CCME
Canadian Council of Ministers of the Environment
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Application and Testing of the Water Quality Index in Atlantic Canada

Report Summary

Acknowledgements
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Preface
This report provides a summary of the report *"Application and testing of the CCME Water Quality Index in selected water bodies in Atlantic Canada"* (Environment Canada *et al.*, 2004). Details on the methodology and data sources are available in an accompanying document (Environment Canada 2004a). A second accompanying document (Environment Canada 2004b) offer practitioners a discussion on the experience of testing and applying the index in the Atlantic Region.

Introduction
Reporting water quality monitoring results in a clear, meaningful way has always presented scientists with a challenge. Traditional reports have tended to be technical and detailed, presenting monitoring data on individual substances, without providing an integrated and interpreted picture of water quality. This project provides a contribution to state of the environment reporting on water quality by communicating the results of testing and applying the CCME Water Quality Index (WQI) for a selection of water bodies in the Atlantic Provinces. It is part of a continuing and coordinated effort among jurisdictions to deliver timely and easy-to-understand water quality indicators and information to senior resource managers and the general public — in short, those who do not have the time or the expertise needed to delve into detailed technical documents.

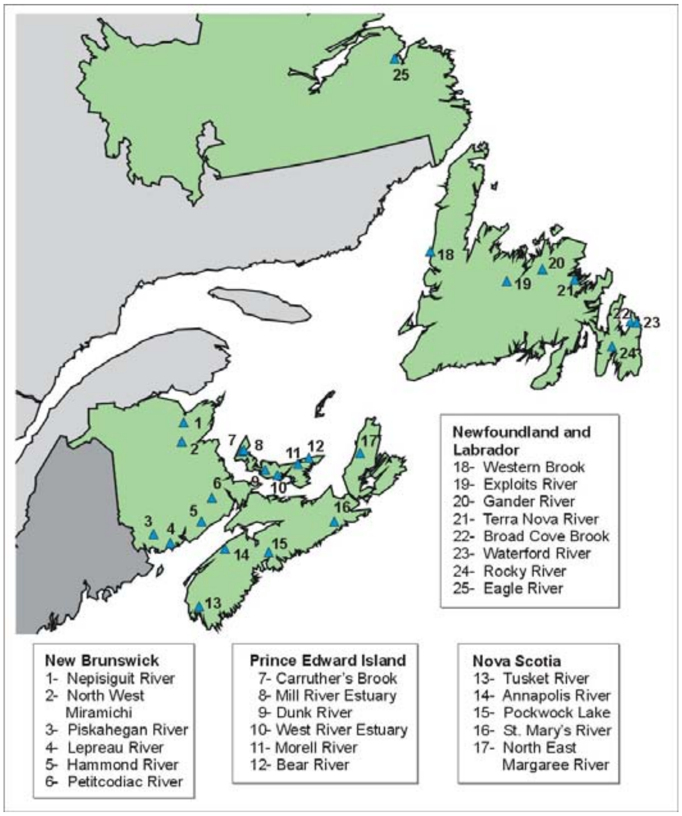
Since the early 1990s, efforts to communicate water quality information using the CCME WQI (or similar indices) continue to be undertaken in many other jurisdictions in Canada. This combined body of work is supporting a broader effort to produce a national indicator of freshwater quality, as recommended by the National Round Table on the Environment and the Economy (NRTEE 2003). The proposed indicator is part of a small recommended set of Environment and Sustainable Development Indicators intended to supplement the traditional macro-economic indicators, such as the gross national product, to take into account the assets that are necessary to sustain a healthy economy, society, and environment for Canadians. Underpinning these initiatives, Environment Canada is leading efforts toward linking water quality monitoring databases across Canada and developing tools to facilitate the calculation of the CCME WQI, and the timely delivery of information.

This project is a first comprehensive attempt to apply the CCME WQI in all four Atlantic Provinces using federal and provincial data sources. It can, therefore, be considered a pilot test of the index reflecting our current state of information and knowledge. This summary presents an overview of methodology used, index ratings for selected water bodies in each province, an assessment of the applications, and the information and data gaps that, when filled, will improve the application of the index for future reporting.

Methodology

For this study, 25 water bodies from the four Atlantic Provinces were selected (20 rivers, 2 streams, 2 estuaries, and 1 lake — see Figure 1). The selection was designed to examine the range of conditions found in the Atlantic Provinces, including pristine water bodies, those affected by various human activities (e.g., agriculture, urban development, forestry, and industry), and those having typical features for the region (e.g., highly coloured), all within the limits of the data available. Nevertheless, the selected water bodies are not necessarily considered to be representative of all water bodies in Atlantic Canada.

Figure 1. Location of water quality sampling stations



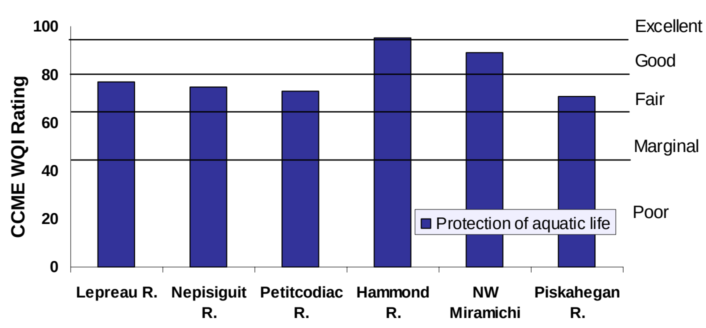
The applications are based on the most commonly measured substances in the water for which guidelines or objectives have been developed and may not incorporate all threats to water quality, especially the substances which are very difficult to measure in water and occur unpredictably (e.g., pesticides). Water quality for the various beneficial uses was evaluated according to provincial water quality guidelines. Where these were not available, the national CCME guidelines have been used. In a few cases, site-specific water quality objectives had been developed and were applied to the index calculation. At a minimum, water quality was assessed for the protection of aquatic life use in all provinces.

The specific set of variables, time periods for which the index was applied, beneficial water uses assessed, and guidelines selected vary from one province to another. **Hence, comparisons among jurisdictions cannot truly be made given these differences, nor was this the objective of the study.**

Application of the WQI in New Brunswick

Based on the index, water quality of the rivers was rated between fair and excellent for the protection of aquatic life. Aluminum and iron commonly exceed the CCME guidelines in New Brunswick surface water, while pH occasionally exceeds the recommended range outlined in the CCME guidelines. Additionally, copper and zinc, and arsenic and zinc exceed the CCME guidelines in the Nepisiguit and Piskahegan Rivers, respectively. Total phosphorus was found to exceed the New Brunswick recommended guideline in only the Petitcodiac River. *Note*: iron, copper, and aluminum CCME guidelines are exceeded consistently throughout Atlantic Canada.

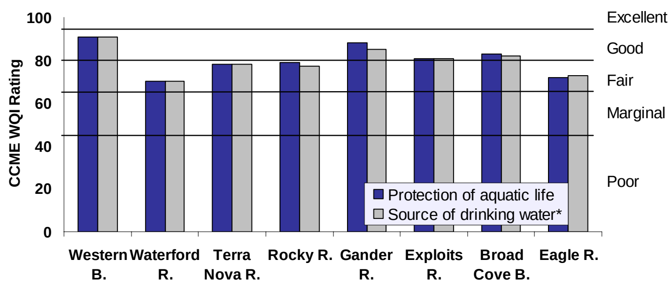
Figure 2: CCME WQI ratings in New Brunswick, 1998–2002



Application of the WQI in Newfoundland and Labrador

Based on the index, the water quality of the selected rivers was rated as fair or good in equal proportions for both the protection of aquatic life and as a source of raw drinking water (see Figure 3). The Waterford River, which runs through the St. John's area and is subject to urban, industrial, and agricultural pollutants, received the lowest WQI scores, while Western Brook, which is located entirely within Gros Morne National Park, had the highest WQI scores among selected Newfoundland and Labrador rivers. Lead, cadmium, arsenic, and other toxic metals were generally not found to be a problem in surface waters, except possibly in the Exploits River. On the other hand, aluminum, iron, and sometimes copper were found at concentrations that exceed CCME guidelines; however, they are believed to be mostly of natural origins and, as such, likely do not pose a threat to aquatic life. Aluminum, iron, manganese, turbidity, pH and colour sometimes exceed drinking water guidelines but are not considered to pose a health risk at present concentrations – generally only reducing the aesthetic appeal of water. Additionally, nutrient loadings and soil erosion do not seem to be a problem except in localized areas.

Figure 3: CCME WQI ratings in Newfoundland and Labrador, 1995–1998

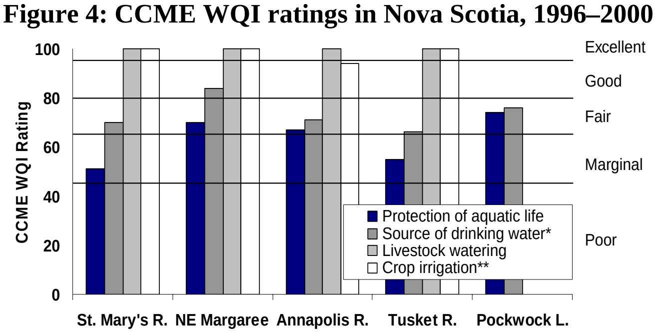


Notes: * Refers to untreated water only and does not include bacteriological measurements. However, disinfection is always required. At present, none of the water bodies is being used as a source of drinking water, except for Gander Lake, which flows into the Gander River.

Application of the WQI in Nova Scotia

Based on the index, the water quality of selected water bodies was rated as fair overall for the protection of aquatic life and source of drinking water (before treatment), mostly because aluminum, iron, and copper are found at concentrations that often exceed CCME guidelines, as they tend to do throughout Atlantic Canada. The pH of many water bodies frequently fails to meet the CCME guideline of 6.5 for the protection of aquatic life. In the majority of cases (St. Mary's River, Northeast Margaree River, Tusket River, and Pockwock Lake), the elevated concentrations of selected metals and the lower pH levels, which are reflected in lower water quality index values, appear to result from normal background levels associated with wetlands, naturally occurring organic acids and geological sources. The water quality for purposes of crop irrigation and livestock watering is generally rated as excellent in the selected water bodies.

Figure 4: CCME WQI ratings in Nova Scotia, 1996–2000 for rivers, 1999–2001 for Pockwock Lake



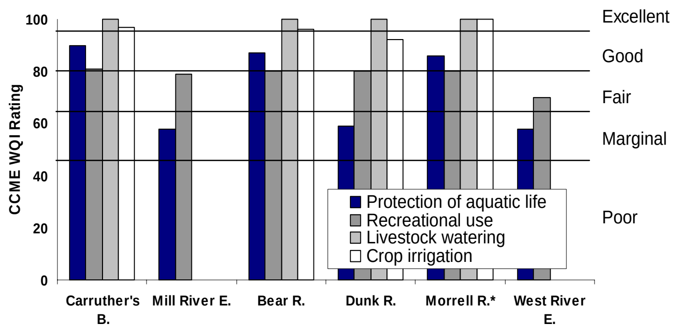
Notes: * The source of drinking water index is for untreated water only and does not include bacteriological measurements; disinfection is always required. ** The crop irrigation index does not include bacteriological measurements.

With the exception of Pockwock Lake, none of the selected water bodies is currently used as a source of drinking water. Nevertheless, the index for source of drinking water has been calculated as part of this pilot test of the WQI on the grounds that there is a reasonable expectation that water could be withdrawn for drinking water use in the future, at or downstream from these river locations.

Application of the WQI in Prince Edward Island

Except for the Dunk River, the water quality of the selected streams for the protection of aquatic life is rated as good overall, while that of the estuaries was rated as marginal for protection of aquatic life. Lead, cadmium, arsenic, and other toxic metals are not thought to be a problem in Prince Edward Island surface waters since the human activities that are known to release these metals are not present on the Island. Therefore, these are no longer regularly monitored and are not used in the index. However, the excessive amounts of nutrients (nitrogen and phosphorus) being carried to streams and the ensuing eutrophication of receiving estuaries can cause problems for aquatic life (Department of Fisheries and Oceans 2000). High levels of suspended solids, which are an indicator of soil erosion, are also problematic, but not yet well reflected in the index. Similarly, phosphorus, which is highly attached to suspended solids, suffers a similar problem for accurate measurement.

Figure 5: CCME WQI ratings for Prince Edward Island, 1995–1998



Based on the index, water quality for recreational use was rated as good in the selected streams and as fair in the selected estuaries. Water quality was rated as good or excellent for crop irrigation and excellent for livestock watering in the four selected rivers. Water quality for drinking water was not measured since groundwater, rather than surface water, is the source of drinking water in the Province.

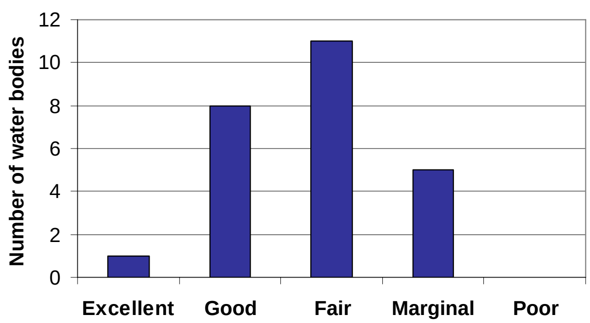
Notes: * Based on data up to 1995; monitoring for this site resumed in 2001.

Fecal coliforms are often found in Prince Edward Island surface waters at concentrations exceeding the guidelines. While this is not a first order health problem, since surface waters are not used as drinking water on Prince Edward Island, it is nonetheless a concern for recreation and harvesting of shellfish.

Overall results and conclusion

Based on the selected sites in Atlantic Canada, water quality tends to be rated as good or fair for protection of aquatic life. Specifically, water quality was rated as excellent in 1 water body, good in 8 water bodies, fair in 11 water bodies, and marginal in 5 water bodies. None of the selected water bodies received a poor rating.

Figure 6: WQI ratings for the protection of aquatic life for all selected water bodies



In some water bodies, lower scores (i.e., fair and marginal) are indicative of human impacts and a need for conservation or remediation measures, while in others, lower scores reflect waters with high levels of some naturally occurring substances (e.g., coloured waters with low pH and high levels of metals). The latter situation points to a need for research in determining: (1) whether current levels of these substances are indeed considered to be having a negative impact, and if not, whether they should be included in the index; and (2) whether the resulting conditions are natural or rather reflect a wider environmental issue, such as acid rain or climate change.

In these situations, development of site-specific objectives is usually warranted because national guidelines (i.e. CCME) tend to be conservative to ensure protection of aquatic life. Site-specific objectives are used in the same way as numeric guidelines, but are derived for individual watersheds or ecosystem types, which take into account natural background conditions and management targets (i.e., remediate to a desired state or prevent current conditions from deteriorating). In this regard, the index becomes a more effective tool for communicating whether water quality has achieved a desired state or departs from natural conditions, rather than a tool to indicate the general state of water quality.

Work remains to fill information and knowledge gaps in order to improve application of the index. In general, most CCME water quality guidelines are suitable for use in the Atlantic region. However, some of the guidelines, including aluminum, copper, iron, and pH, tend to be lower than the natural background levels found in many streams and lakes. In these cases, it should be determined whether the development of site-specific objectives is needed. In addition, some variables, such as turbidity, suspended solids, and phosphorus, do not have CCME water quality guideline numbers, but instead have guidance frameworks, and will require some work to derive.

On the whole, current monitoring programs are generally sufficient to support the minimal requirements of applying the index. Some data gaps do exist and, in some cases, known or suspected sources of pollution have been difficult to include in the index (e.g., pesticides). Ideally, ambient monitoring systems, which provide the foundation for supporting the use of the index, should be designed with the necessary reporting requirement in mind — as opposed to trying to fit reporting activities to existing data collection. This is very challenging and should be done according to the needs and objectives of each jurisdiction.

In addition, the index provides an indication of stress on an ecosystem, not a direct measure of impacts on aquatic life through bioaccumulation and other processes. Thus, complementary tools, such as benthic invertebrate monitoring or sediment toxicology tests, could be used to validate the index results.

In spite of some limitations in applying and interpreting the index, it is concluded on the basis of this pilot study in Atlantic Canada that it is preferable to report to policy-makers, water managers, and the interested public using the index to provide a more general overview of the state of water quality, and be open about our knowledge and information gaps, than to not use the index. The alternative would be to present detailed water chemistry data, with all of the communication challenges that this would involve. As a testament to this conclusion, it is noted that the CCME WQI has been applied or is being considered for use in most other provincial/territorial jurisdictions in Canada.

The next steps needed to improving the application and interpretation of the water quality index, both in Atlantic Canada and throughout Canada as a whole, are:

1. the consideration of the range of purposes for which the WQI is used, with regard to (1) simply communicating about water quality as it is found, based primarily on toxicological information, whether affected by human activities or natural features (e.g., wetlands), or (2) as a management tool to communicate the impact of human stressors on water quality uses and objectives, and measure progress towards the mitigation of these stressors;
2. the continuation of federal–provincial partnerships to improve the delivery of water quality information (linking databases, internet tools);
3. the development of site-specific objectives for water bodies, as required;
4. the use of a wide range of carefully selected water quality variables or parameters, which reflect all of the relevant natural and human stressors, such as acidification, siltation, and eutrophication, in the derivation of the WQI; and
5. the evaluation of water monitoring activities to determine if they adequately support the requirements of the index, and will provide the necessary consistency over the longer term to provide a more complete and accurate picture of water quality in the region.

Improvements in the measurement, calculation, and consistency of reporting of the WQI for ambient water quality will contribute towards increased awareness and knowledge of water quality issues by the public, and a more integrated management of water resources.

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