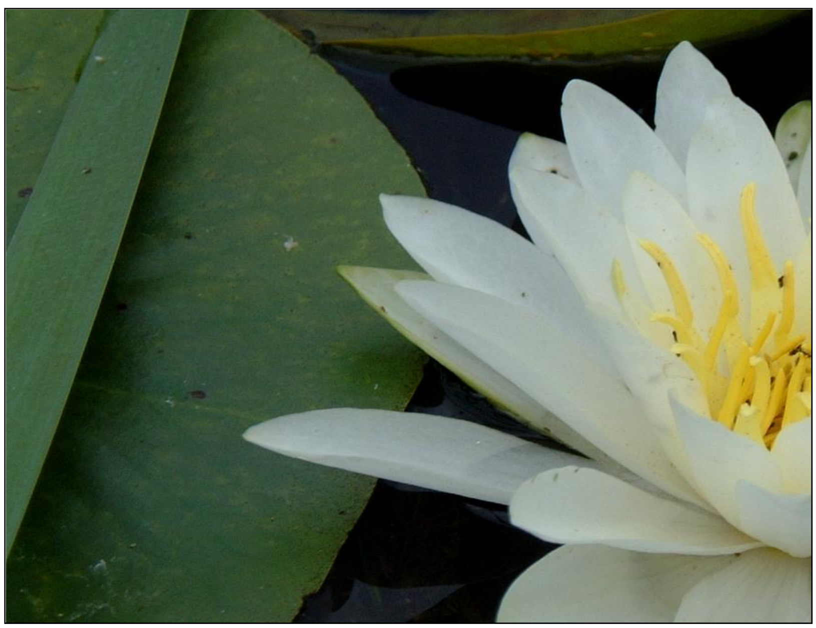
# Durham Region Coastal Wetland Monitoring Project:
# 6-Year Technical Report

## Module 1 – Introduction and Assessment Methods



**December 2009**

Environment Canada
Canadian Wildlife Service

Environnement Canada
Service canadien de la faune

Central Lake Ontario Conservation

**Project support gratefully acknowledged from:**

DURHAM REGION

Environment Canada Environnement Canada

Central Lake Ontario Conservation

GANARASKA REGION CONSERVATION AUTHORITY

ONTARIO POWER GENERATION
Darlington Nuclear

TORONTO AND REGION Conservation for The Living City

# PREFACE

The Durham Region Coastal Wetland Monitoring Project: 6-Year Technical Report is published in four modules. Each module may be read independently, however in successive order they constitute a complete document delivering a technical explanation of wetland condition and statistical analysis of results. This segment, Module 1, contains the executive summary, introduction and description of the assessment methods. The scope of the project is examined along with a complete description of the study sites. Wetland assessment methods are described and focus on the use of Indices of Biological Integrity (IBIs). Module 2 includes the geophysical condition of Durham Region coastal wetlands. It describes the water and sediment quality, water levels and changes in adjacent land cover. The condition of biological communities, including macroinvertebrates, amphibians, birds, fish, and submerged aquatic vegetation is presented in Module 3. A summary of wetland status is presented in Module 4 where the components of the preceding modules are compiled offering a detailed description of changes and trends in overall condition of each Durham Region coastal wetland over the study period.

This report describes the Durham Region Coastal Wetland Monitoring Project (DRCWMP) in considerable detail and is intended for a technical audience who are interested in using this information to inform their own monitoring projects or to gain specific information about the wetlands included in this report.

# EXECUTIVE SUMMARY

The primary goal of the Durham Region Coastal Wetland Monitoring Project (DRCWMP) is to implement a long-term monitoring program that enables reporting on the condition of coastal wetlands in this Region. The project framework and methodologies have evolved since its initiation in 1999. A Monitoring Committee, consisting of stakeholders from various governmental and non-governmental organizations, developed a set of specific protocols for a monitoring program and released them as the Methodology Handbook in 2002. Subsequent evaluations of these methodologies have resulted in their refinement and are most recently published in this report together with the 2007 Methodology Handbook, (EC and CLOCA 2007).

Fifteen Durham Region coastal wetlands that vary in size, level of disturbance, and hydrogeomorphic features were monitored through this project. In 2007 however, three additional coastal wetlands received Provincially Significant Wetland status after evaluation by the Ontario Ministry of Natural Resources and were therefore incorporated in the monitoring protocol that year. Plant, fish, aquatic macroinvertebrate, bird, and amphibian community health are the focus of the biological condition assessment, while abiotic wetland and watershed variables are examined to assess the geophysical condition.

The wetland and watershed attributes being monitored were identified by drawing largely on coastal wetland indicator development from the State of the Lakes Ecosystem Conferences (SOLEC) and Bird Studies Canada's Marsh Monitoring Program. The biennial SOLEC conferences focus on progress being made towards the goals of the Great Lakes Water Quality Agreement, which are to restore and maintain the chemical, physical and biological integrity of the Great Lakes basin ecosystem.

The Great Lakes Coastal Wetlands Consortium (GLCWC) was a project under the leadership of the Great Lakes Commission, arising from the SOLEC process. Its focus was to develop and implement a monitoring plan for coastal wetlands at the Great Lakes basin-wide level which was completed and published in 2008. Over the past several years, the DRCWMP has collaborated with the GLCWC Implementation Plan to ensure consistency in reporting. This has allowed the DRCWMP to compare results within Durham Region coastal wetlands to other wetlands in the Great Lakes basin.

This technical report evaluates data collected between 2002 and 2007 and uses a multi-metric approach for simplifying comparisons among biotic communities, and across years of the study. Metrics are biological attributes that are known to respond in specific and predictable ways to changes in wetland condition. Individual metrics can then be combined to create an Index of Biotic Integrity (IBI) for biological monitoring. Additional data from other coastal wetlands within Lake Ontario were used to provide a lake-wide context for comparison and to support broader conclusions.

Measures of wetland disturbance are estimated primarily by using geophysical data collected through this project as human-induced wetland disturbance can affect biotic communities. Wetland disturbance has been assessed using a multivariate statistical

approach. It was found that, overall, Durham Region coastal wetlands experience high levels of disturbance compared to other Lake Ontario coastal wetlands.

The intensity of disturbance in Durham Region sites has affected the condition of the biotic communities. Submerged aquatic vegetation communities remained in poor condition over the period of study and generally had low richness and abundance of turbidity intolerant species. Overall, macroinvertebrate communities were in fair condition, with a significant decline present only in Port Newcastle Marsh. The amphibian communities were also in fair condition, with no significant trends over the study period. The majority of Durham Region wetlands have breeding bird and fish IBI scores in the fair and good categories. However, with regards to the fish community, IBIs were approximately half of the calculated average for that of other Lake Ontario wetlands.

Between 2002 and 2007, the state of water quality within Durham Region coastal wetlands has deteriorated from moderately degraded to very degraded. Although some sites have shown improvements (e.g. Duffins Creek Marsh and Oshawa Second Marsh), the overall decline in condition is in contrast to other Lake Ontario wetlands, which displayed significant improvements in water quality over the same time frame.

The integrity of both water quality and submerged aquatic vegetative community diversity within Great Lakes wetland watersheds are negatively impacted by the adjacent land use. Most Durham Region coastal wetlands are primarily surrounded by human development. Several wetlands were found to have watersheds comprised of less than 5% forest cover, and in many watersheds, the amount of intensive land use has increased over the past several years.

The successive monitoring of coastal wetlands through the DRCWMP has provided insight into temporal trends in wetland condition. While recognizing there are limitations to reporting results through IBIs, it is clear the health of Durham Region coastal wetlands are adversely impacted by human development. Details of this Year 5 Technical Report offer valuable information for directing coastal wetland restoration and conservation projects in the Durham Region as well as providing a pundit source of methodologies for regionally-based monitoring in the Great Lakes.

# TABLE OF CONTENTS

# LIST OF FIGURES

# LIST OF TABLES

# ACKNOWLEDGEMENTS

Modules in this report were authored by Kimberly Hughes (on contract to Environment Canada – Ontario, Canadian Wildlife Service; EC-ON CWS) Satu Pernanen (Central Lake Ontario Conservation Authority; CLOCA) and Greg Grabas, Diana Macecek and Stephanie Maguire of EC-ON CWS.  Editorial assistance was provided by EC-ON CWS (Angela Darwin, Christian Friis, Greg Grabas, Krista Holmes, Nancy Patterson and Paul Watton), and CLOCA (led by Heather Brooks and Heather Pankhurst).

The authors recognize and thank the following project partner organizations for their role in data collection and compilation, data analysis, and reviewing.

Environment Canada – Ontario Region, Canadian Wildlife Service

Central Lake Ontario Conservation Authority

Toronto and Region Conservation Authority

Ganaraska Region Conservation Authority

Ontario Ministry of Natural Resources

Environment Canada - Ontario Region, Ecosystem Health Division

Marsh Monitoring Program Volunteers

Bird Studies Canada

Michigan State University

University of Toronto

Ontario Power Generation

Ontario Streams

Financial support from Environment Canada, Ontario Region – Canadian Wildlife Service, Environment Canada, Ontario Region – Great Lakes Sustainability Fund, Ontario Power Generation, and the Regional Municipality of Durham is gratefully acknowledged.

Cover Photos: Environment Canada – Ontario Region, Canadian Wildlife Service

# 1. INTRODUCTION

## 1.1 BACKGROUND AND DIRECTION

The Durham Region Coastal Wetland Monitoring Project (DRCWMP) has evolved from an initial concept and agreement in principle in 1999, to a detailed monitoring plan that was implemented in 2002. The first step in the process was the development of a project concept and background report on the coastal wetlands within the area of interest. Environment Canada and Central Lake Ontario Conservation Authority (2001; herein EC and CLOCA) compiled this information, as well as a summary of recent monitoring activities. The benefits of a coordinated monitoring approach are many, and include:

- Sharing of resources and costs;
- Ability to identify common trends across several watersheds;
- Implementation of a practical, standardized and scientifically-robust monitoring program;
- Data sharing among agencies to reduce duplication;
- Improved support to deliver a long-term monitoring project; and
- Assessment of coastal wetlands at a regional scale.

Building on this background report, Monitoring and Implementation Committees were established to oversee project development and delivery, respectively. The Monitoring Committee, made up of interested stakeholders, was charged with the development of specific project goals and objectives, and with recommending monitoring protocols to meet those objectives, which were compiled in April 2001 (Gartner Lee Limited 2001).

In March 2002, a monitoring methodology handbook was released to direct data collection efforts within the project (EC and CLOCA 2002a). The first year of data collection and compilation was 2002.

In June 2003, the Durham Region Coastal Wetland Monitoring Project: Interim Report (EC and CLOCA 2002b) outlined Year 1 findings based on preliminary data and analysis. The report also evaluated the data collection methodology and analysis. Methodologies were revised accordingly in spring 2003 and data collection resumed through the 2003 field season.

After two years of data collection, EC and CLOCA (2004a) released the Year 2 Technical Report, which documented the biological and geophysical state of Durham Region wetlands. To report on the condition of biological communities, EC and CLOCA (2004a) developed Indices of Biotic Integrity (IBIs; see Sections 1.3 and 1.4 in this document) from data collected across the Canadian side of Lake Ontario (Figure 1.5-2 in EC and CLOCA 2004a). This allowed reporting of DRCWMP sites in the context of Lake Ontario, rather than the Durham Region only. The report also examined the statistical properties of the IBIs (e.g., minimum detectable differences) and made recommendations on sample sizes for field surveying.

*Durham Region Coastal Wetlands: Baseline Conditions and Study Findings 2002 - 2003* (EC and CLOCA 2004b) was created as a companion product to the Year 2 Technical Report. It relayed key findings to non-scientific audiences (e.g., general public and municipal councilors) and served as an engagement tool for Great Lakes coastal wetland conservation.

EC and CLOCA's Year 3 Technical Report (2005) continued to document and update the status of the Region's coastal wetlands. It also addressed additional technical aspects of data quality raised in the Year 2 Technical Report, such as timing of sampling for water quality surveys, replicate sampling requirements for the invertebrate community, and repeatability of the submerged aquatic vegetation, aquatic macroinvertebrate, amphibian, and fish community IBI results.

Years 4, 5 and 6 were data collection and monitoring years. During this time, the coastal wetland monitoring framework developed through the DRCWMP was extended to Bay of Quinte Area of Concern. Here, the DRCWMP protocols were used to refine and report on delisting criteria (EC-CWS 2006, EC-CWS 2007). These reports present data for Durham Region coastal wetlands, but focus on Bay of Quinte coastal wetlands.

The current technical report represents the culmination of data available through six years of the DRCWMP with most data being from 2003-2007. The purpose of this report is to:

1) Detail the recent biological and geophysical state of Durham Region wetlands;
2) Identify and explain, where possible, temporal trends within Durham Region wetlands and at a regional scale; and
3) Provide overall wetland status reporting for each Durham Region coastal wetland.

The information gathered from this project provides valuable data that can be used to direct planning decisions and inform land acquisition, land conservation and restoration projects.

# 1.2 PROJECT FRAMEWORK

The primary goal of the Durham Region Coastal Wetland Monitoring Project is to implement a long-term monitoring program that enables reporting on the condition of coastal wetlands in the Region. Additionally, the information collected through the monitoring program will be used to assess the impacts of human activities on the condition of these wetlands and provide direction for actions. These goals were incorporated into a framework (Figure 1) that provides the basis for development of the Durham Region Coastal Wetland Monitoring Project.

Biological monitoring requires five types of information (Karr and Chu 1999):

1) present biological condition;
2) reference biological condition (i.e., no or minimal human disturbance);
3) present geophysical setting;
4) reference geophysical setting; and
5) anthropogenic activities likely to alter both the biological and geophysical conditions.

Managers, policy-makers and society-at-large can use this information to decide if current wetland condition is acceptable, to set biological goals for the wetland, and to assist in the development of conservation activities.

While the Implementation Committee has been responsible for defining the project direction, identifying resourcing requirements and publicizing the project, the Monitoring Committee has identified and set priorities for specific wetland attributes of importance to stakeholders (Gartner Lee Limited 2001). These attributes were identified by drawing largely on coastal wetland indicators, as identified in the State of the Lakes Ecosystem Conferences (SOLEC) (Bertram and Stadler-Salt 2000) and Bird Studies Canada's Marsh Monitoring Program (Weeber and Vallianatos 2000). The biennial SOLEC conferences report on progress towards the goals of the Great Lakes Water Quality Agreement, which are to restore and maintain the chemical, physical, and biological integrity of the Great Lakes ecosystem (www.on.ec.gc.ca/solec).

The Great Lakes Coastal Wetlands Consortium (GLCWC) project under the leadership of the Great Lakes Commission (GLC) also has direct relevance to the DRCWMP. This bi-national, multi-partnered initiative arose from the SOLEC process and was focused on developing an implementation plan and monitoring framework for coastal wetlands at the Great Lakes basin-wide level (www.glc.org/monitoring). In contrast, the DRCWMP developed a monitoring framework for coastal wetlands at the regional-level. The coincident launch of these two projects (c. 2001) was intentional. While the GLCWC generally focused on basin-wide protocols and indicator development, the DRCWMP had obligations to focus on regional implementation and reporting in addition to protocol and indicator development. The idea was that a regional implementation framework could be extended in chunks across the Great Lakes – the result being a basin-wide monitoring network using comparable data collection, analysis, and reporting methods.

The result was a synergy between the GLCWC and the DRCWMP based on reciprocal contributions. For example, the DRCWMP-developed aquatic macroinvertebrate data treatment and reporting methods were determined to be more applicable to Lake Ontario coastal wetlands than the GLCWC methods. As a result, these methods were recommended by the GLCWC for Lake Ontario coastal wetlands. On the other hand, the

DRCWMP has relied on the GLCWC to refine the bird and amphibian data treatment and reporting methods. The DRCWMP has adopted these methods (see Module 3, Section 4.2.2 and Section 4.2.3 for birds and amphibians, respectively).

As the DRCWMP emerges from its infancy to continue collecting and reporting data and making conservation recommendations, the GLCWC final report and Implementation Plan was completed in January 2008 (Burton et al. 2008).

The DRCWMP will continue to collaborate and communicate results in parallel with the GLCWC Implementation Plan to ensure comparable results are available within Durham Region coastal wetlands and among other wetlands around the Great Lakes. In the past, DRCWMP results have been couched in the context of other Canadian Lake Ontario coastal wetlands. As the project continues, the DRCWMP will take steps to move toward the GLCWC approach which reports on sites in the context of the Great Lakes basin. This may require ‘cross-walking’ exercises to relate differing but strongly engrained methodologies within each project (e.g., fish monitoring protocols – fyke nets; GLCWC vs. electrofishing; DRCWMP). This will allow the DRCWMP to better contribute to SOLEC and overall lake ecosystem reporting while continuing to meet the needs of regional project partners and stakeholders.

The ongoing support of DRCWMP’s regional partners and stakeholders underlines the importance of this project not only Great Lakes wide, but at a local and regional scale. Durham Region has a large number of coastal wetlands for the length of shoreline it occupies. Since these wetlands are located at the downstream end of the watershed, they are impacted by the cumulative effects of anthropogenic activities throughout much of the Region. The condition of these wetlands is a reflection of the overall health of the associated watersheds, as well as Durham Region. The information gained from the DRCWMP allows partners and stakeholders to make informed management decisions for each particular wetland as well as the watersheds that contribute to them. The role that the DRCWMP plays in the GLCWC and in regional programs emphasizes the need to continue the monitoring of these wetlands for the foreseeable future.

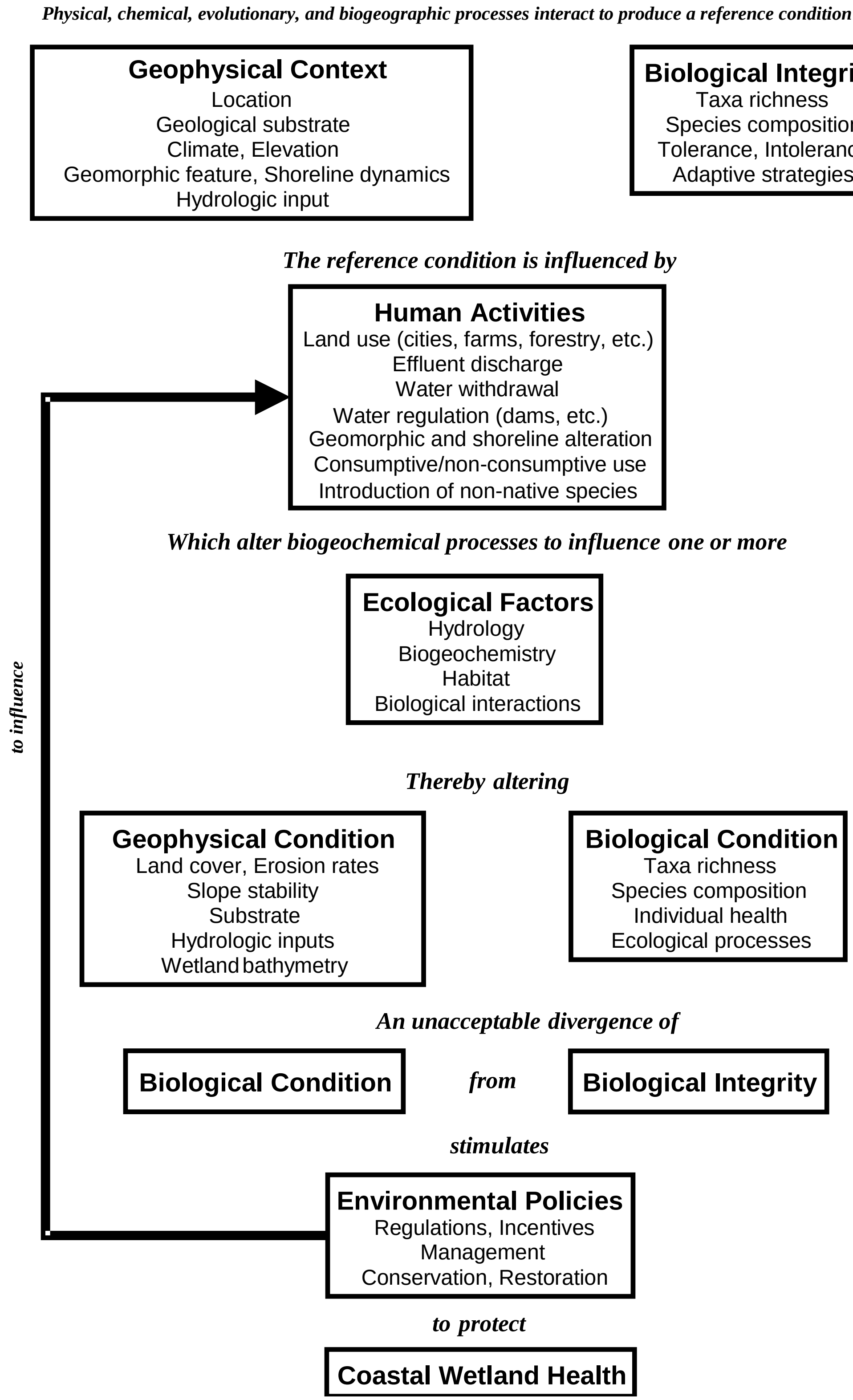



Figure 1. Relationships among attributes to be measured, understood, and evaluated through biological monitoring. Biological condition is the endpoint of concern (adapted from Karr and Chu 1999 and Mack *et al*. 2000).

# 1.3 ASSESSING COASTAL WETLAND CONDITION

### *Wetland Health vs. Integrity*

Karr (1996) and Karr and Chu (1999) provide discussions regarding the definition and use of the terms "health" and "integrity" to describe biological systems. The following discussion summarizes and simplifies the points made in these two papers and outlines the applicability of "health" and "integrity" in this report.

Karr and Chu (1999) note that:

> *Webster's dictionaries define health as a flourishing condition, well being, vitality, or prosperity. A healthy person is free from physical disease or pain; a healthy person is sound in mind, body and spirit. An organism is healthy when it performs all its vital functions normally and properly, when it is able to recover from stresses, when it requires minimal outside care. A country is healthy when a robust economy provides for the well-being of its citizens. An environment is healthy when the supply of goods and services required by both human and nonhuman residents is sustained. To be healthy is to be in good condition.* [p. 16]

It is clear that health is a subjective term. For coastal wetlands, one person may define a healthy wetland as one that affords ample opportunities for observing different bird species. Another person may define it as one that provides a good harvest of wild rice. Other definitions may be related to pike habitat, plant assemblage, or water quality.

For the DRCWMP, coastal wetland health can be defined through the overall condition of biotic communities being monitored (e.g., fish, birds, amphibians, vegetation). But how is the condition of a biotic community defined – how is its health measured? A tool used to measure biotic community health is the community's biotic integrity. Karr (1996) defines biotic integrity as:

> *…the capacity to support and maintain a balanced, integrated, adaptive biological system having the full range of elements (genes, species, assemblages) and processes (mutation, demography, biotic interactions, nutrient and energy dynamics, and metapopulation processes) expected in the natural habitat of a region.* [p. 101]

Karr (1997) clarifies that:

> *Inherent in this definition is that: (1) living systems act over a variety of scales from individuals to landscapes; (2) a fully functioning living system includes items one can count (the elements of biodiversity) plus the processes that generate and maintain them; and (3) living systems are embedded in dynamic evolutionary and biogeographic contexts that influence and are influenced by their physical and chemical environments.* [p. 483]

So what range of biotic integrity is considered healthy or unhealthy? A healthy level of integrity can be subjective and must be defined by the DRCWMP stakeholders; however, the definition of a healthy wetland should be based on Lake Ontario coastal wetlands that experience the least disturbance (Figure 2). Using these less disturbed wetlands, the stakeholders can objectively set thresholds of biotic integrity that reflect a healthy wetland.

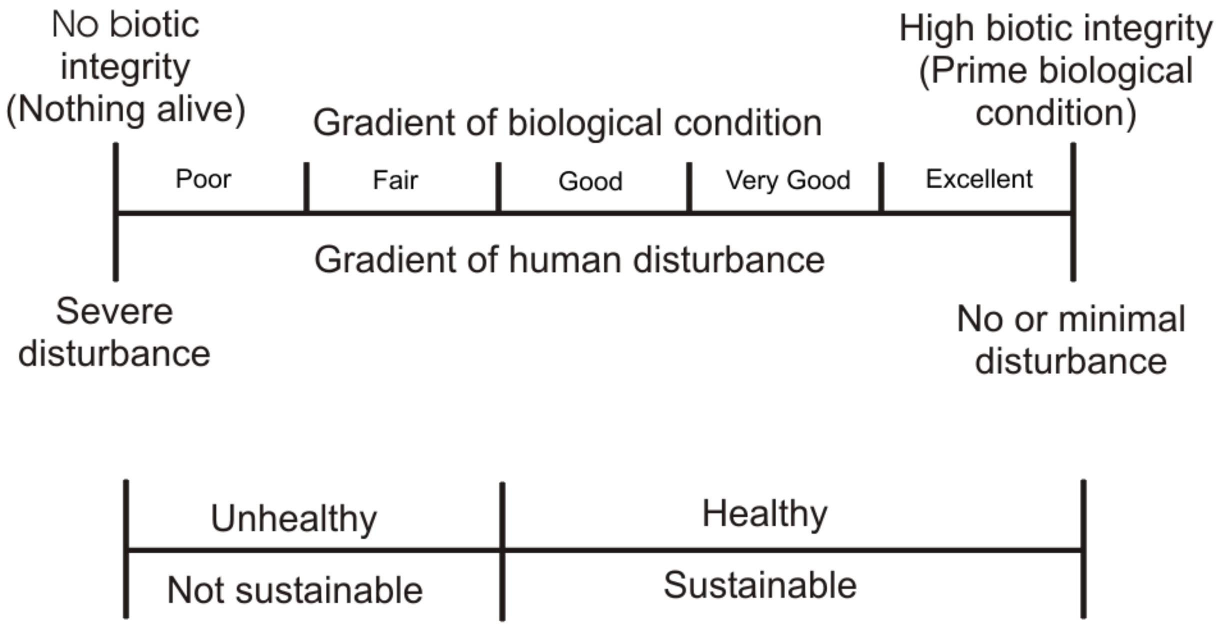



Figure 2. Gradient of biological condition in relation to a level of human disturbance (top). By combining the condition of several biological communities, a parallel gradient (bottom) representing the health of the wetland can be determined. Subsequently, a specific range on the health gradient can be set as a goal for each wetland (adapted from Karr and Chu 1999).

## 1.4 DETERMINING BIOTIC INTEGRITY OF WETLAND COMMUNITIES

A multimetric approach was developed to determine biotic integrity of coastal wetland communities. Metrics are biological attributes that are known to respond in specific and predictable ways to changes in wetland condition (Figure 3). For example, coastal wetland biological community metrics for the submerged aquatic vegetation (SAV) community could be percent cover, exotic species richness, mean coverage of turbidity intolerant taxa, or overall floristic quality. In Figure 3, biological attribute A increases with increasing disturbance and is an appropriate metric for biological monitoring. Conversely, biological attribute B is robust within the range of disturbances experienced and does not respond predictably to wetland disturbance. Biological attribute B is not a suitable metric.

Once a suite of suitable metrics are defined for a biotic community, the metrics are scored, standardized and combined. This creates an Index of Biotic Integrity (IBI) for the particular community. The multimetric IBI incorporates several suitable biological attributes to increase the accuracy in describing the condition of the particular biological community. Details of the scoring, standardizing, and combining metrics are described in Section 3.2 of EC and CLOCA (2004a), and EC and CLOCA (2005).

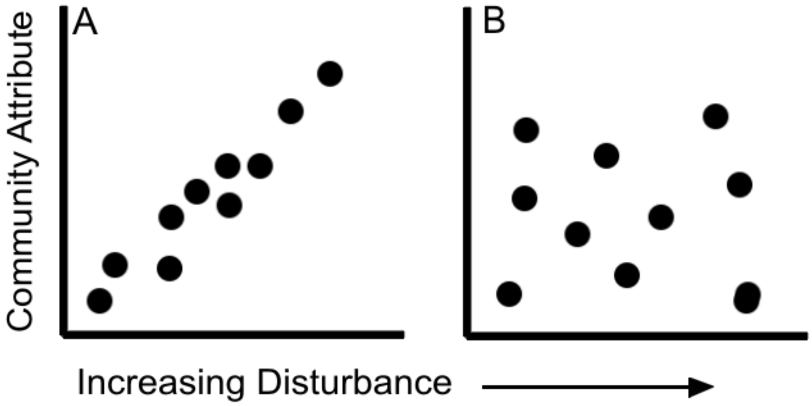



Figure 3. The theoretical response of biological community attributes A and B to increasing disturbance.

## 1.5 STUDY SITES

Fifteen coastal wetlands were originally identified for monitoring within Durham Region Recent wetland evaluations conducted by the Ontario Ministry of Natural Resources (OMNR) resulted in three additional coastal wetlands receiving Provincially Significant Wetland status (OMNR 2007b). In recognition of these new designations, the DRCWMP has taken steps (starting in 2007) to extend the DRCWMP framework to include monitoring of these wetlands. Eighteen wetlands throughout the region are now being monitored (Figure 4). These wetlands vary in size, level of disturbance and hydrogeomorphic features. The source of hydrologic input to the wetland is an important factor in determining the influence of adjacent human activities on the biological condition of the wetland. For this reason, coastal wetlands are divided into two classes based on the geomorphic formation and dominant hydrological input, i.e., barrier beach lagoon or drowned river-mouth (Table 1).

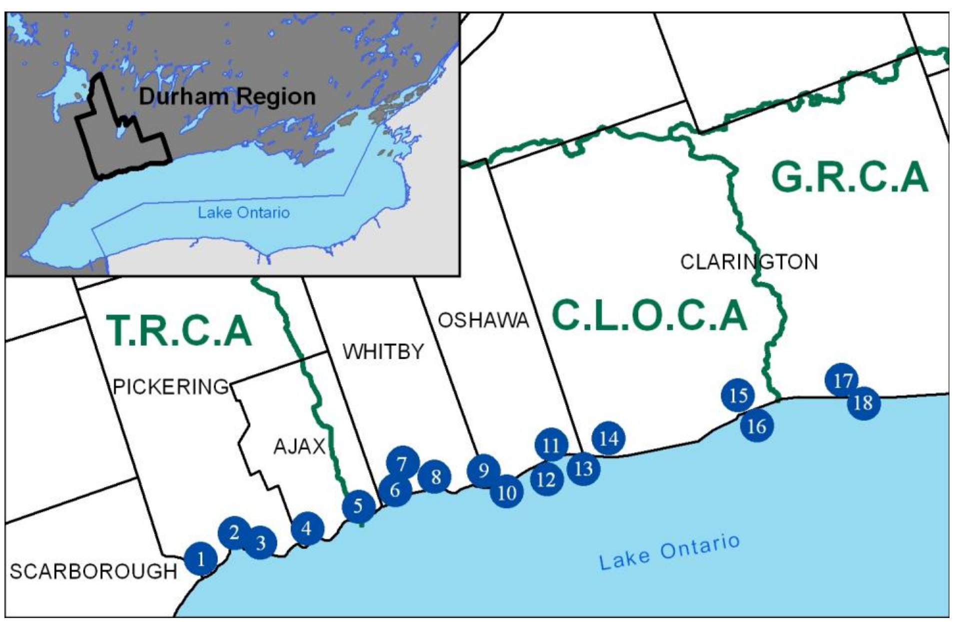



Figure 4. The location of the 18 Durham Region coastal wetlands. Wetlands associated with keymap numbers are located in Table 1.

The following classification is based on the GLCWC Great Lakes Coastal Wetlands Classification System (Albert *et al.* 2003; Albert *et al*. 2005):

1) **Barrier Beach Lagoon:** These wetlands form behind a sand beach or dune barrier. Because of the barrier, there is reduced mixing of lake and wetland water. These wetlands can become hydrologically isolated from the lake. The frequency and length of isolation can vary greatly among sites and years.

2) **Drowned River-mouth**: These wetlands form where tributary rivers enter the lake, representing a zone of transition from stream to lake. They are characterized by meandering stream channels that are backflooded during high lake levels.

Table 1. Durham Region coastal wetlands included in the monitoring program.

| Wetland Name | Keymap Number | Wetland Type* | Conservation Authority** | Area (hectares) |
|---|---|---|---|---|
| Rouge River Marsh | 1 | DR | TRCA | 59 |
| Frenchman's Bay Marsh | 2 | BB | TRCA | 23 |
| Hydro Marsh | 3 | BB | TRCA | 24 |
| Duffins Creek Marsh | 4 | DR | TRCA | 69 |
| Carruthers Creek Marsh | 5 | DR | TRCA | 141 |
| Cranberry Marsh | 6 | BB | CLOCA | 47 |
| Lynde Creek Marsh | 7 | DR | CLOCA | 130 |
| Whitby Harbour Marsh | 8 | DR | CLOCA | 8 |
| Corbett Creek Marsh | 9 | DR | CLOCA | 21 |
| Gold Point Marsh | 10 | DR | CLOCA | 4 |
| Oshawa Creek Marsh | 11 | DR | CLOCA | 20 |
| Pumphouse Marsh | 12 | BB | CLOCA | 7 |
| Oshawa Second Marsh | 13 | BB | CLOCA | 133 |
| McLaughlin Bay Marsh | 14 | BB | CLOCA | 42 |
| Westside Marsh | 15 | BB | CLOCA | 45 |
| Bowmanville Marsh | 16 | DR | CLOCA | 29 |
| Wilmot Creek Marsh | 17 | DR | GRCA | 26 |
| Port Newcastle Marsh | 18 | DR | GRCA | 8 |

Shading indicates priority sites (see text)

* DR = drowned river-mouth; BB = barrier beach lagoon

** TRCA = Toronto and Region Conservation Authority
CLOCA = Central Lake Ontario Conservation Authority
GRCA = Ganaraska Region Conservation Authority

### *Priority Sites*

The DRCWMP Monitoring Committee selected priority sites (Table 1; as reported in Gartner Lee Limited 2001) that represented the typical coastal wetlands in the Region. The selection criteria for the priority sites include:

1) wetlands with barrier beach and those that are more or less permanently open to Lake Ontario;
2) wetlands that may be subject to significant change;
3) sites with different landowners or managers; and
4) sites that attract a variety of stakeholder interest.

These sites are a priority for monitoring in the event of resource limitations and for pilot methodology testing.

### *Additional Lake Ontario Coastal Wetlands*

The condition of biotic communities in Durham Region coastal wetlands was assessed in the context of additional Lake Ontario coastal wetlands. These additional wetlands represent sites that experience a range of disturbance but, in general, are less disturbed than the Durham Region counterparts (Figure 5). The assessment framework for Lake Ontario coastal wetlands is described in detail in EC and CLOCA (2004a)

## 1.6 REPORT LAYOUT

One purpose of this report is to describe the physical and biotic conditions in Durham Region coastal wetlands and watersheds (Table 2). The assessment methods developed to describe the physical and biotic conditions of the wetlands are briefly discussed in Section 2. Further details regarding all sampling protocols are found in the Durham Region Coastal Wetland Monitoring Project: Methodology Handbook (EC and CLOCA 2007). Physical conditions are reported in Module 2 followed by biotic community condition reporting in Module 3. The second purpose of the report, an examination of regional and temporal trends, is also reported in Modules 2 and 3. The final purpose of this report is to provide a succinct overall wetland status reporting for each Durham Region coastal wetland in the study (Module 4).

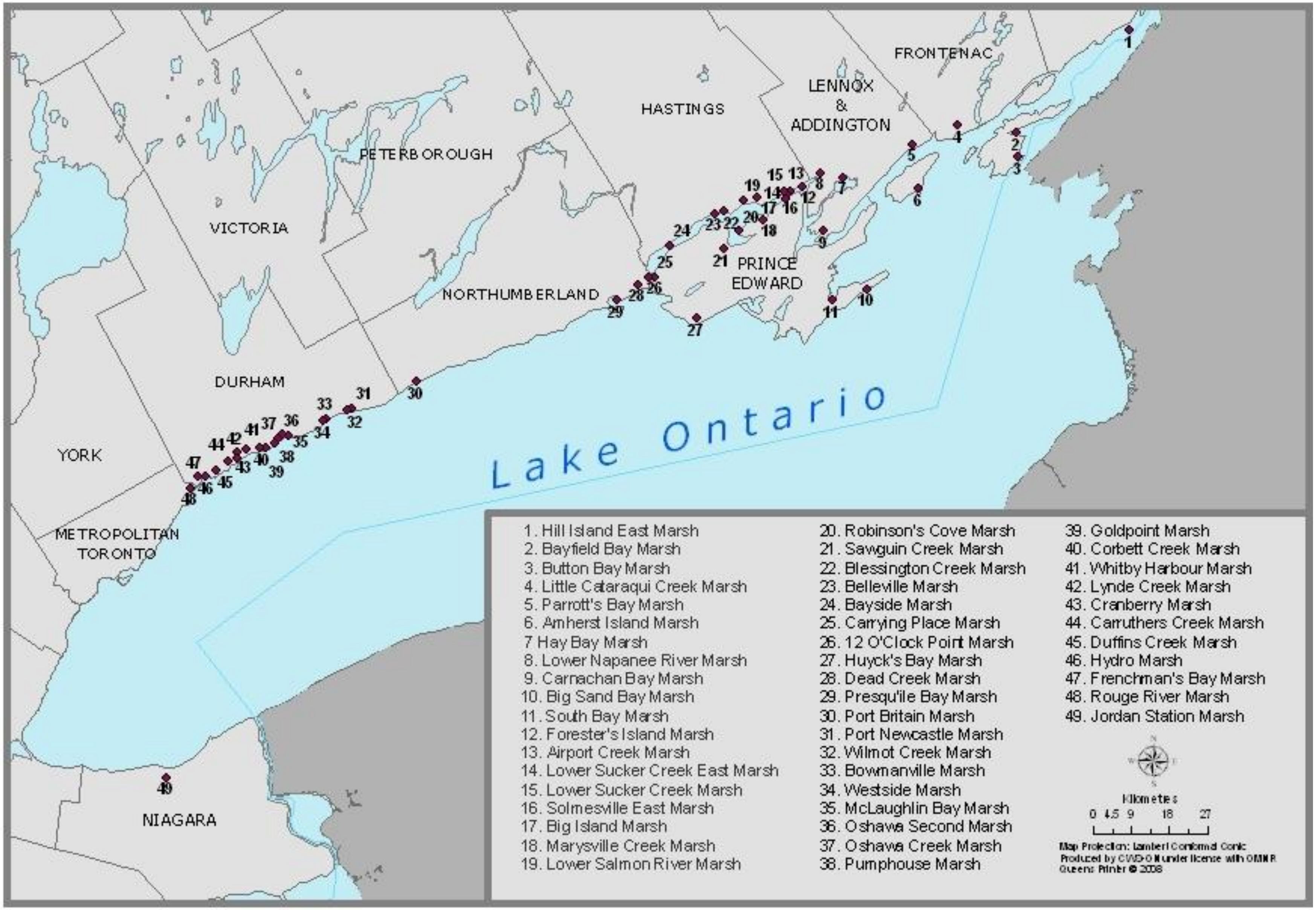



Figure 5. The location and names of Durham Region and additional Lake Ontario coastal wetland monitoring sites.

Table 2. Summary of goals and monitoring tasks for the Durham Region Coastal Wetland Monitoring Project.

| | Goals | Monitoring Task | Method Summary |
|---|---|---|---|
| GEOPHYSICAL CONDITION | Wetland | Water levels | • Used Lake Ontario water level data for wetlands with constant connection to the lake<br>• For wetlands frequently closed off from the lake, used water level data loggers |
| | | Sediment quality | • Sediment contaminant analysis (Metals, PCBs, OCs, PAHs)<br>• 3 homogenized surficial sediment samples stratified across wetland |
| | | Water quality | • Collected water quality parameters to calculate a Water Quality Index (Chow-Fraser 2006)<br>• Used data to assess disturbance at wetland |
| | | Wetland bathymetry | • Boat equipped with depth sounding and GPS equipment; significant post processing with GIS required. Tested methodology at pilot sites. |
| | Watershed | Land cover | • Mapped entire watersheds using air photos with focus on land cover<br>• Completed Ecological Land Classification (ELC) mapping to Community Series, and extended to incorporate all cultural designations (currently under development) and summarize to subwatershed |
| | | Land-use changes in adjacent uplands | • Identified land use within 1,000 metres of the OMNR *Evaluated Wetland* boundary and monitored for change<br>• Data used to assess disturbance at wetland |
| | | Land-use change in watershed | • Map at Regional or Municipal Official Plan level |
| | | Public ownership of watershed lands | • Using digital parcel data (Terranet), if available; liaising with municipalities |
| | | Sediment and nutrient loads | • When available, used Digital Elevation Model for each watershed (basic quantitative data for deriving terrain elevation, slope and/or surface roughness information) |

Table 2 Continued.

| | Goals | Monitoring Task | Method Summary |
|---|---|---|---|
| BIOLOGICAL CONDITION | Plant Community Condition | Wetland and adjacent land vegetation communities | • Mapped wetland and adjacent upland cover through current ELC methodology to the community unit of Vegetation Type |
| | | Key habitats | • No longer a focus of this project; completed through other provincial and federal species at risk programs |
| | | Submerged plant community condition | • Sampled submerged aquatic vegetation (SAV) in 20 one-metre square quadrats randomly located within the open water zone of each wetland<br>• Analyzed data by calculating an IBI based on plant guilds in Albert and Minc (1994) |
| | Fish and Wildlife Community Condition | Aquatic macroinvertebrate community condition | • Collected aquatic macroinvertebrates from water column at three replicate locations using sweep net sampling<br>• Analyzed data by calculating an IBI based on Burton *et al.* (1999); Uzarski *et al*. (2004) |
| | | Fish community condition | • Collected fish through electrofishing in various habitat types along a 44-m transect<br>• Used IBI analysis to compute an IBI based on Minns *et al.* (1994) |
| | | Breeding bird community condition | • Data collected through Marsh Monitoring Program (MMP)<br>• Analyzed data by calculating an IBI based on Great Lakes Coastal Wetlands Consortium final report (see Burton et al. 2008) |
| | | Amphibian community condition | • Data collected through Marsh Monitoring Program (MMP)<br>• Analyzed data by calculating an IBI based on Great Lakes Coastal Wetlands Consortium findings (see Burton et al. 2008) |

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# 2. WETLAND ASSESSMENT METHODS

## 2.1 DEVELOPMENT AND APPLICATION OF COASTAL WETLAND STATUS ASSESSMENT METHODS

Wetland loss (e.g., infilling, draining) coupled with changing land use in the areas surrounding coastal wetlands and within Great Lakes watersheds has greatly affected the extent and condition of wetlands in the Great Lakes basin. Recognition and growing concern over these impacts has resulted in conservation initiatives for Great Lakes coastal wetlands. These initiatives stem from local community and stakeholder efforts (e.g., Friends of the Rouge Watershed, Friends of Second Marsh), non-government organizations (e.g., Ducks Unlimited, Nature Conservancy Canada), universities (e.g., Trent University, University of Windsor) and all levels of government. In addition, several multi-jurisdictional, multi-agency conservation initiatives focus on or include aspects of Great Lakes coastal wetland conservation (e.g., Great Lakes Wetlands Conservation Action Plan, Great Lakes Water Quality Agreement, State of the Lakes Ecosystem Conference (SOLEC), Lakewide Management Plans, and Remedial Action Plans for Great Lakes Areas of Concern (AOCs)).

A key element of coastal wetland conservation and protection is assessment and monitoring. Great Lakes coastal wetlands are complex physical and biological systems that are influenced by lake and watershed ecological dynamics. Effectively synthesizing wetland data into reportable and meaningful results has been an ongoing focus among Great Lakes coastal wetland scientists. These efforts have resulted in scientific collaborations aimed at developing coastal wetland assessment, data treatment, and reporting methods. The intention of this section is not to discuss these consortia; further information is available through the Great Lakes Environmental Indicators Project (http://glei.nrri.umn.edu/default/), the Great Lakes Coastal Wetlands Consortium (GLCWC; http://www.glc.org/wetlands/), Simon and Stewart (2006), and the DRCWMP (EC and CLOCA 2004). The purpose of this section is to describe and substantiate reporting methods used in the DRCWMP based on developments by the aforementioned consortia.

The introduction for this document (Section 1) describes the linkage and reciprocal reliance between the DRCWMP and GLCWC. Part of the DRCWMP's role was developing Indices of Biotic Integrity (IBIs) for several biotic communities (EC and CLOCA 2004). This was necessary to fulfill reporting requirements within the DRCWMP but synergistically was able to contribute to GLCWC development goals. There have been significant advancements in coastal wetland science since this initial IBI development. The DRCWMP is now poised to integrate more applicable indices where the science has allowed (i.e., Water Quality Index; Module 2, Section 1.1.3) or where basin-wide applicability of the index has improved (e.g., Bird IBI; Module 3, Section 1.2.2). The following subsections describe the indices currently being used and reported on in this report.

**Submerged Aquatic Vegetation (SAV) Community**

The SAV IBI used in this report was developed by EC and CLOCA (2004). The GLCWC developed a subsequent vegetation community IBI that incorporates combined details of the submerged, emergent, and meadow coastal wetland communities (Burton et al. 2008). Until the DRCWMP has had the opportunity to fully consider the properties and outcomes, as well as the field work required for the GLCWC vegetation IBI, the current SAV IBI will continue to be used to maximize dataset and reporting continuity. Adoption of the GLCWC vegetation IBI will depend on the efficacy of the modification and the ability to streamline current SAV data collection methodology to meet the GLCWC requirements.

The IBI developed by EC and CLOCA (2004) is recommended for assessment of Lake Ontario coastal wetlands and is used in this report. However, because it is lake-specific, additional work will be required by the GLCWC to crosswalk the results of this IBI to allow interpretation in a Great Lakes basin-wide context.

**Fish Community**

Assessment of the health of Great Lakes fish communities received considerable discussion and deliberation. While sampling frameworks exist for freshwater littoral zones (Minns *et al.* 1994), the DRCWMP Methodology Committee had concerns regarding its applicability to diverse coastal wetland habitats of the Great Lakes entire (e.g., open water, SAV beds, shallow backwaters). There is currently not a published method to effectively electrofish these representative habitats in Great Lakes coastal wetlands. As a result, the fish community data collection and reporting IBI methods used by the DRCWMP are unique to this project and its associated projects (i.e., Bay of Quinte AOC coastal wetland fish community sampling).

Recently, the literature has emphasized a fyke net methodology for fish sampling efforts in the Great Lakes (Brazner and Beals 1997, GLCWC – Uzarski *et al*. 2005, GLEI – Bhagat 2005; Burton et al. 2008). Although different sampling methods (i.e., overnight fyke nets vs. daytime electrofishing) have been shown to target different components of fish assemblages (Chow-Fraser *et al.* 2006), fyke net sampling is quickly becoming the preferred method by research scientists, partially owing to significantly reduced short-term sampling equipment costs. In contrast, daytime electrofishing was considered an appropriate sampling method for long-term monitoring projects such as the DRCWMP as it allows coastal wetlands to be sampled:

1. In one day, opposed to two with fyke netting, which allows a large number of wetlands to be sampled within a relatively short period of time.
2. With a consistent effort between varying wetland conditions i.e., water levels (temporal and spatial).
3. For a lower cost realized over the life of the project e.g., 10 – 20 years or longer.
4. With no incidental wildlife casualties (e.g., turtles, muskrats, waterfowl), compromised data, or equipment damage from turtles eating fish and creating holes in nets.

The fish community IBIs reported in this document were calibrated using samples obtained with electrofishing equipment in Lake Ontario wetlands (See Module 3, Section 1.2.1). Therefore, basin-wide or between basin comparisons will require calibration between DRCWMP-based fish community IBIs and fyke net-generated Great Lakes wetland IBIs.

**Bird Community**
The bird community IBI originally developed for the DRCWMP was based on data collected in 2002 from 17 Lake Ontario coastal wetlands. Recently, the GLCWC developed an IBI by combining the methods used by EC and CLOCA (2004) and Crewe and Timmermans (2005). The revised IBI used data from nine years (1995-2003, including high and low water level periods) across 64 sites in the Great Lakes basin within the Canadian *Mixedwood Plains* Ecozone; North American Ecoregion 8: *Eastern Temperate Forest* (USEPA), extending from the southern part of lakes Huron and Michigan and including all of lakes St. Clair, Erie and Ontario with their connecting channels (Burton et al. 2008). As such, sites in Lake Ontario including those in Durham Region can also be compared in the context of Ecoregion 8 and not only Lake Ontario.

Adoption of the GLCWC bird IBI within the DRCWMP was prudent, as it is more compatible and comparable with other Great Lakes marsh bird assessments (e.g., SOLEC, Great Lakes AOCs) and will streamline results reporting. Because the GLCWC bird IBI is based on the original DRCWMP IBI, the two are highly correlated ($r=0.88$, $p<0.001$, $n=40$; 2006 data); adoption of the GLCWC has had a modest effect on past DRCWMP results (See Module 3, Section 1.2.2).

**Amphibian Community**
A revised amphibian IBI was also developed through the GLCWC process in parallel with the revised bird IBI as described above. The amphibian IBI was also highly correlated with the original DRCWMP amphibian IBI ($r=0.92$, $p<0.001$, $n=19$; 2002 data) and has been adopted by the DRCWMP for regional and basin-wide reporting (See Module 3, Section 1.2.3).

**Aquatic Macroinvertebrate Community**
The GLCWC has also developed an aquatic macroinvertebrate IBI (Burton et al. 2008). GLCWC researchers, which include collaborators of the DRCWMP, found suitable metrics from inner and outer *Scirpus* (bulrush) zones and meadow marsh vegetation zones. However, data collected from *Typha* (cattail) zones did not yield suitable metrics (Burton *et al.* 1999, Uzarski *et al.* 2004). The *Typha* zone is the only vegetation zone consistently found within Lake Ontario coastal wetlands. Inner and outer *Scirpus* zones are not common in Lake Ontario and meadow marsh (when present) is seldom inundated in July and August. In support of the Consortium process, the DRCWMP developed a separate Lake Ontario-based *Typha* community aquatic macroinvertebrate IBI (EC and CLOCA 2004).

The IBI was developed using data collected from a suite of Durham Region and other Lake Ontario sites that represented a range in disturbances and hydrogeomorphic types. Data were collected according to Uzarski *et al.* (2004) and assessed for suitability to report on Lake Ontario *Typha* zones using consistent metrics as identified in Burton *et al.* (1999). This IBI has been successfully used in the DRCWMP to report on the condition of coastal wetlands across Lake Ontario and in contributing to the Remedial Action Plan for the Bay of Quinte AOC (EC-CWS 2007).

**Water Quality**
When data collection began for the DRCWMP in 2001, there was not a published water quality indicator for Great Lakes coastal wetlands. More recently, Chow-Fraser (2006) developed a Water Quality Index (WQI) to report on water quality in a Great Lakes

context. The WQI was developed based on data collected for twelve water quality variables in 110 wetland complexes in the Great Lakes. However, it was soon recognized that most implementation agencies would not realistically be able to efficiently and cost-effectively collect data for all twelve variables. Subsequently, eight predictive equations based on subsets and combinations of the original twelve variables were developed to generate WQI scores. These equations incorporate between four and seven water quality variables. One WQI equation, using the parameters of turbidity (TURB), conductivity (COND), water temperature (TEMP), and pH, was identified as best suited to variables collected by the DRCWMP from 2001 to 2007 (see Table 5.6, equation #7 in Chow-Fraser 2006). WQIs were normalized on a scale from +3 to -3 and were divided into six categories ranging from excellent to very degraded.

Since the WQI has been developed and applied to all Great Lakes, it has direct relevance to DRCWMP reporting and, in addition, it represents a good measure of site disturbance (Chow-Fraser 2006). While EC and CLOCA (2004; see Section 3 of the report) also had developed a water quality and landscape-based site disturbance measure, it was much more complex. A comparison between the WQI and DRCWMP's disturbance measures showed a strong correlation ($r=0.84$, $p<0.001$, $n=28$; 2003 data). Since data collection and calculation of the WQI is easier, it is a more cost-effective method to estimate site disturbance and thus has been adopted for use within DRCWMP wetlands.

**Sediment Quality**

The Sediment Quality Index (SQI) used within the DRCWMP was developed as a means of combining individual sediment contaminant data to provide an integrated numerical score indicating the overall contaminant status of sediments at a site. The SQI was derived from the Canadian Water Quality Index developed by the Canadian Council of Ministers of the Environment. It is based on the number of sediment quality guideline exceedences and the magnitude of those exceedences for a suite of contaminants of interest in the locality. Similar to the WQI (as reported above), the SQI score is categorized using five qualitative rankings ranging from excellent to poor (See Module 2, Section 1.1.1). The SQI also allows for spatial comparisons of sediment quality among sites based on the scores (see Marvin *et al.* 2004 for assessing trends in sediment quality in the major depositional basins of lower Great Lakes).

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