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

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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

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 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 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 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

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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
  • Standard: free of “unnatural” turbidity

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
  • 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

![Bar chart](image)

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  
  - **Standard**: free of “unnatural“ colour

Aesthetic, Physical & Chemical Parameters

- **Water odour**
  - None
  - **Standard:** free of “unnatural“ odour

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Aesthetic, Physical & Chemical Parameters

• Algae
  • Rocks, floating, on substrate
  • No blooms or mats
  • Standard: free of “large algal blooms”

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 \(^{18}\)

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

Aesthetic, Physical & Chemical Parameters

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

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

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 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