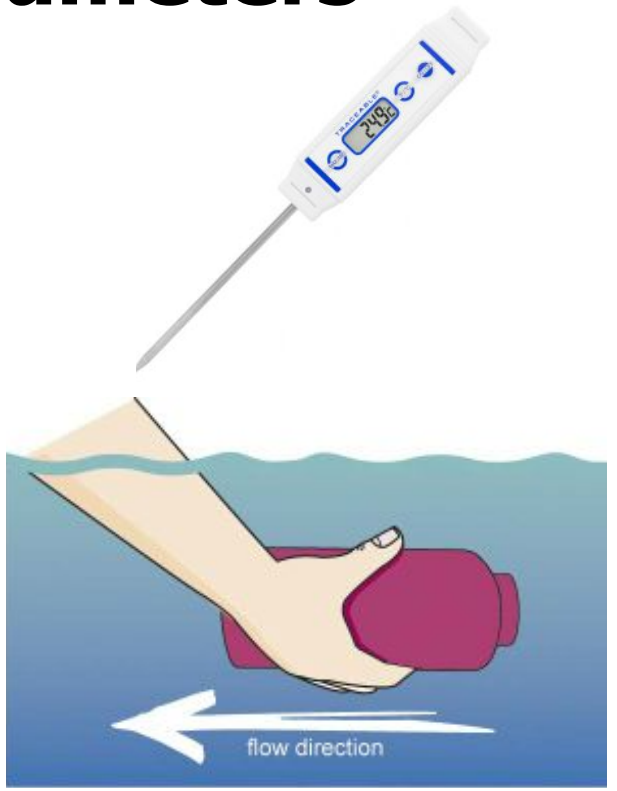


# Aesthetic Parameters

- Water clarity
- Water colour
- Water odour
- Algae
- Debris

# Physical & Chemical Parameters

- Water temperature
- Water pH
- Total suspended solids
- Turbidity
- Chlorophyll a
- Dissolved oxygen
- Nutrients [6]


[6] Total Phosphorus, Dissolved Organic Carbon, Total Nitrogen (Ammonia, Nitrite, Nitrate, Organic Nitrogen)

# Quality Control & Data Analysis

- Sampling protocols
- Field replicates
- Lab duplicates
- Basic statistics
- Analysis of variance

# Results & Discussion

# Site Characteristics

- **May to October 2014**
  - 10 am to 5 pm
- **Air temperature**
  - 7.5 to 25.8 °C
- **Weather**
  - Sun, wind, rain, fog
  - Rain events and post rain days

# Site Characteristics

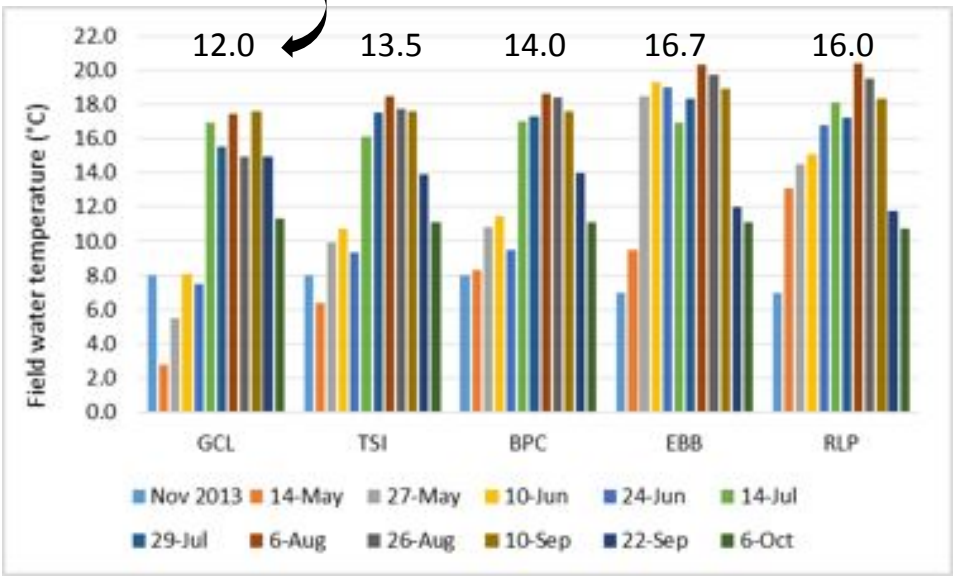
- **Substrate type**
  - Rocks, cobbles, gravel, sand
- **Waterfowl**
  - Geese, gulls, loons, ducks, cormorants, tracks, scat
- **Human uses**
  - Camping, dog-walking, fishing, swimming, hiking, sight-seeing
  - Garbage left behind

# Site Characteristics

- **Photographs**
  - Upstream, downstream, shoreline, water, bottles
- **GPS coordinates**
  - Varied slightly with changing water levels

# Aesthetic, Physical & Chemical Parameters

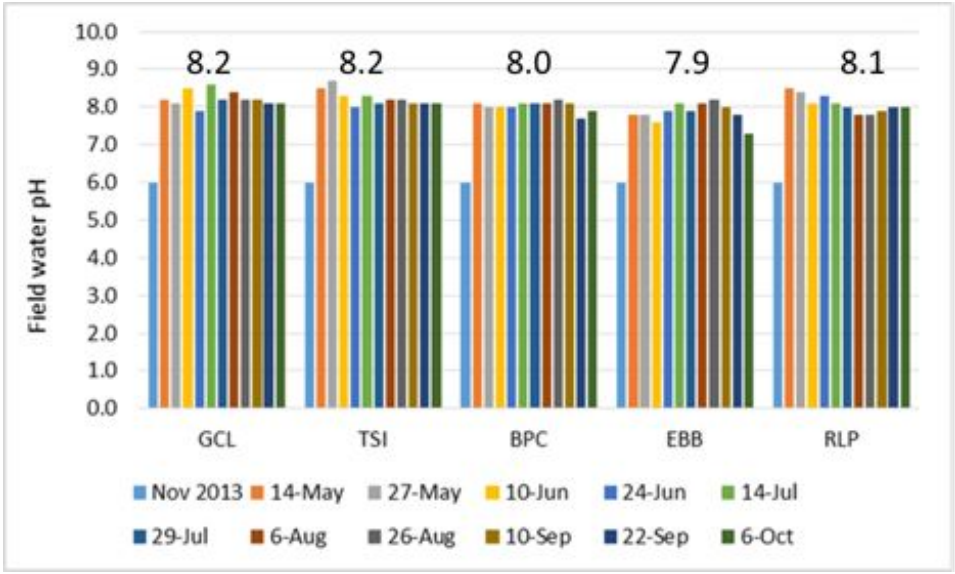
- **Water temperature**
  - 2.8 to 20.4 °C
  - Varied with air temperature
  - Published: 0 to 22 °C [7]




[7] St. Marys River Stage 1 Remedial Action Plan (1992)

# Aesthetic, Physical & Chemical Parameters

- **Water pH**
  - 7.3 to 8.7
  - May 27 TSI: human activity
  - Standard: 6.5 to 8.5 [8]




[8] Provincial Water Quality Objectives (MOE 1999)

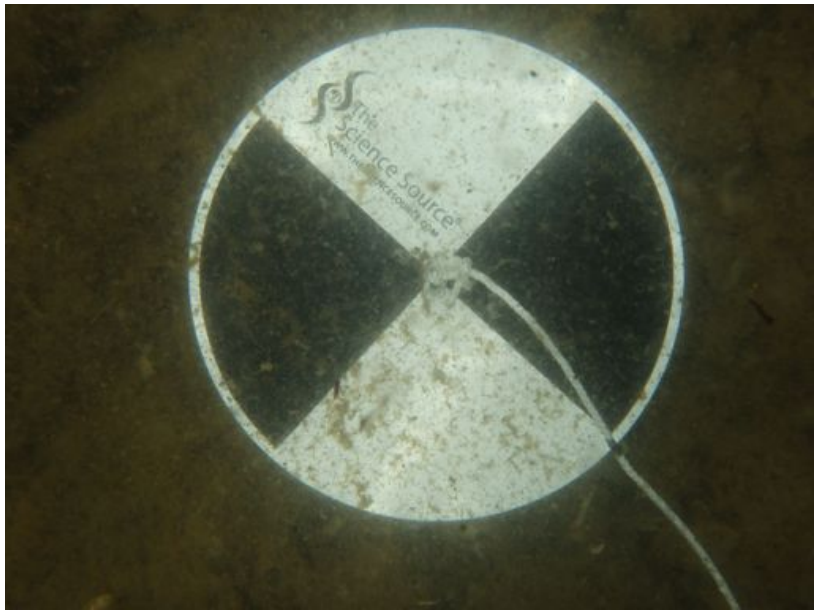
# Aesthetic, Physical & Chemical Parameters

- **Water clarity**
  - "Clear" at Gros Cap, Bellevue Park, Bell's Point
  - "Slight" to "moderate" turbidity Echo Bay and Richards Landing
  - Clarity: substrate, weather, water velocity, vegetation [9]
  - Standard: free of "unnatural" turbidity [10]

[9] CWQG: Total Particulate Matter (CCME 2002), [10] St. Marys River Stage 2 RAP Implementation Annex (2015)

# Aesthetic, Physical & Chemical Parameters

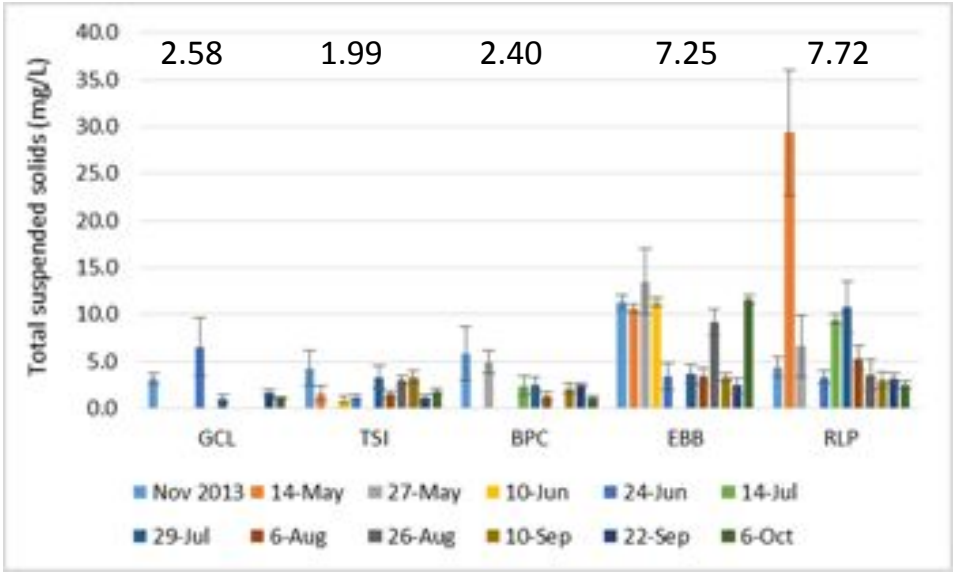
- **Water clarity**
  - Secchi depth maximum at all sites except Echo Bay (4/11)
  - Turbidity tube maximum except Gros Cap (1/11), Richards Landing (2/11), Echo Bay (4/11)
  - Clarity: substrate, weather, water velocity, vegetation [9]
  - Standard: natural Secchi disc reading should not change >10% [11]




[9] CWQG: Total Particulate Matter (CCME 2002), [11] Provincial Water Quality Objectives (MOE 1999)

# Aesthetic, Physical & Chemical Parameters

- **Total suspended solids**
  - 0.93 to 29.33 mg/L*
  - May 14 RLP: wind, waves, previous rain, last stop
  - Standard: "clear"<20 mg/L [12]

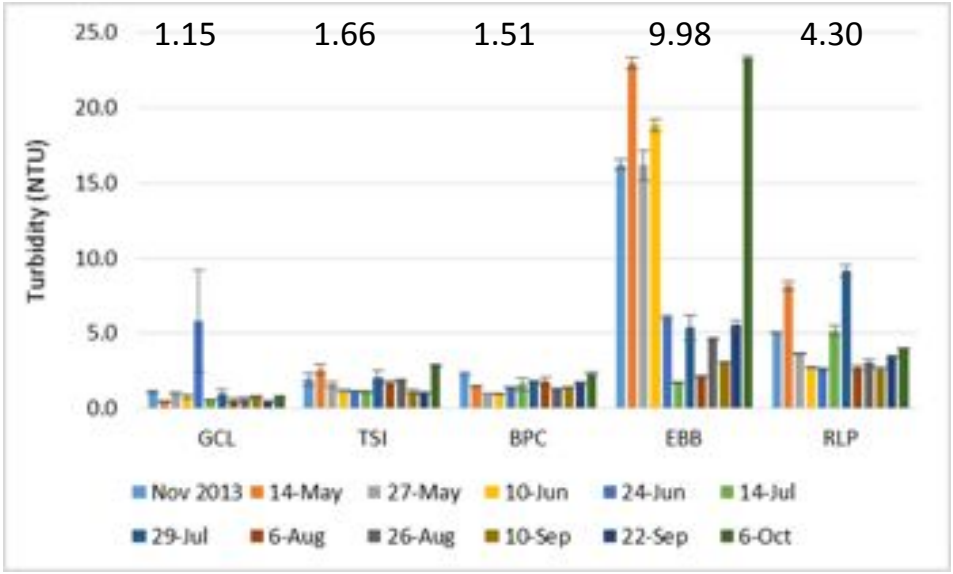



Bars represent average values for 3 replicates (n=3)
Error bars represent +/- standard error

* Average values for 3 replicates, [12] State of Michigan (2013)

# Aesthetic, Physical & Chemical Parameters

- **Turbidity**
  - 0.43 to 23.27 NTU
  - > 20 EBB: wind and wave action
  - Standard: normal range 0 to 20 NTU [13]




[13] Canadian Water Quality Guidelines for the Protection of Aquatic Life: Total Particulate Matter (CCME 2002)

# Aesthetic, Physical & Chemical Parameters

- **Water colour**
  - "Clear" at Gros Cap, Bellevue Park, Bell's Point
  - Light "yellow" to "brown" Echo Bay and Richards Landing
  - Colour: minerals, plant debris, plankton, sediments [14]
  - Standard: free of "unnatural" colour [15]

[14] CWQG: Colour (CCME 2001), [15] St. Marys River Stage 2 Remedial Action Plan Implementation Annex (2015)

# Aesthetic, Physical & Chemical Parameters

- **Water odour**
  - None
  - Standard: free of "unnatural" odour [16]

[16] St. Marys River Stage 2 Remedial Action Plan Implementation Annex (2015)

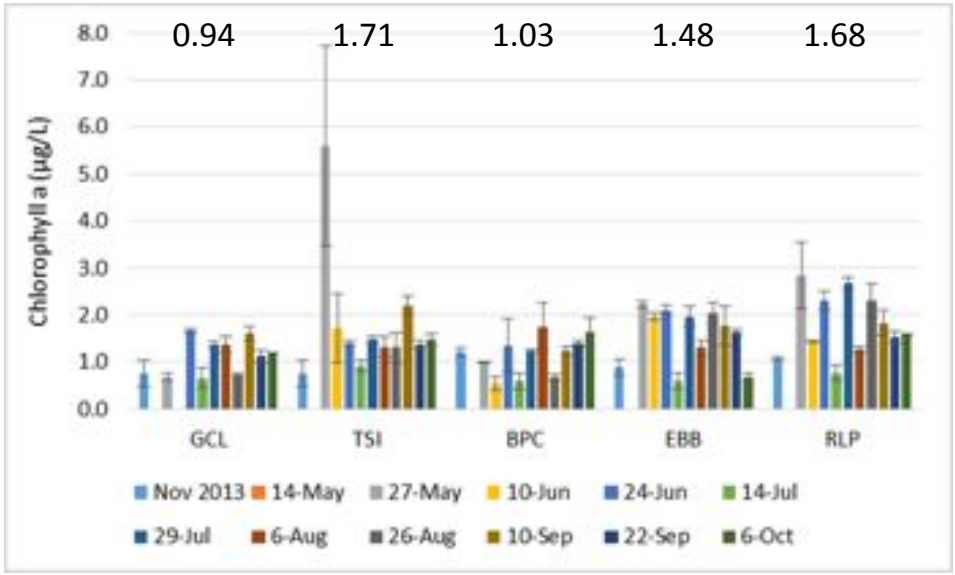
# Aesthetic, Physical & Chemical Parameters

- **Algae**
  - Rocks, floating, on substrate
  - No blooms or mats
  - Standard: free of "large algal blooms" [17]

[17] St. Marys River Stage 2 Remedial Action Plan Implementation Annex (2015)

# Aesthetic, Physical & Chemical Parameters

- **Chlorophyll a**
  - 0.58 to 5.60 µg/L
  - Related to observations of algae or turbidity
  - May 27 TSI: disturbance
  - Standard: < 10 µg/L [18]




[18] St. Marys River Stage 2 Remedial Action Plan (2002)

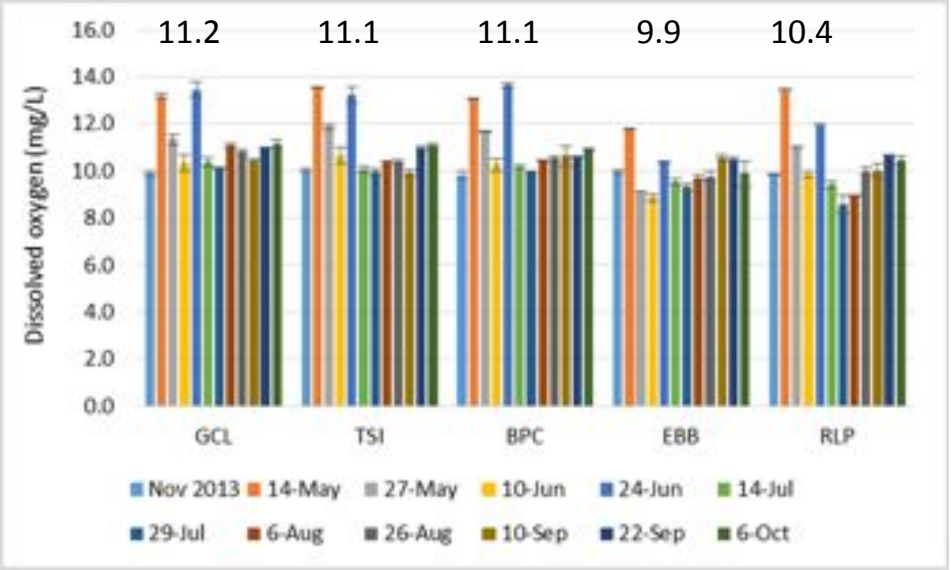
# Aesthetic, Physical & Chemical Parameters

- **Debris**
  - Leaves, sticks, plants, all natural debris
  - Standard: no oil or grease [19]
  - Standard: no "objectionable deposits" [20]

[19] Provincial Water Quality Objectives (MOE 1999), [20] St. Marys River Stage 2 RAP Implementation Annex (2015)

# Aesthetic, Physical & Chemical Parameters

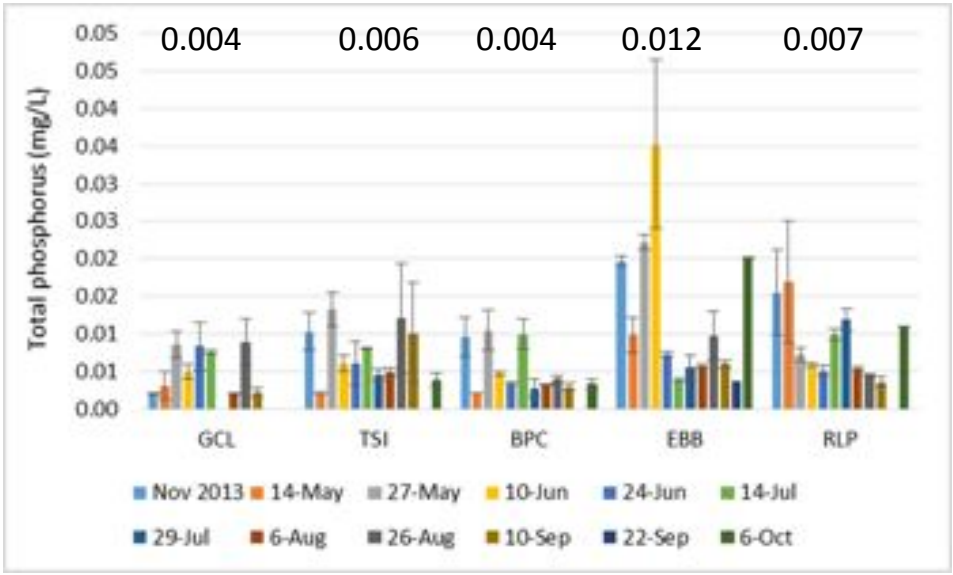
- **Dissolved oxygen**
  - 8.58 to 13.62 mg/L
  - Standard: > 8 mg/L [21]
  - Standard: free of "oxygen stress" [22]




[21] Provincial Water Quality Objectives (MOE 1999), [22] St. Marys River Stage 2 RAP Implementation Annex (2015)

# Aesthetic, Physical & Chemical Parameters

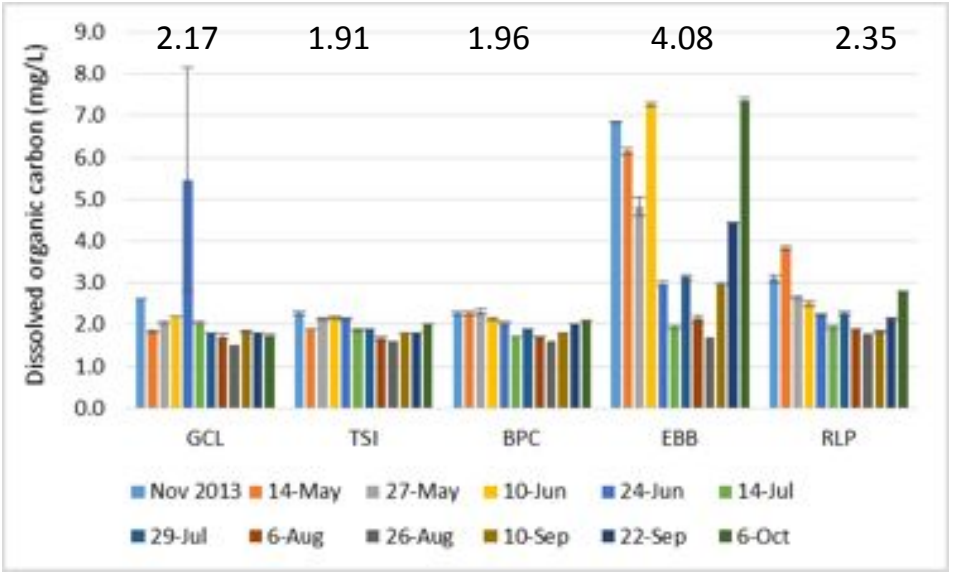
- **Total phosphorus**
  - 0.002 to 0.035 mg/L
  - June 10 EBB: recreation, fertilizers
  - Standard: < 0.03 mg/L [23]




[23] Provincial Water Quality Objectives (MOE 1999)

# Aesthetic, Physical & Chemical Parameters

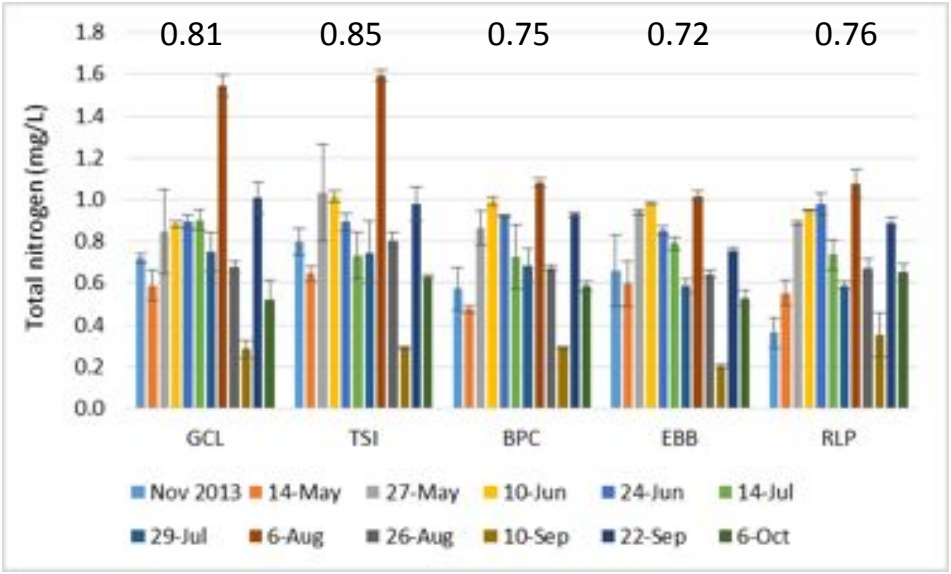
- **Dissolved organic carbon**
  - 1.50 to 7.27 mg/L
  - June 24 GLC: rain runoff
  - EBB: plankton, plants, runoff
  - Standard: normal < 5 mg/L [23]




[23] Government of British Columbia Ambient Water Quality Guidelines for Organic Carbon (2015)

# Aesthetic, Physical & Chemical Parameters

- **Total nitrogen**
  - 0.52 to 1.59 mg/L
  - Main type: organic nitrogen
  - Source: recreational activities
  - Standard: < 1.5 mg/L [24]




[24] CWQG: Nitrate Ion (CCME 2012), 0-1.5 mg/L total nitrogen in oligotrophic to mesotrophic streams

# Conclusion

# Eutrophication & Undesirable Algae

- There were no large algal blooms, low oxygen levels or elevated levels of nutrients indicative of eutrophic conditions

# Degradation of Aesthetics

- There was no evidence of oil, grease, objectionable deposits, unnatural colour, unnatural turbidity or unnatural odour

# Future Work

- Interim report 2014
- Field work 2015
- Final report 2016

# Questions

- Thank you for your support, please ask questions!

# References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