Bay of Quinte Area of Concern:
Coastal Wetland Status and Remedial Action Plan
Delisting Target Recommendations

June 2007

Environment Canada – Canadian Wildlife Service
Executive Summary

The Bay of Quinte was designated as a Great Lakes Area of Concern (AOC) in 1985 due to problems with its chemical, physical and biological integrity. Eleven of 14 possible impaired beneficial uses (BUIs) were identified including: degradation of fish and wildlife populations and loss of fish and wildlife habitats (i.e., BUIs 3 and 14 respectively).

There has been much effort directed toward improving and restoring the aquatic ecosystem of the Bay of Quinte to address the BUIs. This process has included evaluations of the Bay of Quinte ecosystem, the nature and causes of impairments, and the development and implementation of a restoration plan.

In most cases, before specific restoration actions can be undertaken, the magnitude of impairment must be evaluated. These evaluations have been occurring for many BUIs, but there is a lack of data for wildlife populations and their habitats in Bay of Quinte coastal wetlands.

In 2005, data were collected from six Bay of Quinte coastal wetlands and analyzed through the coastal wetland monitoring framework developed by the Durham Region Coastal Wetland Monitoring Project. Results were presented in a pilot report which detailed how the implementation of a regional coastal wetland monitoring framework could be used to assess: 1. fish and breeding bird communities, and 2. elements of fish and wildlife habitats, in the Bay of Quinte AOC coastal wetlands.

In spring 2007, the Bay of Quinte Remedial Action Plan (RAP) Restoration Council completed A Management Plan to Address Wildlife Related Impairments for the Bay of Quinte Area of Concern. This Management Plan incorporated suggestions from the pilot report, the Bay of Quinte RAP Wildlife Steering Committee, and additional data collected from 20 Bay of Quinte sites in 2006. The Management Plan specifies delisting criteria for BUIs 3 and 14.

Using data collected between 2002 and 2006, this document reports the status of 20 Upper and Middle Bay of Quinte AOC coastal wetlands and discusses the biotic and physical state of these wetlands compared to other Canadian Lake Ontario coastal wetlands. This document also provides the background and scientific justification for the specification of delisting criteria elements of BUI 3 (bird community) and 14 (submerged aquatic vegetation and water quality) included in the Management Plan. In addition, rationale to include aquatic macroinvertebrate community condition as a delisting criterion for BUI 14 is presented.

In general, Bay of Quinte AOC coastal wetlands are in better condition than other Lake Ontario sites. Most fish and wildlife habitat and populations BUI components discussed in this report (i.e., water quality, submerged aquatic vegetation, aquatic macroinvertebrates, and breeding birds) are demonstrated to be delisted. However, there are other components recommended in the 2007 Management Plan that still need to be considered (e.g., amphibian community).

This report provides an introduction to the Bay of Quinte AOC, fish and wildlife related BUIs, assessment framework, and site selection (Section 1). Section 2 outlines general
methods for site selection, data collection and data use. Sections 3, 4 and 6, address the development and justification of delisting criteria for the Loss of Fish and Wildlife Habitat (i.e., FWH-2, FWH-3) and Degradation of Wildlife Populations (i.e., WP-2). Rationale to include aquatic macroinvertebrate community condition as a delisting criterion for BUI 14 is presented in Section 5. Section 7 suggests future activities to be undertaken and recommends the Bay of Quinte RAP Restoration Council take ownership of coastal wetland reporting in the Bay of Quinte AOC and coordinates the continued monitoring of priority sites listed in the Management Plan. This section also offers a conceptual flow model which can be used to refine delisting criteria and to direct actions throughout the Area in Recovery and Delisted stages of the Bay of Quinte AOC. Section 8 (Summary) consolidates the recommendations and gives a post hoc justification of representative site suitability.
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Acknowledgements

The primary authors of this report were Greg Grabas and Angela Darwin (EC-CWS). The authors gratefully acknowledge the review and comments from Shawn Meyer (EC-CWS), Nancy Patterson (EC-CWS), and Satu Pemanen (CLOCA). Additional data from Lake Ontario coastal wetlands were provided through the Durham Region Coastal Wetland Monitoring Project and collected in partnership with the Central Lake Ontario Conservation Authority, Toronto and Region Conservation Authority, and Ganaraska Region Conservation Authority.

Environment Canada – Canadian Wildlife Service acknowledges and thanks Lake Ontario shoreline property owners and stewards for granting land access in support of this project, in particular, The Mohawks of the Bay of Quinte, Teresa Craven, Derryl and Debbie Van Vlack, Peter Williams, Barbara Renwick, Ben and Jill Easterbrook, and Seymour Hamilton.

Funds for this project in 2006/07 were provided by Environment Canada with in-kind support from Quinte Conservation.

Cover Photos: Environment Canada – Canadian Wildlife Service
1.0 Introduction

Bay of Quinte Area of Concern (BQ AOC)

In 1985, the International Joint Commission identified the Bay of Quinte as a Great Lakes Area of Concern. This designation was due to problems with the chemical, physical and/or biological integrity within the Bay of Quinte. These problems are called Beneficial Uses Impairments (BUIs). Eleven of 14 possible BUIs were identified for the BQ AOC (Table 1).

Table 1. Impaired Beneficial Uses identified in the Bay of Quinte Area of Concern.

<table>
<thead>
<tr>
<th>#</th>
<th>Description</th>
<th>Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Restrictions on fish and wildlife consumption</td>
<td>Impaired</td>
</tr>
<tr>
<td>2</td>
<td>Tainting of fish and wildlife flavour</td>
<td>Not impaired</td>
</tr>
<tr>
<td>3</td>
<td>Degradation of fish and wildlife populations</td>
<td>Impaired</td>
</tr>
<tr>
<td>4</td>
<td>Fish tumours and other deformities</td>
<td>Impaired</td>
</tr>
<tr>
<td>5</td>
<td>Bird or animal deformities or reproduction problems</td>
<td>Not impaired</td>
</tr>
<tr>
<td>6</td>
<td>Degradation of benthos</td>
<td>Impaired</td>
</tr>
<tr>
<td>7</td>
<td>Restrictions on dredging activities</td>
<td>Impaired</td>
</tr>
<tr>
<td>8</td>
<td>Eutrophication or undesirable algae</td>
<td>Impaired</td>
</tr>
<tr>
<td>9</td>
<td>Restrictions on drinking water or taste and odour problems</td>
<td>Impaired</td>
</tr>
<tr>
<td>10</td>
<td>Beach closures</td>
<td>Impaired</td>
</tr>
<tr>
<td>11</td>
<td>Degradation of aesthetics</td>
<td>Impaired</td>
</tr>
<tr>
<td>12</td>
<td>Added costs to agriculture or industry</td>
<td>Needs assessment</td>
</tr>
<tr>
<td>13</td>
<td>Degradation of phytoplankton and zooplankton populations</td>
<td>Impaired</td>
</tr>
<tr>
<td>14</td>
<td>Loss of fish and wildlife habitat</td>
<td>Impaired</td>
</tr>
</tbody>
</table>

Much effort has been spent improving and restoring the aquatic ecosystem of the Bay of Quinte to address the BUIs. In 1990, the Remedial Action Plan (RAP) Coordinating Committee, with support from the Public Advisory Committee, produced "Stage 1 – Environmental Setting and Problem Definition" as an initial phase of the Bay of Quinte Remedial Action Plan (BQ RAP). The Stage 1 document was a framework for action and intended to:

- describe the Bay of Quinte and its environs;
- outline what is known about past and present environmental conditions, including a description of those beneficial uses that are impaired; and,
- confirm and evaluate the causes of impaired beneficial uses, including sources of pollution.

The second phase of the BQ RAP was completed in 1993 and included the Stage 2 Report – "Time to Act" and the technical reports that resulted from Stage 1. The Stage 2 document identified a comprehensive action plan to restore and protect the BQ AOC. It outlined the ecosystem problems, causes, restoration objectives, and remedial options, as well as an implementation strategy. Stage 2 also identified 80 recommendations to restore beneficial uses and improve water quality in the BQ AOC.
Stage 3 of the RAP involves cleanup, monitoring, and delisting. To facilitate this stage, a multi-agency group called the Bay of Quinte RAP Restoration Council (BQ-RAPRC) was formed in 1997. The Restoration Council’s mission focuses on “...provision of coordination and facilitation services to restore beneficial uses, delist the Bay of Quinte Area of Concern, promote ecosystem management actions, and stewardship, review emerging issues, and seek cost-effective solutions to sustain environmental quality in the Bay of Quinte watershed into the future.”

**Delisting Criteria for Fish and Wildlife BUIs**

Since 1997, part of the BQ-RAPRC’s work included updating the 1993 Bay of Quinte BUI delisting targets based on new scientific data. This divided most of the BUIs to more logically reflect the specific issues. For example, BUI 3, *degradation of fish and wildlife populations*, was divided into two components:

- 3.1 – *Degradation of fish populations*, and
- 3.2 – *Degradation of wildlife populations*.

Before beneficial uses can be considered restored, it is essential to define an end point for restoration – a delisting target. To define a delisting target, the current state of the BUI must be known. The level of impairment has been well documented for some BUIs, while for others, data are limited or absent.

For BUI 3.1 - *Degradation of fish populations*, there are sufficient data to report on the state of walleye populations, but limited data exist for other fish species (BQ-RAPRC 2003). There is very little information specific to the BQ AOC regarding the condition of wildlife populations (BQ-RAPRC 2003). Setting and evaluating delisting targets requires specific knowledge of fish and wildlife communities in several habitats – including coastal wetlands.

Impaired Beneficial Use 14 was also divided to reflect separate fish and wildlife issues:

- 14.1 – *Loss of fish habitat*, and
- 14.2 – *Loss of wildlife habitat*.

To delist these BUIs, function, diversity, and quantity of significant natural fish and wildlife habitat features should be protected to the greatest extent possible (BQ-RAPRC 2003). Plans to attain delisting targets for fish and wildlife habitat impairments rely heavily upon Natural Heritage Strategies and Management Plans (i.e., *Backgrounder – Wildlife and Wildlife Habitat in the Bay of Quinte, Bay of Quinte Fish Habitat Management Strategy, and A Management Plan to Address Wildlife Related Impairments for the Bay of Quinte Area of Concern*). There are few programs in place to report on the status or quantity of fish and wildlife habitat in the BQ AOC (BQ-RAPRC 2003). In particular, there are no programs that specifically address fish and wildlife habitat issues in BQ AOC coastal wetlands. Yet BQ RAP (1993) identifies the loss of coastal wetland habitats through urban encroachment as a factor contributing to BUI 14.

The BQ RAP has recently focused on addressing the need for quantitative assessments of coastal wetland fish and wildlife populations and habitat in the BQ AOC. This can be achieved through regional coastal wetland monitoring.
Regional Coastal Wetland Monitoring and Delisting Criteria

Over the last century, Great Lakes coastal wetlands have decreased in size and quality or have disappeared entirely in some areas. Government agencies, local groups, and individual citizens have identified the need for conservation and monitoring of these important ecosystems. Through recommendations at the State of the Lakes Ecosystem Conferences (SOLEC), and with United States Environmental Protection Agency funding, the Great Lakes Commission responded by creating the Great Lakes Coastal Wetland Consortium (GLCWC). The Consortium is a bi-national group of scientists and agency personnel responsible for developing coastal wetland health indicators and a basin-wide implementation framework for monitoring.

In support of this effort, and regional requirements for coastal wetland monitoring, the Durham Region Coastal Wetland Monitoring Project (DRCWMP) was initiated in 2002 by Environment Canada – Canadian Wildlife Service (EC-CWS) and the Central Lake Ontario Conservation Authority (CLOCA). The project has been designed to monitor the biological condition of 15 coastal wetlands using a coordinated multi-partnered approach at a regional scale.

In 2004/05, the Great Lakes Sustainability Fund (GLSF) provided funds to EC-CWS to assess the application of DRCWMP regional coastal wetland monitoring framework to support regional monitoring and delisting targets in the BQ AOC. The proposed assessment was timely since the BQ-RAPRC was exploring methods to refine delisting targets for impaired beneficial uses involving fish and wildlife.

The assessment of the DRCWMP framework occurred through two workshops that were well attended by federal and provincial governments, conservation authorities, BQ-RAPRC members, Ducks Unlimited Canada, and the Mohawks of Tyendinaga. Workshop recommendations indicated that the coastal wetland monitoring framework used for the DRCWMP could be used in the BQ AOC for regional monitoring and as a means of refining delisting targets. As a result, a pilot study was recommended.

With funding provided by GLSF, EC-CWS initiated a pilot study in 2005 to assess biotic communities (i.e., aquatic macroinvertebrates, submerged aquatic vegetation, marsh birds, and fish) and water quality parameters in a subset of BQ AOC coastal wetlands. The results of the assessment are also intended to:

1. Support refinement of delisting targets based on the current state of BQ AOC coastal wetland fish and wildlife populations and habitats in reference to other Lake Ontario coastal wetlands; and
2. Provide the BQ-RAPRC with a tool to monitor and report on the state of BQ AOC coastal wetlands throughout the Area in Recovery stage.

In 2006, EC-CWS expanded the coastal wetland assessments to include 20 BQ AOC coastal wetlands. Under the advice of the BQ-RAPRC, the assessments focused on wetlands located in the Upper and Middle Bay (i.e., Quinte West to Deseronto, south to Adolphustown). These wetlands were chosen because:

1. Coastal wetlands are more prevalent in the Upper and Middle Bay; and,
2. These wetlands are expected to be affected more by:
   a. urbanization (e.g., Quinte West, Belleville, Napanee); and,
   b. watercourses which drain large watersheds into the Upper Bay (i.e., Trent, Moira, Salmon, and Napanee rivers).
Biotic communities including aquatic macroinvertebrates, submerged aquatic vegetation, and marsh birds were surveyed along with water quality parameters at each wetland. Fish communities were not sampled through this project in 2006. In 2005, fish community sampling for the pilot study was completed by the Central Lake Ontario Conservation Authority in partnership with EC-CWS. EC-CWS (2006) recommended that if the BQ-RAPRC determined coastal wetland fish evaluations were merited, partnership opportunities should be sought with agencies capable of the work (i.e., CLOCA, Fisheries and Oceans Canada).

The results and recommendations in this report contributed to the March 2007 BQ-RAPRC report: A Management Plan to Address Wildlife Related Impairments for the Bay of Quinte Area of Concern. The reports were written and finalized concurrently. All efforts were made to keep the recommendations between the reports consistent; however, slight variations may have been introduced during report finalization.

The delisting criteria developed through this document are based on the best available data and science and knowledge of BQ AOC coastal wetlands. The criteria may be updated, as required, to reflect a better understanding and representation of the BQ AOC.
Table 2. *Delisting criteria for BUI 14: Loss of fish and wildlife habitat.* (from BQ-RAPRC 2007) Shaded rows relate primarily to the fish habitat component of BUI 14.

<table>
<thead>
<tr>
<th>Delisting Criteria Code</th>
<th>Delisting Criteria Description</th>
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<tbody>
<tr>
<td>FWH-1</td>
<td>The extent (surface area) of submerged aquatic vegetation in the Bay of Quinte has been restored to levels more reflective of the mesotrophic system that existed in the Bay of Quinte before nutrient loading created a eutrophic/hyper-eutrophic system.</td>
</tr>
<tr>
<td></td>
<td>• Criteria for submerged aquatic vegetation (i.e., macrophytes) restoration, as set out in BUI 8 (Eutrophication and undesirable algae), has been met.</td>
</tr>
<tr>
<td>FWH-2</td>
<td>Submerged aquatic vegetation in Bay of Quinte wetlands is not impaired.</td>
</tr>
<tr>
<td>FWH-3</td>
<td>Coastal wetland water quality is not impaired.</td>
</tr>
<tr>
<td>FWH-4</td>
<td>Shorelines around the Bay of Quinte have an acceptable level of natural vegetation which protects water quality and contributes to fish and wildlife habitat.</td>
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<tr>
<td></td>
<td>• An undisturbed terrestrial vegetated buffer of 30-m along shorelands and 120-m adjacent to Provincially Significant Wetlands (PSW).</td>
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<tr>
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<td>• 80 percent of the shorelines along the Bay of Quinte must have an undisturbed natural terrestrial vegetative buffer of five metres or greater from the high water mark. From five metres to thirty metres (or 120-m for PSW) the extent of the buffer should be 60 percent naturally vegetated. This criterion may be revised pending initial field verification that will examine current extent of buffering within the 30-m and 120-m areas of the Bay of Quinte.</td>
</tr>
<tr>
<td>FWH-5</td>
<td>Implement the institutional arrangements and site-specific habitat rehabilitation recommendations outlined in the Bay of Quinte Remedial Action Plan Fish Habitat Management Plan.</td>
</tr>
<tr>
<td>FWH-6</td>
<td>Implement the institutional arrangements and site-specific habitat rehabilitation recommendations outlined in the Bay of Quinte Remedial Action Plan 'A Management Plan to Address Wildlife Related Impairments for the Bay of Quinte Area of Concern' (pp 25-31).</td>
</tr>
<tr>
<td>FWH-7</td>
<td>Complete Natural Heritage Reports for all local governments bordering the Bay of Quinte and ensure that they are implemented into the Official Plans of the local governments.</td>
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Table 3. Wildlife population delisting criteria from BQ-RAPRC (2007).

<table>
<thead>
<tr>
<th>Delisting Criteria Code</th>
<th>Delisting Criteria Description</th>
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<tbody>
<tr>
<td>WP-1</td>
<td>Healthy amphibian populations in Bay of Quinte coastal wetlands.</td>
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<tr>
<td>WP-2</td>
<td>Healthy wetland bird populations in Bay of Quinte coastal wetlands.</td>
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<tr>
<td>WP-3</td>
<td>Shoreline habitat is suitable for supporting raptors.</td>
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<td></td>
<td>• Presence of nesting ospreys, including the successful fledging of chicks, on or near the Bay of Quinte shoreline each year.</td>
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<td></td>
<td>• Maintain identified critical natural areas.</td>
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<td></td>
<td>• Preferred criteria would also include the presence of nesting bald eagles, but this should not be considered a prerequisite for delisting.</td>
</tr>
<tr>
<td>WP-4</td>
<td>Species at risk</td>
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<td></td>
<td>• Where appropriate and feasible, support species at risk recovery plans for those plants and animals that reside in the Bay of Quinte.</td>
</tr>
<tr>
<td></td>
<td>• Maintain existing habitats for species at risk that have been identified in recovery plans.</td>
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1 only delisting criteria related to wildlife populations are shown (not fish populations).
Selection of Sites for Reporting

BQ-RAPRC (2007) recognizes that sampling and reporting on the status of delisting criteria for BUIs 3 and 14 in all BQ AOC coastal wetlands is not feasible. A subset of 10 representative sites is specified in Appendix IV of that document (Table 4). BQ-RAPRC (2007) indicates that the sites were chosen to cover a range of disturbance, size (small sites, <25ha were excluded), and dominant hydrologic influence (riverine/lacustrine).

Although the majority of the representative sites are located in the Upper Bay of Quinte, this is indicative of the overall distribution of wetlands within the bay. In addition, the representative sites listed in BQ-RAPRC (2007) were not finalized before the summer of 2006. As such, EC-CWS was not aware that Carnachan Bay would be a representative site and did not perform the suite of field surveys at the site. Delisting criteria developed in this document integrate the condition of the surveyed representative sites into the recommendations.

Table 4. Recommended Bay of Quinte Area of Concern representative coastal wetlands for monitoring (BQ-RAPRC 2007). Solmesville Marsh has been replaced by Airport Creek Marsh due to small size.

<table>
<thead>
<tr>
<th>Wetland name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Big Island Marsh</td>
</tr>
<tr>
<td>Blessington Creek Marsh</td>
</tr>
<tr>
<td>Carrying Place Marsh</td>
</tr>
<tr>
<td>Carnachan Bay Marsh</td>
</tr>
<tr>
<td>Dead Creek Marsh</td>
</tr>
<tr>
<td>Hay Bay Marsh</td>
</tr>
<tr>
<td>Lower Napanee River Marsh</td>
</tr>
<tr>
<td>Lower Sucker Creek Marsh</td>
</tr>
<tr>
<td>Sawguin Creek Marsh</td>
</tr>
<tr>
<td>Airport Creek Marsh</td>
</tr>
</tbody>
</table>

*Solmesville Marsh was included in this list of priority sites as a 'medium' sized site at 28 hectares. Based on data from the GLCWC: Inventory and Classification, Solmesville is approximately 2.8 hectares, not 28 hectares, in size. EC-CWS suggests replacement of this wetland with one of 'medium' sized wetland, namely Airport Creek Marsh (29.1 hectares). Throughout this report Airport Creek Marsh will be considered a representative site.
2.0 General Methods

**Site Selection**

As part of EC-CWS coastal wetland monitoring and assessment commitments, several Lake Ontario coastal wetlands were surveyed (Figure 1) using the same methods as in the BQ AOC. Results from these surveys are included in the appropriate sections for comparison purposes.

Within the BQ AOC, twenty coastal wetland sites were selected for assessment (Figure 2; excluding Belleville Marsh; see Field Data Collection section). Sites were selected in accordance with BQ-RAPRC advice (see Introduction) and represent the majority of sites in the Upper and Middle Bay of Quinte (See Figure 2). Smaller sites such as Bayside and Belleville Treatment marshes did not have enough wetland habitat to warrant sampling. In general, the sites represent a range in size, geomorphic type, exposure to human disturbance, and public and conservation interest.

Brief site descriptions, including colour infrared air photos, are shown below (Figure 3-Figure 22).

Figure 1. Names and locations of Lake Ontario coastal wetlands sampled by EC-CWS and partners in 2006.

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Figure 2. Names and locations of Bay of Quinte Area of Concern coastal wetlands sampled in 2006.
**Field Data Collection**

Water quality and biotic community data (submerged aquatic vegetation, aquatic macroinvertebrates, and marsh birds) were collected at most sites in the summer of 2006 (Table 5). Sampling locations are shown in Figure 3–Figure 22. Locations of the 20 submerged aquatic vegetation sampling are not shown as they tend to clutter the figures.

Brief field data collection descriptions are included in each section. Detailed methodologies for biotic community sampling are available in the Durham Region Coastal Wetland Monitoring Project: Methodology Handbook. (Environment Canada and Central Lake Ontario Conservation Authority 2007; herein EC and CLOCA 2007).

Table 5. The number of data collection points for water quality (WQ), submerged aquatic vegetation (SAV), aquatic macroinvertebrates (Inverts), and breeding marsh birds (Birds) in each Bay of Quinte Area of Concern coastal wetland.

<table>
<thead>
<tr>
<th>Wetland Name</th>
<th>Number of Stations Surveyed</th>
<th>WQ</th>
<th>SAV</th>
<th>Inverts</th>
<th>Birds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hay Bay South Marsh</td>
<td>3</td>
<td>20</td>
<td>3</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Hay Bay North Marsh</td>
<td>3</td>
<td>20</td>
<td>3</td>
<td>15</td>
<td></td>
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<tr>
<td>Lower Napanee River Marsh</td>
<td>3</td>
<td>20</td>
<td>3</td>
<td>4</td>
<td></td>
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<td>Forester’s Island Marsh</td>
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<td>20</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
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<td>Airport Creek Marsh</td>
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<td>20</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Lower Sucker Creek East Marsh</td>
<td>3</td>
<td>20</td>
<td>3</td>
<td>1</td>
<td></td>
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<tr>
<td>Marysville Creek Marsh</td>
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</tr>
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</tr>
<tr>
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<td>3</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Lower Salmon River Marsh</td>
<td>3</td>
<td>20</td>
<td>3</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Robinson’s Cove Marsh</td>
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<td>2</td>
<td></td>
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<td>3</td>
<td>5</td>
<td></td>
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<td>3</td>
<td>18</td>
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</tr>
<tr>
<td>Sawguin Creek Ditched Marsh</td>
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<td>3</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Carrying Place Marsh</td>
<td>3</td>
<td>20</td>
<td>3</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>12 O’Clock Point Marsh</td>
<td>3</td>
<td>20</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Dead Creek Marsh</td>
<td>3</td>
<td>20</td>
<td>3</td>
<td>12</td>
<td></td>
</tr>
</tbody>
</table>
**Hay Bay South Marsh**

Geomorphic Type: Open Bay  
Size: 122.0 hectares  
Sub-watershed: Hay Bay Watershed  
Site Description: At the southeast shore of Hay Bay, this wetland is located at the end of a long (more than five kilometre) fetch and is regularly exposed to strong prevailing west winds (Figure 3). EC-CWS previously collected data on surrounding land use, water quality, aquatic macroinvertebrates, marsh birds, amphibians, and submerged aquatic vegetation at this site.

**Figure 3.** A colour infrared aerial photograph of Hay Bay South Marsh showing various field sampling locations.
Hay Bay North Marsh
Geomorphic Type: Open Drowned Rivermouth
Size: 307.2 hectares
Sub-watershed: Hay Bay Watershed
Site Description: Located at the confluence of Little and Wilton creeks at the northeast end of Hay Bay, this site represents a large riverine coastal wetland (Figure 4). The site has expansive stands of cattail-dominated vegetation (southeast section of photo). EC-CWS previously collected data on surrounding land use, water quality, aquatic macroinvertebrates, and submerged aquatic vegetation at this site. This site is popular for recreational fishing and waterfowl hunting.

Figure 4. A colour infrared aerial photograph of Hay Bay North Marsh showing various field sampling locations.
**Lower Napanee River Marsh**

Geomorphologic Type: Open Drowned Rivermouth

Size: 268.6 hectares

Sub-watershed: Napanee River Watershed

Site Description: This wetland is a common destination for birders and anglers and is dotted with several shrubby islands (Figure 5). Surrounding property owners note the marsh was interspersed with channels in the 1960's and relay anecdotes of ample pike spawning habitat and an abundant harvest of muskrats. The interspersed areas have since filled in with cattails and sediments. There is an active osprey nesting platform within this wetland.

Of particular interest are the seiche-induced bores described by property owners, recent EC-CWS field crews, and Crowder et al. (1996). During sampling in 2006, EC-CWS staff witnessed the upstream flow of water while sampling at northeast point shown in blue in Figure 5. It is unclear how much the water level dynamics in this wetland differ from other BO AOC coastal wetlands or what the direct effect has been in terms of habitat and wildlife use.

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Figure 5. A colour infrared aerial photograph of Lower Napanee River Marsh showing various field sampling locations.
Forester's Island
Geomorphic Type: Protected Embayment
Size: 10.1 hectares
Sub-watershed: Forester's Island
Site Description: Viewed from its coastal wetlands at the south end of the island (Figure 6), it is not apparent this small island supported a three-story, 45-metre long orphanage. The orphanage was the crowning achievement of Mohawk physician Dr. Oronhyatekha (Burning Sky in the Mohawk language, and also carried the baptismal name Peter Martin). The large orphanage reportedly operated for a short time circa 1904 until Oronhyatekha’s death in 1907 and was funded by the fraternal institution associated with the Orange Order – the Independent Order of Foresters (see Library Archives Canada at http://www.biographi.ca/EN/ShowBio.asp?Bioid=41098 and also http://en.wikipedia.org/wiki/Oronhyatekha).

The island is now recognized as important coastal wetland habitat for fish spawning and nursery and its neighbouring waters are an autumn hotspot for walleye anglers. The relatively short distance from the mainland to the island also makes it a canoe destination for birders.

Figure 6. A colour infrared aerial photograph of Forester’s Island showing various field sampling locations.
Airport Creek Marsh
Geomorphologic Type: Open Drowned Rivermouth
Size: 29.1 hectares
Sub-watershed: Napanee River Watershed
Site Description: Named for its proximity to the north-lying airport (Figure 7), this mid-sized wetland is composed of 35 percent swamp (mostly thicket) and 65 percent marsh habitat. Although this wetland is listed as a PSW, little additional information regarding its local significance is available.

Figure 7. A colour infrared aerial photograph of Airport Creek Marsh showing various field sampling locations.
Lower Sucker Creek East Marsh
Geomorphic Type: Open embayment - fringe
Size: ~2.0 hectares
Sub-watershed: Napanee River Watershed
Site Description: Fringe bulrush on an open, sandy substrate characterizes the Lower Sucker Creek East Marsh (Figure 8). This type of wetland is found on all Great Lakes shorelines and consists of relatively narrow fringe wetlands exposed to wave and wind action. This wetland is located less than two kilometres to the east of Lower Sucker Creek Marsh.

Figure 8. A colour infrared aerial photograph of Lower Sucker Creek East Marsh showing various field sampling locations.
**Lower Sucker Creek Marsh**

Geomorphologic Type: Open Drowned Rivermouth (57 percent); Protected Embayment (43 percent)

Size: 53.4 ha

Sub-watershed: Napanee River Watershed

Site Description: Tyendinaga (Mohawk) Airport, originally known as Deseronto Airport, lies less than one kilometre to the northeast of this wetland (Figure 9). The field opened in 1916 as a training school for pilots during World War I. During World War II, it hosted the No. 1 Instrument Navigation School for the British Commonwealth Air Training Plan, providing advanced instrument-navigation training for air crews. The airport is currently the site of the First Nations Technical Institute and the First Nations Flying School.

Lower Sucker Creek Marsh is a PSW, made up of six individual wetlands, which are composed of two wetland types (42 percent swamp and 58 percent marsh; Bracken and Huizer 1993).

During site visits in 2006, EC-CWS staff observed several sizable gar (likely longnose gar) cruising the flats of the protected embayment portion of the wetland. The scene was unique among BQ AOC coastal wetlands.

![Figure 9. A colour infrared aerial photograph of Lower Sucker Creek Marsh showing various field sampling locations.](image)
Solmesville East Marsh
Geomorphic Type: Protected embayment – fringe
Size: ~2.5 hectares
Sub-watershed: Prince Edward County Watershed
Site Description: This is a small, protected, fringe wetland characterised by bulrush and cattail (Figure 10). A sandy bottom in the protected area gives way to rockier shoreline on the north end of the protective island. There are a few residences on the southern edge of the wetland, which may play a role in the future stability of the local area. Sport-fishing is common through the channel to the north of the wetland, where some of the best walleye fishing in the area can occur. Telegraph Island to the northwest originally had a lighthouse that began operation in 1870, but was deactivated in 1950 and has been replaced by a steel skeleton tower, which is still in operation today.

Figure 10. A colour infrared aerial photograph of Solmesville East Marsh showing various field sampling locations.
Marysville Creek Marsh
Geomorphic Type: Open, Drowned Rivermouth
Size: 352 hectares
Sub-watershed: Napanee River and Salmon River watersheds
Site Description: Marysville Creek Marsh is a PSW comprised of two wetland types (57 percent swamp and 43 percent marsh; Atkinson et al. 1995). The marsh is not truly a coastal wetland because the influence of Lake Ontario is moderated through a water level control structure at the outlet (Figure 11). The concrete structure was built in the early 1960's and was the first Ducks Unlimited Canada project of its kind in Ontario. Marysville Creek Marsh is the largest wetland in the Tyendinaga Mohawk Territory and is popular with the community for fishing off the water control structure and fall waterfowl hunting in the marsh proper. There is also an active osprey nesting platform in the marsh.

Marysville Creek flows through the Tyendinaga Mohawk Territory and has been a site of concern because of the expansion of the Richmond Landfill Site and its possible effect on the ground- and surface-water supply.

Figure 11. A colour infrared aerial photograph of Marysville Creek Marsh showing various field sampling locations.
Big Island Marsh (East and West)
Geomorphic Type: Protected Bay
Size: 685.4 hectares
Sub-watershed: Prince Edward County Watershed
Site Description: Big Island Marsh is a large BQ AOC coastal wetland (Figure 12 and Figure 13). It has formed between Big Island and the Prince Edward County (PEC) mainland. Local observations note the open water area between the island and mainland has been filling in with vegetation and the marsh has been expanding towards the lake at an increased rate since the construction of the causeway connecting the mainland to Big Island. Much of this marsh expansion results from cattail (*Typha* spp.) stands advancing toward open water. Habitat restoration through level-ditching has been raised as a potential option for this site.

Due to its size, Big Island Marsh was separated into sections east and west of the causeway. Although these are not considered separate wetlands, the full suite of sampling was done in each section to give a better representation of the site condition. The two sections are reported upon separately throughout most of this document.

Figure 12. A colour infrared aerial photograph of Big Island East Marsh showing various field sampling locations.
Figure 13. A colour infrared aerial photograph of Big Island West Marsh showing various field sampling locations.
Lower Salmon River Marsh
Geomorphic Type: Open, Drowned Rivermouth (96 percent), Protected Embayment (4 percent)
Size: 99.5 hectares
Sub-watershed: Salmon River Watershed
Site Description: During the logging days of the 1850’s, most of the easily merchantable timber from the entire Salmon River watershed was floated down sections of the river, much of it all the way to Rathbun’s Mill at Deseronto on the Bay of Quinte. Fortunately, much of that forest cover has regrown, moving the watershed back toward more natural cover and preventing the rapid runoff and loss of the sparse soil layer from the Precambrian rock that underlies most of the northern part of the watershed.

Lower Salmon River Marsh (Figure 14) is a PSW made up of eight individual wetlands, comprised of two wetland types (11 percent swamp and 89 percent marsh; Huizer and Bracken, 1993).

Figure 14. A colour infrared aerial photograph of Lower Salmon River Marsh showing various field sampling locations.
Robinson's Cove Marsh
Geomorphologic Type: Open Bay
Size: 8.8 hectares
Sub-watershed: Prince Edward County Watershed
Site Description: Robinson's Cove Marsh is one of the smaller coastal wetlands in the BQ AOC. EC-CWS staff previously collected data on surrounding land use, water quality, marsh birds, amphibians, aquatic macroinvertebrates, and submerged aquatic vegetation at this site (Figure 15).

In the past, much of the surrounding land at this site was agricultural (row crop). As of 2004, the property had changed ownership. The new owners of the adjacent land have planted hundreds of trees along the upland perimeter of the wetland and have indicated they plan to reduce the intensity of the agricultural activities on the adjacent land.

Figure 15. A colour infrared aerial photograph of Robinson's Cove Marsh showing various field sampling locations.
**Blessington Creek Marsh**

Geomorphic Types: Protected Bay (96 percent), Open Drowned Rivermouth (4 percent)
Size: 113.9 hectares
Sub-watershed: Blessington Creek

Site Description: This site was recommended for study by the BQ-RAPRC because of the watershed’s proximity to Belleville (Figure 16). Located at the east end of the city of Belleville, the majority of the wetland’s watershed extends north and east of the city. Currently, the most common land use in the watershed is agriculture, but increasing development pressures are expected. A railway used to run through the area, heading roughly east-west, but has since been abandoned. The wetland also has an active osprey nesting platform.

Figure 16. A colour infrared aerial photograph of Blessington Creek Marsh showing various field sampling locations.
Sawguin Creek Marsh
Geomorphic Types: Open Drowned Rivermouth (54 percent), Protected Embayment (31 percent), Open Embayment (10 percent), Open Shoreline (5 percent)
Size: 2,180 hectares
Sub-watershed: Prince Edward County (PEC) Watershed
Site Description: This wetland has several geomorphic types and is the largest coastal wetland in the BQ AOC. In recognition of this, the wetland complex was divided into three sections for sampling: North, Central, and Ditched (South).

The North section of the wetland complex (Figure 17) lies on the north shore of PEC – just east of the Norris Whitney Bridge (Hwy 62) that connects Belleville and PEC. Although the surrounding land does not support high density residential development compared to the Golden Horseshoe, this part of the marsh has more residential development than the portions of the wetland to the south.

Figure 17. A colour infrared aerial photograph of Sawguin Creek North Marsh showing various field sampling locations.
The Central section is located to the north of Huff’s Island (Figure 18). This section is characterized by a channel that meanders through dense stands of emergent vegetation (mainly cattail). The Central section of the marsh is bisected by a north-south stretching causeway.

Figure 18. A colour infrared aerial photograph of Sawguin Creek Central Marsh showing various field sampling locations.
During the winter of 1998, a habitat enhancement project was undertaken in the marsh south of Huff's Island (Figure 19). The project involved creating 5.6 kilometres of level ditching within a 98-hectare section of cattail dominated marsh. This southern section of the marsh is referred to as Sawguin Creek Ditched Marsh.

Figure 19. A colour infrared aerial photograph of Sawguin Creek Ditched Marsh showing various field sampling locations.
Carrying Place Marsh
Geomorphic Type: Open Drowned Rivermouth
Size: 4.3 hectares
Sub-watershed: Prince Edward County Watershed
Site Description: Carrying Place was named in reference to the historical canoe portage between Lake Ontario and the Bay of Quinte. The small marsh is located southeast of the Murray Canal, on the historic Trent-Severn Waterway. The canal is crossed by two swing bridges (Highway 33 and County Rd 26) and a decommissioned railway bridge still exists but is kept permanently open.

The canal was used for many years for coal and commercial shipping but with the advent of the St. Lawrence Seaway in the 1950’s, the traffic declined. Since then, there has been a steady rise in recreational use and today, the Murray Canal is used by boaters who travel the Trent-Severn Waterway. Much of the surrounding land use is agricultural and land to the southeast of the marsh is primarily residential.

A beaver dam just upstream of the southernmost water quality sampling point severs the inland section of the marsh from Lake Ontario water level influence (Figure 20).

Figure 20. A colour infrared aerial photograph of Carrying Place Marsh showing various field sampling locations.
12 O'Clock Point Marsh
Geomorphic Type: Open Drowned Rivermouth
Size: 24.9 hectares
Sub-watershed: Prince Edward County Watershed
Site Description: Located adjacent to the Murray Canal, 12 O'Clock Point (Figure 21) has been affected by the canal's construction in the past, but only the northern section has experienced shoreline hardening as a result.

The canal runs eight kilometres and connects the north shore of Lake Ontario with the Bay of Quinte. It was constructed between 1882 and 1889 to provide an alternative shipping route to the dangerous waters surrounding PEC. It is now frequented by recreational and commercial boaters alike and is an integral part of the historic Trent-Severn Waterway.

Figure 21. A colour infrared aerial photograph of 12 O'Clock Point Marsh showing various field sampling locations.
Dead Creek Marsh
Geomorphologic Type: Open, Drowned Rivermouth
Size: 330.4 hectares
Sub-watershed: Lower Trent and Crowe River Watershed
Site Description: The Dead Creek was apparently named by British Colonel Richard Bullock in reference to its dark and stagnant waters. This wetland is severed by the Murray Canal, cutting the headwater areas off from the riverine and lacustrine wetland (Figure 22). There is good representation of marsh communities, mature deciduous swamp, and some upland forest on sand plain. Its mature red ash-red maple swamp, open water wild rice marsh, and mature black maple limestone talus slope are considered rare along the waterfront, and is the only example of its kind in the area. The majority of this site is high quality, intermediate-mature swamp, upland forest and marsh habitat, although the edges are disturbed in places (Brownell, 1993).

Figure 22. A colour infrared aerial photograph of Dead Creek Marsh showing various field sampling locations.
Assessing Coastal Wetland Condition

Wetland Health Versus Integrity

Karr (1996) and Karr and Chu (1999) discuss 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 publications 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 is defined through the overall condition of biotic communities being monitored (e.g., fish, marsh birds, invertebrates, submerged aquatic vegetation). But how is the condition of a biotic community 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 appropriate stakeholders. For BQAOC coastal wetlands, the definition of a healthy wetland should be based on Lake Ontario coastal wetlands that experience a range disturbance (Figure 23). Using these
wetlands, the stakeholders can objectively set thresholds of biotic integrity that reflect a healthy wetland.

![Gradient of biological condition and human disturbance](image)

Figure 23. Gradient of biological condition in relation to gradient 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).

**Determining Biotic Integrity of Wetland Communities**

A multimetric approach was used 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 disturbance (Figure 24). 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 24, 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 attributes that do not have a constant and predictable relationship within the range of disturbance are not suitable metrics.

Once a suite of suitable metrics is 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 of describing the condition of the particular biological community. IBIs are scored out of 100. Details of the scoring, standardizing, and combining metrics are described in Section 3 of the Durham Region Coastal Wetland Monitoring Project: Year 2 Technical Report (Environment Canada and Central Lake Ontario Conservation Authority 2004; herein EC and CLOCA 2004).
Figure 24. The theoretical response of biological community attributes A and B to increasing disturbance.
3.0 Water Quality

Water is an important habitat component of Great Lakes coastal wetlands and water quality has a strong influence on the overall aquatic habitat quality in these environments. Poor water quality compromises fish and wildlife habitat in several ways. First, and most obvious, water is the medium in which fish and many other wildlife species exist (e.g., frogs, grebes). Poor water quality can affect the behaviour (i.e., foraging) and physiology (i.e., respiration) of these animals and hence their ability to survive.

Second, water quality affects food sources for fish and wildlife. Aquatic macroinvertebrates (also considered wildlife by BQ-RAPRC 2005) and submerged aquatic vegetation are impacted by poor water quality (See Section 4 and 5). Submerged aquatic vegetation also provides habitat for fish and wildlife (e.g., fry, amphibian larvae and macroinvertebrates) by providing cover, shelter, and egg-laying substrate.

For these reasons, BQ AOC coastal wetland water quality was specified as a component of BUI 3 and assessed through delisting criterion FWH-3 (BQ-RAPRC 2007). In addition, water quality data can help provide insight into observations linked to the abundance or richness of certain biotic guilds (e.g., submerged aquatic vegetation species richness; Chow-Fraser 2007) or presence of exotic marine amphipods (Gammarus tigrinus) in parts of the Great Lakes (Grigorovich et al. 2005).

Water quality in littoral and off-shore zones has been evaluated in the BQ AOC for decades. The addition of standardized coastal wetland water quality assessments will contribute to the understanding of the overall aquatic habitat quality in the BQ AOC.

Method Summary

Water quality sampling stations were established within each wetland along the edge of the emergent vegetation and open water (Figure 3 - Figure 22). A Hydrolab Datasonde 5 multiprobe unit was used to measure dissolved oxygen (mgL\(^{-1}\)), pH, water temperature (°C), conductivity (μS cm\(^{-1}\)), redox potential (mO), chlorophyll \(a\) (μgL\(^{-1}\)), and turbidity (NTU). Water samples for ammonia nitrogen (NH\(_4\)), nitrate nitrogen (NO\(_3\)), and total phosphorus (TP) concentrations (mgL\(^{-1}\)) were collected for off-site analysis.

Information on the dominant vegetation was recorded for each sampling location, along with observations of incidental macrophyte species within three metres of the sampling location. A Trimble GEO XT global positioning system was used to record each sampling location.

Ranking Water Quality

Six water quality parameters were combined into an overall water quality ranking for each site. Parameters used were: total phosphorus, ammonia, nitrate, turbidity, chlorophyll \(a\), and conductivity (Table 6). For each of these parameters, higher measured field values indicate increased disturbance at the site.

Each parameter within a site was assigned an ordinal score of 1, 3, or 5. This was done by calculating the 25\(^{th}\) and 75\(^{th}\) percentiles from water quality data from 35 Lake Ontario coastal wetlands in 2006 – 20 Bay of Quinte Sites and 15 Durham Region sites.
Table 6. Descriptions of water quality parameters used to score and rank water quality.

<table>
<thead>
<tr>
<th>Disturbance Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Phosphorus</td>
<td>The concentration (mgL⁻¹) of all forms of phosphorus dissolved in the sample. This is an important indicator of enrichment in surface waters.</td>
</tr>
<tr>
<td>Ammonia</td>
<td>The concentration (mgL⁻¹) of ammonia nitrogen in the sample. Ammonia can be toxic to aquatic organisms and is released into waterways by many industries, primarily municipal wastewater treatment plants.</td>
</tr>
<tr>
<td>Nitrate</td>
<td>The concentration of nitrate nitrogen (mgL⁻¹) in the sample. The primary sources of nitrates in the environment are sewage, fertilizer, and manure.</td>
</tr>
<tr>
<td>Turbidity</td>
<td>A measure of the degree to which light traveling through a water column is scattered by the suspended organic (including algae) and inorganic particles measured in Nephelometric Turbidity Units (NTU).</td>
</tr>
<tr>
<td>Chlorophyll a</td>
<td>A measurable parameter for all phytoplanktonic production. On average, 1.5 percent of algal organic matter is chlorophyll-a. Thus, if chlorophyll-a levels are known, the phytoplankton biomass in the water body can be estimated.</td>
</tr>
<tr>
<td>Conductivity</td>
<td>A measure of the dissolved ions in water measured in microseimens per centimetre (μScm⁻¹). Conductivity is a good indicator of urban run-off – especially from road salt.</td>
</tr>
</tbody>
</table>

If the mean parameter value at each site was above the 75th percentile, the parameter was considered impacted and received a score of 1. If the mean parameter value was below the 25th percentile, the parameter was considered to be far less impacted and scored a 5. Mean values between the 25th and 75th percentile scored a 3 (See Table 28 in Appendix for percentiles used in calculations). After each parameter within the site was scored, a mean score was calculated for water quality at the wetland; higher scores indicate better water quality. Mean scores were converted to a qualitative rank according to Table 8. To maintain annual consistence and comparability, it is recommended that the same percentiles presented in Table 28 be used to calculate water quality scores for future assessments.

Results
All BQ AOC coastal wetlands, except 12 O’Clock Point Marsh, had mean water quality parameter scores between 3.00 and 5.00 and were ranked good to excellent relative to other sites sampled on Lake Ontario (Table 7). Of the BQ AOC sites, 12 O’Clock Point Marsh scored the lowest (a mean score of 2.00) and Robinson’s Cove Marsh scored the highest (a mean score of 4.67). By contrast, the majority of the Durham Region sites had a mean water quality parameter between 2.00 and 3.00 (ranked fair to good).
There were no consistent patterns in parameters among BQ AOC sites, with individual parameter scores varying from 1.00 to 5.00. However, the scores were significantly higher for the Bay of Quinte sites ($\bar{x} = 3.60 \pm 0.45$SD) when compared with the Durham Region sites (2.31±0.65; $t_{19.14} = -6.62$, $p<0.0001$).

Within the BQ AOC, lacustrine coastal wetlands received higher water quality scores (3.81±0.53) than riverine sites (3.42±0.69) but the difference was not statistically significant ($t_{8.10} = 1.38$, $p=0.18$).

Chow-Fraser (2007) developed a Water Quality Index (WQI) to report on the water quality in the context of all the Great Lakes. The WQI was developed from 12 water quality variables. In apparent recognition that most implementation agencies would not realistically be able to collect data for all 12 variables, eight additional WQIs were developed from subsets and combinations of the original 12 variables. These additional WQIs incorporate between four and seven water quality variables. The seventh WQI equation presented (see Chow-Fraser 2007; Table 5.6), using the parameters of Turbidity (TURB), Conductivity (COND), Temperature (TEMP), and pH, was best suited to variables collected by EC-CWS in the past (2001-2006). WQIs were calculated for the Lake Ontario sites surveyed in 2006 (Table 9).

Using the WQIs, Chow-Fraser (2007) ranked the sites based on a six category scale. Scores were arbitrarily divided into the six categories as the data ranged from greater than -3 to less than +3 (Table 10). These same ranks have been applied to the WQI calculated in this report (Table 9).
Table 7. Water quality parameter means (M), score (S), mean score, and rank for 20 Bay of Quinte Area of Concern (shaded) and 15 Durham Region coastal wetland sites. Wetlands are ordered vertically from east to west.

<table>
<thead>
<tr>
<th>Wetland Name</th>
<th>Conductivity (mS cm⁻¹)</th>
<th>Turbidity (NTU)</th>
<th>NH₃ (mg L⁻¹)</th>
<th>NO₃ (mg L⁻¹)</th>
<th>Phosphorus (mg L⁻¹)</th>
<th>Chlorophyll a (μg L⁻¹)</th>
<th>Mean Score</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hay Bay South Marsh</td>
<td>0.32</td>
<td>3</td>
<td>13.85</td>
<td>3</td>
<td>0.05</td>
<td>3.63</td>
<td>3</td>
<td>0.06</td>
</tr>
<tr>
<td>Hay Bay North Marsh</td>
<td>0.38</td>
<td>3</td>
<td>3.27</td>
<td>5</td>
<td>0.03</td>
<td>0.97</td>
<td>1</td>
<td>0.04</td>
</tr>
<tr>
<td>Lower Napanee River Marsh</td>
<td>0.31</td>
<td>3</td>
<td>3.77</td>
<td>2</td>
<td>0.02</td>
<td>0.03</td>
<td>5</td>
<td>0.13</td>
</tr>
<tr>
<td>Forestier’s Island Marsh</td>
<td>0.30</td>
<td>3</td>
<td>5.77</td>
<td>5</td>
<td>0.05</td>
<td>0.70</td>
<td>3</td>
<td>0.07</td>
</tr>
<tr>
<td>Airport Creek Marsh</td>
<td>0.64</td>
<td>1</td>
<td>5.60</td>
<td>5</td>
<td>0.02</td>
<td>0.40</td>
<td>3</td>
<td>0.09</td>
</tr>
<tr>
<td>Lower Sucker Creek East Marsh</td>
<td>0.29</td>
<td>5</td>
<td>16.62</td>
<td>1</td>
<td>0.01</td>
<td>0.73</td>
<td>3</td>
<td>0.05</td>
</tr>
<tr>
<td>Lower Sucker Creek Marsh</td>
<td>0.38</td>
<td>3</td>
<td>2.03</td>
<td>5</td>
<td>0.02</td>
<td>0.60</td>
<td>3</td>
<td>0.04</td>
</tr>
<tr>
<td>Selmisville East Marsh</td>
<td>0.29</td>
<td>5</td>
<td>3.37</td>
<td>3</td>
<td>0.01</td>
<td>0.70</td>
<td>3</td>
<td>0.08</td>
</tr>
<tr>
<td>Meafordville Creek Marsh</td>
<td>0.30</td>
<td>5</td>
<td>2.92</td>
<td>5</td>
<td>0.01</td>
<td>0.47</td>
<td>3</td>
<td>0.10</td>
</tr>
<tr>
<td>Big Island East Marsh</td>
<td>0.31</td>
<td>3</td>
<td>1.72</td>
<td>5</td>
<td>0.07</td>
<td>0.82</td>
<td>3</td>
<td>0.09</td>
</tr>
<tr>
<td>Big Island West Marsh</td>
<td>0.24</td>
<td>5</td>
<td>0.83</td>
<td>5</td>
<td>0.09</td>
<td>0.23</td>
<td>3</td>
<td>0.03</td>
</tr>
<tr>
<td>Lower Salmon River Marsh</td>
<td>0.23</td>
<td>5</td>
<td>29.50</td>
<td>5</td>
<td>0.02</td>
<td>0.77</td>
<td>3</td>
<td>0.03</td>
</tr>
<tr>
<td>Robinson’s Cove Marsh</td>
<td>0.27</td>
<td>5</td>
<td>2.92</td>
<td>5</td>
<td>0.03</td>
<td>0.77</td>
<td>3</td>
<td>0.04</td>
</tr>
<tr>
<td>Blessington Creek Marsh</td>
<td>0.29</td>
<td>5</td>
<td>3.03</td>
<td>5</td>
<td>0.03</td>
<td>0.77</td>
<td>3</td>
<td>0.16</td>
</tr>
<tr>
<td>Saugeen Creek North Marsh</td>
<td>0.26</td>
<td>5</td>
<td>2.33</td>
<td>5</td>
<td>0.02</td>
<td>0.97</td>
<td>1</td>
<td>0.03</td>
</tr>
<tr>
<td>Saugeen Creek Central Marsh</td>
<td>0.30</td>
<td>5</td>
<td>2.43</td>
<td>5</td>
<td>0.03</td>
<td>0.70</td>
<td>3</td>
<td>0.10</td>
</tr>
<tr>
<td>Saugeen Creek Prepared Marsh</td>
<td>0.34</td>
<td>3</td>
<td>4.46</td>
<td>5</td>
<td>0.01</td>
<td>0.57</td>
<td>3</td>
<td>0.09</td>
</tr>
<tr>
<td>Caryaing Place Marsh</td>
<td>0.36</td>
<td>3</td>
<td>14.37</td>
<td>3</td>
<td>0.05</td>
<td>0.80</td>
<td>3</td>
<td>0.11</td>
</tr>
<tr>
<td>12 O’Clock Point Marsh</td>
<td>0.51</td>
<td>5</td>
<td>51.70</td>
<td>1</td>
<td>0.02</td>
<td>0.63</td>
<td>3</td>
<td>0.19</td>
</tr>
<tr>
<td>Dead Creek Marsh</td>
<td>0.37</td>
<td>3</td>
<td>3.50</td>
<td>3</td>
<td>0.07</td>
<td>1.67</td>
<td>1</td>
<td>0.07</td>
</tr>
<tr>
<td>Port Newcastle Marsh</td>
<td>0.50</td>
<td>3</td>
<td>3.66</td>
<td>3</td>
<td>0.07</td>
<td>1.67</td>
<td>1</td>
<td>0.07</td>
</tr>
<tr>
<td>Wilmot Creek Marsh</td>
<td>0.71</td>
<td>1</td>
<td>8.44</td>
<td>3</td>
<td>0.07</td>
<td>6.47</td>
<td>1</td>
<td>0.05</td>
</tr>
<tr>
<td>Bowmanville Marsh</td>
<td>0.59</td>
<td>3</td>
<td>14.16</td>
<td>3</td>
<td>0.05</td>
<td>6.47</td>
<td>1</td>
<td>0.05</td>
</tr>
<tr>
<td>Westside Marsh</td>
<td>0.67</td>
<td>1</td>
<td>24.25</td>
<td>1</td>
<td>0.04</td>
<td>1.67</td>
<td>1</td>
<td>0.10</td>
</tr>
<tr>
<td>McLaughlin Bay Marsh</td>
<td>1.39</td>
<td>1</td>
<td>34.05</td>
<td>1</td>
<td>0.11</td>
<td>17.23</td>
<td>3</td>
<td>0.14</td>
</tr>
<tr>
<td>Oshawa Second Marsh</td>
<td>0.79</td>
<td>1</td>
<td>19.43</td>
<td>3</td>
<td>0.11</td>
<td>17.23</td>
<td>3</td>
<td>0.14</td>
</tr>
<tr>
<td>Pumphouse Marsh</td>
<td>0.66</td>
<td>1</td>
<td>11.50</td>
<td>5</td>
<td>0.04</td>
<td>2.73</td>
<td>5</td>
<td>0.27</td>
</tr>
<tr>
<td>Corbett Creek Marsh</td>
<td>1.40</td>
<td>1</td>
<td>13.42</td>
<td>3</td>
<td>0.04</td>
<td>6.47</td>
<td>1</td>
<td>0.11</td>
</tr>
<tr>
<td>Lynde Creek Marsh</td>
<td>0.68</td>
<td>1</td>
<td>60.39</td>
<td>3</td>
<td>0.31</td>
<td>19.51</td>
<td>1</td>
<td>0.14</td>
</tr>
<tr>
<td>Cranberry Marsh</td>
<td>0.49</td>
<td>3</td>
<td>28.12</td>
<td>1</td>
<td>0.04</td>
<td>41.36</td>
<td>1</td>
<td>0.91</td>
</tr>
<tr>
<td>Campbells Creek Marsh</td>
<td>0.53</td>
<td>3</td>
<td>26.74</td>
<td>1</td>
<td>0.23</td>
<td>14.10</td>
<td>1</td>
<td>0.17</td>
</tr>
<tr>
<td>Duffins Creek Marsh</td>
<td>0.51</td>
<td>3</td>
<td>55.94</td>
<td>1</td>
<td>0.14</td>
<td>5.25</td>
<td>3</td>
<td>0.19</td>
</tr>
<tr>
<td>Hydro Marsh</td>
<td>0.61</td>
<td>3</td>
<td>15.11</td>
<td>3</td>
<td>0.04</td>
<td>5.25</td>
<td>3</td>
<td>0.11</td>
</tr>
<tr>
<td>Frenchman’s Bay Marsh</td>
<td>0.44</td>
<td>3</td>
<td>17.86</td>
<td>3</td>
<td>0.25</td>
<td>5.25</td>
<td>3</td>
<td>0.11</td>
</tr>
<tr>
<td>Rouge River Marsh</td>
<td>0.79</td>
<td>1</td>
<td>10.02</td>
<td>3</td>
<td>0.07</td>
<td>5.25</td>
<td>3</td>
<td>0.21</td>
</tr>
</tbody>
</table>

Table 8. Corresponding mean water quality parameter score and qualitative rank.

<table>
<thead>
<tr>
<th>Mean Score</th>
<th>Qualitative Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>Poor</td>
</tr>
<tr>
<td>3-4</td>
<td>Fair</td>
</tr>
<tr>
<td>4-5</td>
<td>Good</td>
</tr>
<tr>
<td>6-7</td>
<td>Excellent</td>
</tr>
</tbody>
</table>
Table 9. Water Quality Index for Lake Ontario sites using the Chow-Fraser WQI (for Turbidity, Conductivity, Temperature and pH) and ranked based on six categories (below).

<table>
<thead>
<tr>
<th>Wetland Name</th>
<th>WQI</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hay Bay South Marsh</td>
<td>-0.72</td>
<td>Moderately degraded</td>
</tr>
<tr>
<td>Hay Bay North Marsh</td>
<td>-0.01</td>
<td>Moderately degraded</td>
</tr>
<tr>
<td>Lower Napanee River Marsh</td>
<td>0.04</td>
<td>Good</td>
</tr>
<tr>
<td>Forester's Island Marsh</td>
<td>-0.12</td>
<td>Moderately degraded</td>
</tr>
<tr>
<td>Airport Creek Marsh</td>
<td>-0.46</td>
<td>Moderately degraded</td>
</tr>
<tr>
<td>Lower Sucker Creek East Marsh</td>
<td>-0.76</td>
<td>Moderately degraded</td>
</tr>
<tr>
<td>Lower Sucker Creek Marsh</td>
<td>0.22</td>
<td>Good</td>
</tr>
<tr>
<td>Solmesville East Marsh</td>
<td>0.26</td>
<td>Good</td>
</tr>
<tr>
<td>Marysville Creek Marsh</td>
<td>0.32</td>
<td>Good</td>
</tr>
<tr>
<td>Big Island East Marsh</td>
<td>0.53</td>
<td>Good</td>
</tr>
<tr>
<td>Big Island West Marsh</td>
<td>1.01</td>
<td>Very good</td>
</tr>
<tr>
<td>Lower Salmon River Marsh</td>
<td>-0.94</td>
<td>Moderately degraded</td>
</tr>
<tr>
<td>Robinson's Cove Marsh</td>
<td>0.22</td>
<td>Good</td>
</tr>
<tr>
<td>Blessington Creek Marsh</td>
<td>0.29</td>
<td>Good</td>
</tr>
<tr>
<td>Sawguin Creek North Marsh</td>
<td>0.36</td>
<td>Good</td>
</tr>
<tr>
<td>Sawguin Creek Central Marsh</td>
<td>0.34</td>
<td>Good</td>
</tr>
<tr>
<td>Sawguin Creek Ditched Marsh</td>
<td>-0.12</td>
<td>Moderately degraded</td>
</tr>
<tr>
<td>Carrying Place Marsh</td>
<td>-0.80</td>
<td>Moderately degraded</td>
</tr>
<tr>
<td>12 O'Clock Point Marsh</td>
<td>-1.76</td>
<td>Very degraded</td>
</tr>
<tr>
<td>Dead Creek Marsh</td>
<td>-0.09</td>
<td>Moderately degraded</td>
</tr>
<tr>
<td>Port Newcastle Marsh</td>
<td>-0.23</td>
<td>Moderately degraded</td>
</tr>
<tr>
<td>Wilmot Creek Marsh</td>
<td>-0.85</td>
<td>Moderately degraded</td>
</tr>
<tr>
<td>Bowmanville Marsh</td>
<td>-1.24</td>
<td>Very degraded</td>
</tr>
<tr>
<td>Westside Marsh</td>
<td>-1.61</td>
<td>Very degraded</td>
</tr>
<tr>
<td>McLaughlin Bay Marsh</td>
<td>-2.42</td>
<td>Highly degraded</td>
</tr>
<tr>
<td>Oshawa Second Marsh</td>
<td>-1.51</td>
<td>Very degraded</td>
</tr>
<tr>
<td>Pumphouse Marsh</td>
<td>-1.37</td>
<td>Very degraded</td>
</tr>
<tr>
<td>Corbett Creek Marsh</td>
<td>-1.71</td>
<td>Very degraded</td>
</tr>
<tr>
<td>Lynde Creek Marsh</td>
<td>-2.05</td>
<td>Highly degraded</td>
</tr>
<tr>
<td>Cranberry Marsh</td>
<td>-1.45</td>
<td>Very degraded</td>
</tr>
<tr>
<td>Carruthers Creek Marsh</td>
<td>-1.51</td>
<td>Very degraded</td>
</tr>
<tr>
<td>Duffins Creek Marsh</td>
<td>-1.92</td>
<td>Very degraded</td>
</tr>
<tr>
<td>Hydro Marsh</td>
<td>-1.19</td>
<td>Very degraded</td>
</tr>
<tr>
<td>Frenchman's Bay Marsh</td>
<td>-1.29</td>
<td>Very degraded</td>
</tr>
<tr>
<td>Rouge River Marsh</td>
<td>-1.17</td>
<td>Very degraded</td>
</tr>
</tbody>
</table>

Table 10. WQI Scores and Categories based on Chow-Fraser (2007).

<table>
<thead>
<tr>
<th>WQI Score</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>+3 to +2</td>
<td>Excellent</td>
</tr>
<tr>
<td>+2 to +1</td>
<td>Very good</td>
</tr>
<tr>
<td>+1 to 0</td>
<td>Good</td>
</tr>
<tr>
<td>0 to -1</td>
<td>Moderately degraded</td>
</tr>
<tr>
<td>-1 to -2</td>
<td>Very degraded</td>
</tr>
<tr>
<td>-2 to -3</td>
<td>Highly degraded</td>
</tr>
</tbody>
</table>
Based on this ranking scale, most of the BQ AOC sites are ranked as Moderately degraded or Good whereas the majority of the Durham Region sites were ranked Very degraded.

As comparison, some Lake Ontario sites presented in the Chow-Fraser study are also shown here (Table 11). It should be noted the data from the Chow-Fraser study varies from 1998-2002 which may in part, explain some of the differences observed between the two studies. Compare results obtained from this study with those obtained by Chow-Fraser (2007) is cautioned.

Table 11. WQIs for selected Lake Ontario sites (Chow-Fraser 2007; sample years in parentheses) compared with ranks for similar sites surveyed in 2006 by EC-CWS.

<table>
<thead>
<tr>
<th>Wetland Name</th>
<th>Chow-Fraser (2007) Rank</th>
<th>EC-CWS 2006 data Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hay Bay Marsh</td>
<td>Good (2002)</td>
<td>Moderately degraded</td>
</tr>
<tr>
<td>Sawguin Creek Marsh</td>
<td>Good (1998)</td>
<td>Good to Moderately degraded</td>
</tr>
<tr>
<td>Blessington Bay Creek Marsh</td>
<td>Good (2002)</td>
<td>Good</td>
</tr>
<tr>
<td>Lower Napanee River Marsh</td>
<td>Moderately degraded (1998)</td>
<td>Good</td>
</tr>
<tr>
<td>Frenchman’s Bay Marsh</td>
<td>Moderately degraded (2002)</td>
<td>Very degraded</td>
</tr>
</tbody>
</table>

Discussion and Delisting Criteria Recommendations

Justifying Water Quality Reporting for Delisting Criteria in the BQ AOC

Water quality indicators generated by EC-CWS (i.e., mean score) and Chow-Fraser (2007; i.e., WQI) are presented above. Although the Chow-Fraser (2007) four-parameter method only incorporates a subset of variables used by EC-CWS, there is excellent agreement between the two reporting methods. When water quality data from the same year and site are compared through the two reporting methods, the results are highly correlated in 2005 (r=0.90, n=23) and also when 12 additional sites were sampled in 2006 (r=0.87, n=35).

The consistency between these two methods confirms either method is suitable for reporting a ‘rolled-up’ water quality indicator for BQ AOC wetlands. In February 2007, the BQ Wildlife Steering Committee decided to use the EC-CWS method of generating and reporting water quality results for the purposes of the BQ RAP. This decision was based on the context in which each of the water quality measures was developed. The Chow-Fraser (2007) WQI was developed in the context of Great Lakes coastal wetlands whereas the EC-CWS water quality score was developed in the context of Lake Ontario coastal wetlands. Although the two measures are highly correlated, the results from Lake Ontario coastal wetlands occupy different extents of possible scores. The Chow-Fraser WQI reports normalized water quality results ranging from -3 (Highly degraded) to +3 (Excellent). Sites in Lake Ontario rarely score WQIs above +0.5 (Figure 25 and Chow-Fraser 2007). Other Great Lakes sites that scored above +0.5 are generally upstream of Lake Ontario in less disturbed Upper Great Lakes locations - especially Georgian Bay.
Figure 25. The relationship between the EC-CWS water quality score developed for Lake Ontario coastal wetlands and Chow-Fraser (2007) WQI developed for Great Lakes coastal wetlands (EC-CWS 2006 data; Durham Region (red), Bay of Quinte (blue)).

In contrast, the EC-CWS water quality scores range from 1.33 to 4.67 on a scale from 1 to 5 (Figure 25; Table 7). The BQ Wildlife Steering Committee concluded that, in the context of specifying delisting criteria for FWH-3 (Table 2), these water quality scores would better portray attainable water quality scores in the BQ AOC. The Committee decided an EC-CWS water quality score of 3.5 was sufficient to consider a site as not impaired with regard to delisting criterion FWH-3. To refine the delisting criterion in the context of the suite of representative sites (Table 4), the committee specified that for FWH-3 to be considered unimpaired:

The annual average water quality scores at representative Bay of Quinte coastal wetlands will be 3.50 (good) or above, and is stable or improving based on multi-year assessments. However, no more than three of the coastal wetland sites can score less than 3.33.

In contrast, the corresponding delisting criteria using WQIs would state the annual average WQI for the representative sites would be -0.25 (moderately degraded) or above in order to be considered unimpaired. Although Chow-Fraser's (2007) 'moderately degraded' designation actually reflects some of the better water quality conditions in Lake Ontario coastal wetlands, the contradictory nature of the statement does not instil confidence in the criterion. In addition, for BQ AOC stakeholders that are
not aware the WQIs are calculated in the context of Great Lakes coastal wetlands, an unimpaired designation of -0.25 on a scale of -3 to +3 creates additional ambiguity in the delisting criterion.

The 2006 average annual water quality score at representative BQ AOC wetlands is 3.49 (Table 12). Although Camachan Bay Marsh is not included in the calculations, the site would require a mean water quality score of 3.66 or higher for the delisting criterion to be met.

<table>
<thead>
<tr>
<th>Wetland Name</th>
<th>2006 Mean WQ Score</th>
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</thead>
<tbody>
<tr>
<td>Big Island Marsh</td>
<td>4.16*</td>
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<tr>
<td>Blessington Creek Marsh</td>
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<td>Carrying Place Marsh</td>
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<td>Camachan Bay Marsh</td>
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<td>Dead Creek Marsh</td>
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<td>3.16*</td>
</tr>
<tr>
<td>Lower Napanee River Marsh</td>
<td>3.33</td>
</tr>
<tr>
<td>Lower Sucker Creek Marsh</td>
<td>4.33</td>
</tr>
<tr>
<td>Sawguin Creek Marsh</td>
<td>3.77*</td>
</tr>
<tr>
<td>Airport Creek Marsh</td>
<td>3.00</td>
</tr>
<tr>
<td>Average</td>
<td>3.49</td>
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</table>

Table 12. Mean water quality scores at representative BQ AOC coastal wetlands. Rankings denoted with an asterisk indicate a mean for the site calculated by combining values for sub-sites (see Table 7; e.g., Big Island East and West).
4.0 Submerged Aquatic Vegetation Community

Submerged aquatic vegetation (SAV) community evaluations have been completed for many years in near- and off-shore zones in the BQ AOC (Leisti et al. 2006). Coastal wetland SAV assessments combined with continued assessments in other zones of the Bay can provide a more complete representation of overall SAV community condition in the BQ AOC.

BQ-RAPRC (2007) indicates impaired BQ AOC coastal wetland SAV communities are an important component of BUI 14.2 – Loss of wildlife habitat. For example, Prince (1985) found that decreased aquatic vegetation coverage decreased the attractiveness of an area for nesting and foraging birds.

This section provides an assessment of selected BQ AOC coastal wetland SAV community condition and develops a method to report on delisting criteria for FWH-2 (Submerged aquatic vegetation in Bay of Quinte wetlands is not impaired; Table 2).

Method Summary

SAV community evaluations were completed by randomly sampling 20 one-metre-square quadrats in the open water basin of each wetland (e.g., Figure 26). Within each quadrat, the total areal coverage plus species-specific coverage of each submerged and floating-leaved species was recorded.

Results

Submerged aquatic vegetation IBIs in Bay of Quinte coastal wetlands ranged from 34.6 (Lower Sucker Creek East Marsh) to 89.9 (Robinson's Cove Marsh; Table 13). Indices of biotic integrity were much higher in Bay of Quinte AOC sites compared to ($\bar{x} = 69.9 \pm 12.6$SD) Durham Region sites (17.4±19.8, t-test, $t_{20,15}=9.52$, p<0.001) in 2006. A notable exception to low IBIs in Durham Region is Oshawa Second Marsh, a managed wetland, which scored 80.9.

With the exception of Lower Sucker Creek East Marsh, all BQ AOC sites scored well on floristic quality (FQI), total cover (PCOV), and native species richness (SNAT) metrics. Turbidity intolerant species richness (SINT) and turbidity intolerant percent cover (PINT) metric scores were variable among sites. Robinson's Cove, Lower Salmon River, and Airport Creek marshes, which had the highest IBIs (89.9, 88.1, and 88.0), also scored high on the turbidity intolerant species richness metric (between 9.67 and 10) but scored variably for the turbidity intolerant percent cover metric (between 3.99 and 7.45). Many of the IBIs were greatly influenced by the low scores on turbidity intolerant metrics.

Of additional note is Hay Bay South Marsh, which scored IBIs of 90.0 and 97.8 in 2003 and 2005 respectively, but fell to 68.2 in 2006. Although mixed, according to categories defined by EC and CLOCA (2004), the majority of BQ AOC sites were ranked as 'Very Good' (Table 14).
Figure 26. The location of submerged aquatic vegetation sample points for Robinson's Cove Marsh.
Table 13. Submerged aquatic vegetation community metrics (scored out of 10) and IBIs (scored out of 100) for 20 Bay of Quinte Area of Concern (shaded) and 15 Durham Region coastal wetland sites in 2006. Recent IBIs for other Lake Ontario coastal wetlands are also included.

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</table>

**2006 Metrics**
- SINT: Number of turbidity-intolerant species
- PINT: Relative % cover of turbidity-intolerant species
- FQI: Floristic Quality Index
- PCOV: Total coverage
- SNAT: Total number of native species

**IBI**
- 2006
- 2005
- 2004
- 2003
- 2002

Bay of Quinte Coastal Wetland Status and RAP Delisting Targets

45
Table 14. Qualitative rankings (based on EC and CLOCA 2004) of submerged aquatic vegetation community condition in 20 Bay of Quinte Area of Concern coastal wetlands.

<table>
<thead>
<tr>
<th>Wetland Name</th>
<th>2006 IBI</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hay Bay South Marsh</td>
<td>68.2</td>
<td>Very Good</td>
</tr>
<tr>
<td>Hay Bay North Marsh</td>
<td>74.5</td>
<td>Very Good</td>
</tr>
<tr>
<td>Lower Napanee River Marsh</td>
<td>74.9</td>
<td>Very Good</td>
</tr>
<tr>
<td>Forester's Island Marsh</td>
<td>71.1</td>
<td>Very Good</td>
</tr>
<tr>
<td>Airport Creek Marsh</td>
<td>88.0</td>
<td>Excellent</td>
</tr>
<tr>
<td>Lower Sucker Creek East Marsh</td>
<td>34.6</td>
<td>Fair</td>
</tr>
<tr>
<td>Lower Sucker Creek Marsh</td>
<td>63.2</td>
<td>Very Good</td>
</tr>
<tr>
<td>Solmesville East Marsh</td>
<td>79.4</td>
<td>Very Good</td>
</tr>
<tr>
<td>Marysville Creek Marsh</td>
<td>75.9</td>
<td>Very Good</td>
</tr>
<tr>
<td>Big Island East Marsh</td>
<td>58.2</td>
<td>Good</td>
</tr>
<tr>
<td>Big Island West Marsh</td>
<td>58.4</td>
<td>Good</td>
</tr>
<tr>
<td>Lower Salmon River Marsh</td>
<td>88.1</td>
<td>Excellent</td>
</tr>
<tr>
<td>Robinson's Cove Marsh</td>
<td>89.9</td>
<td>Excellent</td>
</tr>
<tr>
<td>Blessington Creek Marsh</td>
<td>69.3</td>
<td>Very Good</td>
</tr>
<tr>
<td>Sawguin Creek North Marsh</td>
<td>57.6</td>
<td>Good</td>
</tr>
<tr>
<td>Sawguin Creek Central Marsh</td>
<td>65.9</td>
<td>Very Good</td>
</tr>
<tr>
<td>Sawguin Creek Ditched Marsh</td>
<td>73.4</td>
<td>Very Good</td>
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<td>Carrying Place Marsh</td>
<td>63.2</td>
<td>Very Good</td>
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<td>12 O'Clock Point Marsh</td>
<td>69.7</td>
<td>Very Good</td>
</tr>
<tr>
<td>Dead Creek Marsh</td>
<td>73.5</td>
<td>Very Good</td>
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</table>

Discussion and Delisting Criteria Recommendations

SAV Community Condition in the BQ AOC

Water quality data (Section 3) indicate BQ AOC sites are less disturbed than Durham Region sites. This is also reflected in the SAV community condition. Of notable exception in the Bay of Quinte is the Lower Sucker Creek East site. This site scored 34.6 out of 100. This site is a fringing shoreline wetland – openly exposed to constant wind and wake-related wave action. Although this type of wetland has a limited capacity to support certain kinds of habitats (see aquatic macroinvertebrate and breeding marsh bird community results; Table 17 and Table 21), they still have vital riparian buffer zone and wildlife corridor functions (see BQ-RAPRC 2007; delisting criterion FWH-4).

Declining SAV IBI at Hay Bay South Marsh

The SAV community IBI at Hay Bay South Marsh has decreased 29.6 IBI points from 2005 to 2006. According to EC and CLOCA (2004) a decrease of this magnitude indicates a statistically significant decrease in SAV community condition. Water quality is known to impact SAV community attributes in Great Lakes coastal wetlands (Chow-Fraser 2007; Albert and Minc 2004; EC and CLOCA 2004; Lougheed et al. 2001). Although site-specific supporting data are limited, the IBI decrease appears related to a decrease in water quality over the same period (Figure 27). Due to an absence of data
from the site for 2004, the timing of the decrease in water quality is unclear. The decrease in water quality is first observed in 2005 while the decrease in SAV community conditions occurs in 2006. This suggests a lag time in SAV community response following the decrease in water quality at the site. The direct cause of the water quality decline is not known. The lack of clarity surrounding this stressor response relationship emphasizes the need to continue coastal wetland monitoring in the BQ AOC.

![Figure 27. The decrease in water quality (●) and submerged aquatic vegetation community condition (▲) at Hay Bay South Marsh from 2003 to 2006.](image)

**The Utility of Assessing SAV Community Condition in Addition to Water Quality**

Although water quality in the BQ AOC coastal wetlands is generally better than Durham Region (see Section 3), it is typically ranked as 'good' or 'moderately degraded' in a Great Lakes context. These water quality parameters represent snapshots in time and are only representative of the relative overall water quality throughout the growing season (see EC and CLOCA 2005). To ensure water quality sampling is representative of the site, samples are not taken during heightened climatic events such as heavy rainfall or strong winds. However, it is clear these events can affect site conditions throughout the growing season. For example, from DRCWMP data, it is evident that there is a relationship between turbidity and total daily rainfall (Figure 28; adapted from EC and CLOCA 2004). A significant correlation exists between the mean daily turbidity and two-day rainfall totals, i.e., the sum of rainfall on the day of the measurement and the previous day ($r=0.49$, $p=0.03$, $n=20$).
Figure 28. Weekly mean turbidimeter readings (NTU) (May to September, 2003) from Lynde Creek Marsh and total daily rainfall (mm). Mean overall turbidity at this wetland is shown for comparison (from EC and CLOCA 2004; Figure 2.1.1-2).

In the BQ AOC coastal wetlands, similar periods of increased turbidity may be responsible for the generally low turbidity intolerant species metrics (SINT and PINT). Examining the relationship between 2006 turbidity measures and these metrics revealed that the richness of turbidity intolerant SAV species (SINT) is negatively affected by increased turbidity ($r=-0.42$, $p<0.05$, $n=35$) but the coverage of those species is not significantly affected.

Wetland water quality in Lake Ontario coastal wetlands affects SAV and aquatic macroinvertebrate species that complete all or part of their lifecycles in aquatic environments (EC and CLOCA 2004). Because aquatic macroinvertebrate communities develop over time, they experience various water quality conditions throughout their development. Therefore aquatic macroinvertebrate community condition is influenced by recent water quality at the site and not just the snapshot provided by single visit sampling. IBIs for aquatic macroinvertebrate communities in Durham Region and BQ AOC coastal wetlands are significantly correlated with all of the SAV metrics – including SINT and PINT ($r=0.51$ and 0.35, respectively, $p<0.05$, $n=35$). This suggests periods of reduced water quality (that involve increased turbidity) may be affecting SINT and PINT of the SAV community. These effects are also mirrored by the condition of the macroinvertebrate community.
Justifying Delisting Criterion

The International Joint Commission has a summarized lists of BUI and delisting criteria for each RAP (Table 1 at http://www.ijc.org/rel/boards/annex2/buis.htm#table1). Delisting criteria for fish and wildlife habitat impairments consistently list no loss of habitat as a delisting goal. In addition, a persisting paradigm for RAP delisting criteria is to demonstrate the BUI is not more impaired within the AOC than outside the AOC. To address these requirements, recent SAV IBIs at 25 Lake Ontario coastal wetlands outside of the BQ AOC and 21 sites within the AOC were considered (Figure 29).

![Figure 29. Submerged aquatic vegetation community IBIs for 46 Lake Ontario coastal wetlands. Points are mean IBIs based on data in Table 13 (i.e., 101 site-years of data). Sites are evenly arranged from west to east so the distance between site labels on the axis is not representative of geographical distance.]

Following the paradigm, it is clear that BQ AOC coastal wetland SAV communities are generally at or in better condition than sites outside of the AOC – and therefore not impaired. As such, current conditions were used to specify delisting criteria for FWH-2. In February 2007, the BQ Wildlife Steering Committee agreed that for FWH-2 to be deemed not impaired:

The average submerged aquatic vegetation Index of Biotic Integrity (IBI) at representative coastal wetlands will be 60 or above using the DRCWMP: Methodology Handbook (EC and CLOCA 2007) protocol to collect data and the
**IBI mean is stable or improving based on multi-year assessments. However, no more than three of the coastal wetland sites can score less than 60 in one year.**

The 2006 average SAV IBI at representative BQ AOC wetlands is 69.7 (Table 15). Although Carnachan Bay Marsh is not included in the calculations, if the site scored above 25.0, the average for the representative sites would be still be above 65.0 with no more than three sites scoring below an IBI of 60.0. No Bay of Quinte sites surveyed in 2006 scored below 34.0 (Lower Sucker Creek East Marsh: 34.6) with the rest of the sites scoring above 58.3. A cursory examination of Carnachan Bay Marsh (air photo interpretation) suggests the SAV community would score well above an IBI of 25.0.

In the absence of data from Carnachan Bay, the status of FWH-2 cannot be confirmed. This delisting criterion should be considered conditionally delisted.

Table 15. Submerged aquatic vegetation IBIs at representative Bay of Quinte Area of Concern coastal wetlands. IBIs denoted with an asterisk indicate a mean for the site calculated by combining values for sub-sites (see Table 13; e.g., Big Island East and West).

<table>
<thead>
<tr>
<th>Wetland name</th>
<th>2006 IBI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Big Island Marsh</td>
<td>58.3*</td>
</tr>
<tr>
<td>Blessington Creek Marsh</td>
<td>69.3</td>
</tr>
<tr>
<td>Carrying Place Marsh</td>
<td>63.2</td>
</tr>
<tr>
<td>Carnachan Bay Marsh</td>
<td>NA</td>
</tr>
<tr>
<td>Dead Creek Marsh</td>
<td>73.5</td>
</tr>
<tr>
<td>Hay Bay Marsh</td>
<td>71.4*</td>
</tr>
<tr>
<td>Lower Napanee River Marsh</td>
<td>74.9</td>
</tr>
<tr>
<td>Lower Sucker Creek Marsh</td>
<td>63.2</td>
</tr>
<tr>
<td>Sawguin Creek Marsh</td>
<td>65.6*</td>
</tr>
<tr>
<td>Airport Creek Marsh</td>
<td>88.0</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>69.7</strong></td>
</tr>
</tbody>
</table>
5.0 Aquatic Macroinvertebrate Community

BQ-RAPRC (2005) uses the Wildlife Ministers Council of Canada (Environment Canada 1990) definition of wildlife. By the definition, wildlife includes all non-domestic organisms – mammals, birds, fish, amphibians, reptiles, vascular plants, etc. – which also includes aquatic macroinvertebrates. As such, BUI 3.2 - Degradation of wildlife populations could consider degradation of aquatic macroinvertebrate communities. Much work has been done in the BQ AOC with respect to the condition of benthic invertebrate communities occupying open water zones of the bay (Dermott 2001, Dermott 2003, Milani et al. 2001, Johnson and McNeil 1986,) but few data are available to evaluate nektonic (free swimming) and epiphytic (plant dwelling) macroinvertebrate communities in coastal wetlands. However, the importance of evaluating coastal wetland aquatic macroinvertebrates as a measure of wildlife population degradation in the BQ AOC and other Canadian AOCs is generally not recognized. This is likely because nektonic and epiphytic macroinvertebrate communities do not provide the same perceivable economic and social value as other faunal communities such as birds and fish.

Coastal wetland macroinvertebrate communities are important in nutrient cycling and as food for other fauna. Aquatic macroinvertebrates are the primary food source for many fish species. In addition, species that emerge as flying insects provide many species of amphibians and wetland-dependent birds with a forage base.

Aquatic macroinvertebrate community structure is also known to reflect current or recent water quality in Great Lakes coastal wetlands (Gathman et al. 1999; Kostuk 2006). Through the development of a coastal wetland aquatic macroinvertebrate IBI, EC and CLOCA (2004) have demonstrated the aquatic macroinvertebrate community structure in Lake Ontario coastal wetlands is affected by anthropogenic disturbance. The disturbance estimates used in the IBI development rely heavily on the integration of water quality parameters.

As a food source and water quality indicator in coastal wetlands, the nektonic and epiphytic aquatic macroinvertebrate community condition can be used, in combination with other factors such as SAV community condition and water quality, as an indicator of aquatic habitat quality. As such, assessing the condition of the aquatic macroinvertebrate community in BQ AOC coastal wetlands can contribute to the evaluation of BUI 14 – Loss of fish and wildlife habitat.

Despite the importance of the aquatic macroinvertebrate community in BQ AOC coastal wetlands, BQ-RAPRC (2007) does not recommend evaluating the condition of this community as an element of delisting criteria for BUIs 3 and 14. This section demonstrates the utility of these data to support and augment existing delisting criteria (i.e., FWH-2 and FWH-3).

Method Summary

Methods for aquatic macroinvertebrate sampling were based on Burton et al. (1999), which were the methods used in the recent Great Lakes Coastal Wetland Consortium indicators research. For each wetland, three replicate sub-samples of approximately 150 aquatic macroinvertebrates (≥500μm) were taken by sweep-netting through the water column in the cattail (Typha spp.) dominated emergent communities. These samples represent a combination of primarily nektonic and epiphytic species.
assemblages – not benthic. Macroinvertebrates were identified to the lowest taxonomic group possible.

A Note on Great Lakes-wide Applicability

An aquatic macroinvertebrate (nektonic and epiphytic) community IBI is currently under finalization by the Great Lakes Coastal Wetland Consortium (www.glc.org/wetlands). The lead investigators have developed an IBI for macroinvertebrates inhabiting vegetation zones such as meadow marsh and dense Scirpus zones, while conceding they were unable to identify suitable metrics in the Typha vegetation zone. However, unlike meadow marsh and Scirpus vegetation zones, Typha zones are omnipresent in Lake Ontario coastal wetlands. With access to more extensive Lake Ontario-based data than those used by GLCWC lead investigators, EC-CWS developed the aquatic macroinvertebrate IBI (EC and CLOCA 2004) which was used in this report. GLCWC lead investigators for the aquatic macroinvertebrate community condition IBIs recognize the suitability of the EC and CLOCA (2004) IBI for use in Lake Ontario coastal wetlands. It is expected this IBI will be included and endorsed as the preferred method to report on Lake Ontario coastal wetland macroinvertebrate community condition in the GLCWC implementation plan to be completed in September 2007.

Results

BQ AOC sites scored IBIs between 44.0 and 90.9 (Big Island East and Lower Salmon River marshes, respectively) and generally scored better than Durham Region sites (Table 20). Most metric scores were variable among Bay of Quinte sites. The metric scores for the relative abundance of Trichoptera (PTRI) were extremely variable ranging from 0 to 10, with only one site, Lower Salmon River Marsh, scoring above 5. The metric scores for total number of families (NFAM) were not as variable, ranging from 5 to 10, with the majority of sites scoring above 9. The majority of BQ AOC sites scored well on the relative abundance of Ephemeroptera (PEPH) metric compared to Durham Region sites. Overall, Bay of Quinte sites were generally ranked as 'Very Good' or 'Excellent' according to EC and CLOCA (2004; Table 18).

In 2006, IBIs in BQ AOC sites (x=71.5±11.2SD) were significantly higher than sites outside the AOC (i.e., Durham Region sites; 57.0±9.8; t-test, t20,15=-4.00, p<0.001).

Table 16. Metric codes used in Table 17.

<table>
<thead>
<tr>
<th>Metric Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCMG</td>
<td>No. of Crustacea + Mollusca genera</td>
</tr>
<tr>
<td>NETG</td>
<td>No. of Ephemeroptera + Trichoptera genera</td>
</tr>
<tr>
<td>NODO</td>
<td>No. of Odonata genera</td>
</tr>
<tr>
<td>NFAM</td>
<td>Total no. of families</td>
</tr>
<tr>
<td>PAMP</td>
<td>% Amphipoda</td>
</tr>
<tr>
<td>PCRM</td>
<td>% Crustacea + Mollusca</td>
</tr>
<tr>
<td>PEPH</td>
<td>% Ephemeroptera</td>
</tr>
<tr>
<td>PISO</td>
<td>% Isopoda</td>
</tr>
<tr>
<td>PTERI</td>
<td>% Trichoptera</td>
</tr>
<tr>
<td>PDIP</td>
<td>% Diptera</td>
</tr>
<tr>
<td>PCRU</td>
<td>% Crustacea</td>
</tr>
</tbody>
</table>
Table 17. Aquatic macroinvertebrate community metrics (scored out of 10) and IBIs (scored out of 100) for 20 Bay of Quinte Area of Concern (shaded) and 15 Durham Region coastal wetland sites in 2006. Recent IBIs for other Lake Ontario coastal wetlands are also included. Wetlands are ordered vertically from east to west. Metric codes are listed in the results section (Table 16).

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Hill Island East Marsh</td>
<td></td>
<td>86.2</td>
<td>73.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Little Cataraqui Marsh</td>
<td></td>
<td>96.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bayfield Bay Marsh</td>
<td></td>
<td>80.2</td>
<td>63.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Burton Bay Marsh</td>
<td></td>
<td>58.9</td>
<td>47.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parrott's Bay Marsh</td>
<td></td>
<td>69.3</td>
<td>76.0</td>
<td>75.4</td>
<td>75.4</td>
<td>85.7</td>
</tr>
<tr>
<td>Amherst Island Diked Marsh</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>43.9</td>
</tr>
<tr>
<td>Amherst Island Undiked Marsh</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>50.4</td>
</tr>
<tr>
<td>Bay of Quinte Coastal Wetland Status and RAP Delisting Targets</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 18. Qualitative rankings of aquatic macroinvertebrate community condition in twenty Bay of Quinte Area of Concern coastal wetlands.

<table>
<thead>
<tr>
<th>Wetland Name</th>
<th>2006 IBI</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hay Bay South Marsh</td>
<td>75.6</td>
<td>Very Good</td>
</tr>
<tr>
<td>Hay Bay North Marsh</td>
<td>87.3</td>
<td>Excellent</td>
</tr>
<tr>
<td>Lower Napanee River Marsh</td>
<td>82.9</td>
<td>Excellent</td>
</tr>
<tr>
<td>Forester’s Island Marsh</td>
<td>69.9</td>
<td>Very Good</td>
</tr>
<tr>
<td>Airport Creek Marsh</td>
<td>82.1</td>
<td>Excellent</td>
</tr>
<tr>
<td>Lower Sucker Creek East Marsh</td>
<td>69.9</td>
<td>Very Good</td>
</tr>
<tr>
<td>Lower Sucker Creek Marsh</td>
<td>71.5</td>
<td>Very Good</td>
</tr>
<tr>
<td>Solmesville East Marsh</td>
<td>78.6</td>
<td>Very Good</td>
</tr>
<tr>
<td>Marysville Creek Marsh</td>
<td>70.1</td>
<td>Very Good</td>
</tr>
<tr>
<td>Big Island East Marsh</td>
<td>44.0</td>
<td>Good</td>
</tr>
<tr>
<td>Big Island West Marsh</td>
<td>52.4</td>
<td>Good</td>
</tr>
<tr>
<td>Lower Salmon River Marsh</td>
<td>90.9</td>
<td>Excellent</td>
</tr>
<tr>
<td>Robinson’s Cove Marsh</td>
<td>68.4</td>
<td>Very Good</td>
</tr>
<tr>
<td>Blessington Creek Marsh</td>
<td>81.9</td>
<td>Excellent</td>
</tr>
<tr>
<td>Sawguin Creek North Marsh</td>
<td>67.2</td>
<td>Very Good</td>
</tr>
<tr>
<td>Sawguin Creek Central Marsh</td>
<td>60.5</td>
<td>Very Good</td>
</tr>
<tr>
<td>Sawguin Creek Ditched Marsh</td>
<td>64.6</td>
<td>Very Good</td>
</tr>
<tr>
<td>Carrying Place Marsh</td>
<td>74.0</td>
<td>Very Good</td>
</tr>
<tr>
<td>12 O’Clock Point Marsh</td>
<td>67.6</td>
<td>Very Good</td>
</tr>
<tr>
<td>Dead Creek Marsh</td>
<td>70.9</td>
<td>Very Good</td>
</tr>
</tbody>
</table>

**Discussion and Delisting Criteria Recommendations**

*The Utility of Assessing the Aquatic Macroinvertebrate Community Condition in BQ AOC*

Aquatic macroinvertebrate IBIs for BQ AOC sites were higher than Durham Region sites in 2006. These findings are consistent with water quality and particularly submerged aquatic vegetation results. Aquatic macroinvertebrate community IBIs are moderately, but significantly correlated with the water quality index ($r=0.34$, $p<0.05$, $n=34$), whereas IBIs are more strongly related to the SAV IBI and its individual standardized metrics (Table 19).

Table 19. Correlations between aquatic macroinvertebrate IBIs in 2006 and SAV IBI and component metrics. All correlations are statistically significant ($p<0.05$, $n=34$).

<table>
<thead>
<tr>
<th>SAV Community Parameter</th>
<th>Correlation r-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of turbidity-intolerant species</td>
<td>0.51</td>
</tr>
<tr>
<td>Relative % cover of turbidity-intolerant species</td>
<td>0.35</td>
</tr>
<tr>
<td>Floristic Quality Index</td>
<td>0.55</td>
</tr>
<tr>
<td>Total coverage</td>
<td>0.50</td>
</tr>
<tr>
<td>Total number of native species</td>
<td>0.56</td>
</tr>
<tr>
<td>SAV IBI</td>
<td>0.56</td>
</tr>
</tbody>
</table>

These results corroborate the notion that aquatic macroinvertebrate communities are indicators of aquatic environmental conditions in Lake Ontario coastal wetlands. The fact macroinvertebrate IBIs show stronger relationships with SAV parameters than with WQI suggests the condition of the aquatic biotic communities may be a more robust...
indicator of site disturbance than one-time water quality measurements. Nonetheless, one time water quality measurements are still essential because they provide concrete physical parameters (e.g., turbidity, conductivity) to link biotic condition and the physical state of the site. For example, the 2006 mean invertebrate IBIs and water conductivity are significantly correlated (r=-0.48, p<0.05, n=34). The regression equation for this relationship is:

\[ \text{Macroinvertebrate IBI} = 76.22 - 21.97 \times \text{Conductivity} \]

For site management or delisting purposes, if an IBI of 70.0 is sought, then solving the equation for conductivity gives 0.283. This suggests that part of attaining the target IBI of 70.0 is that water conductivity at the site should not generally exceed 0.283 mScm⁻¹. There are other aspects of water quality (i.e., total phosphorus) that affect the macroinvertebrate IBI. By exploring the relationship as above or through multiple regression models, similar guidelines for restoration or delisting could be developed.

**Justifying the Suggested Delisting Criterion**

Summarizing and analyzing data from 2002-2006 reveals IBIs in BQ AOC sites (\( \bar{x} = 72.7 \pm 9.0 \text{SD} \)) were significantly higher than Lake Ontario sites outside the AOC (59.4±12.8; t-test, t_{21.27}=-4.02, p=0.0002; Figure 30). These results can be used to form a delisting criterion for the BQ AOC. Current data suggest aquatic macroinvertebrate community condition in BQ AOC coastal wetlands is not more impaired than the rest of Lake Ontario. Therefore, in the context of reporting on representative sites (BQ-RAPRC 2007), it is recommended that, as a possible habitat delisting target:

> The average aquatic macroinvertebrate Index of Biotic Integrity (IBI) at representative coastal wetlands will be 65 or above using the DRCWMP: Methodology Handbook (EC and CLOCA 2007) protocol to collect data and the IBI average is stable or improving based on multi-year assessments. However, no more than three of the coastal wetland sites can score less than 65 in one year.

Of the nine representative sites sampled in 2006, the average IBI was 73.0 with two sites below 65.0 (Table 20). Even if Carnachan Bay Marsh scored albeit an unlikely IBI of 0 (i.e., site is devoid of macroinvertebrates), the mean IBI score would still be 65.7 and no more than three sites would have scored below 65.0.

| Following the above delisting criterion recommendation, impairments to the coastal wetland aquatic macroinvertebrate community would be delisted. |
By combining values for each site (see Table 17) and calculating the mean for the site, the calculated wetland's B/C ratio is determined. The site is then a mean for the site calculated B/C ratio for the site.

Table 20. Aquatic macroinvertebrate community B/C ratio for Great Lake Ontario coastal wetlands.
Meeting Delisting Criterion for Aquatic Macroinvertebrate Community Condition

Although the Sawguin Creek Marsh IBI was marginally below the 65.0 delisting criterion cut-off, Big Island Marsh, at 48.2 was well below the cut-off (Table 20). This is consistent with the findings in the SAV community (average for Big Island Marsh=58.3), which were also generally below the other representative BQ AOC sites.

These findings suggest other factors are impacting aquatic communities at Big Island Marsh. The fact the water quality was ranked as ‘excellent’ (Table 7) at this site implies that either there could be some other water quality parameter affecting these communities that has not been assessed in this study, or there are periods of poor water quality outside of the sampling time at this site.

Outward signs of large impacts to the marsh are not apparent. Agricultural land use surrounding this marsh is moderate compared to other Lake Ontario coastal wetlands (EC-CWS; unpublished data); there is no intense urbanization (industrialization), signs of open erosion zones, or large inputs from connecting watercourses. Further study is required to identify the stressor(s) affecting these communities. It is noteworthy the stressor does not appear to be directly affecting the marsh bird community (2005 and 2006 IBIs all over 90.0; Table 21) or marsh bird habitat.

Importance of Assessing the Aquatic Macroinvertebrate Community Condition

Aquatic macroinvertebrate communities are not mentioned in BQ RAP (2007) for monitoring. However, the State of the Lakes Ecosystem Conferences (SOLEC) determined that macroinvertebrate community condition is a valuable indicator in monitoring Great Lakes coastal wetlands (indicator #4501). In addition to feeding into the SOLEC process, there are several advantages to collecting and reporting these data as part of monitoring BQ AOC coastal wetlands:

1. Data can be used to help define habitat-related delisting criteria.
2. Aquatic macroinvertebrate samples are easy and inexpensive to collect.
3. The condition of the aquatic macroinvertebrate community can reveal recent water quality conditions not apparent from one-time sampling and provides additional information regarding the nature of wetland-specific stressors.
4. Aquatic macroinvertebrates may provide an early warning system of potential change due to their relatively short lifespan, aquatic dependency, and low level in the food chain.

In recognition of these advantages, it is recommended that macroinvertebrate communities be monitored in BQ AOC coastal wetlands in support of delisting target reporting and monitoring Lake Ontario coastal wetland condition in general.
6.0 Marsh Breeding Bird Community

When degraded fish and wildlife populations are listed as impaired (BUI 3) in Canadian Great Lakes AOCs, wetland bird communities are often considered by the RAP as important indicators (e.g., St. Lawrence River, Detroit River; St. Clair River, and Hamilton Harbour). The BQ-RAPRC has recognized the need to determine the condition of wetland breeding bird communities. Part of delisting BUI 3 involves demonstrating these bird communities are not impaired according to delisting criterion WP-2 (Healthy wetland bird populations in Bay of Quinte coastal wetlands).

Data collected through the Marsh Monitoring Program (MMP) have been used to assess the condition of the marsh breeding bird community at a site-level. However, the utility of these data to report on site-level wetland bird communities requires further research. Administrators of the MMP recognize their protocol may not be suitable for site-specific assessments and assert that these data are most applicable to monitoring long-term regional trends in marsh breeding bird populations (Weeber and Vallianatos 2000). Within-year site variability and annual variability may be too high to make reliable annual assessments of breeding marsh bird community condition, and longer-term trends are likely the only feasible method of reporting. Long-term trends may not suit the needs of decision makers and administrators involved with wildlife management. The drawback to relying on long-term trends is that by the time a drop in population parameters (abundance, richness) is detected, the damage is done and it will likely take more resources and time to implement a recovery strategy.

To address this issue, EC-CWS staff, in consultation with Bird Studies Canada (BSC) (administrators of the MMP), completed a study to more accurately assess site-specific breeding marsh bird communities in Lake Ontario coastal wetlands on an annual basis (see Meyer et al. 2006). The study augmented the existing MMP protocol with: 1) three visits to each survey station instead of two, 2) establishment of survey stations in the interior of the marsh as opposed to just the perimeter, and 3) an effort to survey as many stations as possible within each site (based on surveying constraints, logistics, and safety). The specific recommendations that came from Meyer et al. (2006) were:

*If the marsh bird survey protocol from the MMP is implemented to evaluate the marsh bird community annually at a site-level, the following modifications should be made:*

1. Wetland spatial complexity and marsh habitat should be visually assessed from a recent aerial photograph before visiting the site,
2. Potential survey stations should be identified within the wetland based on at least a 250-metre grid system with interior stations required for spatially complex wetlands. Survey stations should be initially selected according to MMP habitat criteria,
3. Survey stations should be visited before surveying and selected based on habitat criteria, accessibility, safety, and to maximize surveying time,
4. An equal number of interior and shoreline stations should be selected for spatially complex wetlands, where possible,
• Each station should be visited three times during the breeding season (i.e., peak vocalization time) for marsh dependent birds in that ecoregion.

These recommendations are recognized in the revised DRCWMP Methodology Handbook (EC and CLOCA 2007) and are recommended for assessment of BQ AOC sites.

Method Summary
From 2002 to 2004, MMP protocol was used to survey bird communities within various Lake Ontario coastal wetlands. Following the recommendations of Meyer et al. (2006), for 2005 and 2006, a modified MMP protocol was used in which an additional visit was added along with interior stations. Data from 2002 to 2006 were collected by volunteers and, in the absence of volunteers, conservation authority and CWS staff.

EC and CLOCA (2004) developed a method to report on the condition of breeding marsh bird communities in Lake Ontario coastal wetlands using IBIs. The development of this marsh bird community IBI was done in part to report on Durham Region coastal wetlands as part of the DRCWMP and also as a contributing partner to the bi-national GLCWC (GLCWC; see www.glc.org/wetlands). BSC staff (Crewe and Timmermans 2005) developed a basin-wide IBI to contribute to the GLCWC process. Since then, the multi-partner academia-based Great Lakes Environmental Indicator (GLEI) project has developed and published a U.S.-focused basin-wide coastal wetland bird indicator (Howe et al. In press). Currently, there is a concerted effort by the aforementioned individuals and organizations to reconcile the three indicators and create a bi-national basin-wide method to report on coastal wetland bird communities using a standardized IBI (herein 'reconciled IBI'). This work is expected to be complete in September 2007.

This document reports on Lake Ontario coastal wetland bird community condition using the IBI developed by EC and CLOCA (2004). An interim delisting criterion for WP-2 will be developed from these results. Once the Great Lakes reconciled IBI is ready for application, the interim delisting criteria can be updated to reflect the new reporting format. It is important to note that EC and CLOCA (2004) and the reconciled IBI are expected to be closely related; results generated from EC and CLOCA (2004) method will be very similar when scored out of 100. This is because both methods use attributes of the bird community that respond to disturbance and provide a 'roll-up' to community condition. Any differences between the IBIs reported here and the reconciled IBI are expected to be due to nuances in data treatment to address all of the partners' needs and concerns.

Results
BQ AOC sites scored IBIs from 38.6 (Lower Sucker Creek East Marsh) to 95.8 (Hay Bay North Marsh); nine of 20 BQ AOC IBIs were over 80.0 (Table 21). Sites with IBIs greater than 80.0 generally scored above 7 across all metrics except for marsh area-sensitive species richness (SMAS) where scores were over 6. Belleville Marsh scored particularly low for the richness and abundance of marsh area-sensitive species richness (SMAS and PMAS) with scores of less than 4. Lower Sucker Creek East, Forester's Island, and Carrying Place marshes also score below 4 for PMAS but were above 4 for SMAS.
In 2006, IBIs in BQ AOC sites ($\bar{x} = 74.2 \pm 18.5SD$) were significantly higher than sites outside the AOC (61.2±20.7; $t$-test, $t_{20,20} = -2.08$, $p=0.044$. Overall, BQ AOC sites were generally ranked in 'Excellent' or 'Very Good' condition (Table 22).

In addition, BQ-RAPRC (2007) includes a description of delisting criterion WP-3 as:

- **Shoreline habitat is suitable for supporting raptors.**
  - Presence of nesting ospreys, including the successful fledging of chicks, on or near the Bay of Quinte shoreline each year.
  - Maintain identified critical natural areas.

Although the purpose of this study was not to evaluate this delisting criterion, it is noteworthy to confirm nesting ospreys occupied platforms at Marysville Creek, Lower Napanee River, and Blessington Creek marshes in 2006.
Table 21. Bird community metrics (scored out of 10) and IBIs (scored out of 100) for 20 Bay of Quinte Area of Concern (shaded) and 19 other Lake Ontario coastal wetland sites in 2006. Recent IBIs for Durham Region sites are also included. Wetlands are ordered vertically from east to west.

<table>
<thead>
<tr>
<th>Wetland Name</th>
<th>2006 Metrics</th>
<th>IBI 2006</th>
<th>2005</th>
<th>2004*</th>
<th>2003*</th>
<th>2002*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SMAS</td>
<td>PMNO</td>
<td>PMUS</td>
<td>PMAS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bayfield Bay Marsh</td>
<td>6.43</td>
<td>10</td>
<td>9.42</td>
<td>10</td>
<td>89.6</td>
<td>91.1</td>
</tr>
<tr>
<td>Button Bay Marsh</td>
<td>2.50</td>
<td>3.95</td>
<td>7.75</td>
<td>3.27</td>
<td>43.7</td>
<td>39.5</td>
</tr>
<tr>
<td>Parrott's Bay Marsh</td>
<td>5.00</td>
<td>7.83</td>
<td>8.64</td>
<td>5.83</td>
<td>68.3</td>
<td>80.7</td>
</tr>
<tr>
<td>Hay Bay South Marsh</td>
<td>8.33</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>95.8</td>
<td>92.5</td>
</tr>
<tr>
<td>Hay Bay North Marsh</td>
<td>6.88</td>
<td>10</td>
<td>8.42</td>
<td>10</td>
<td>88.3</td>
<td>92.5</td>
</tr>
<tr>
<td>Big Sand Bay Marsh</td>
<td>6.67</td>
<td>6.95</td>
<td>9.23</td>
<td>8.65</td>
<td>78.8</td>
<td>58.6</td>
</tr>
<tr>
<td>South Bay Marsh</td>
<td>6.25</td>
<td>9.34</td>
<td>8.36</td>
<td>10</td>
<td>84.9</td>
<td></td>
</tr>
<tr>
<td>Lower Napanee River Marsh</td>
<td>5.00</td>
<td>4.59</td>
<td>7.44</td>
<td>3.47</td>
<td>51.3</td>
<td></td>
</tr>
<tr>
<td>Forester's Island Marsh</td>
<td>5.00</td>
<td>7.26</td>
<td>7.90</td>
<td>10</td>
<td>75.4</td>
<td></td>
</tr>
<tr>
<td>Airport Creek Marsh</td>
<td>5.00</td>
<td>4.15</td>
<td>6.20</td>
<td>3.40</td>
<td>38.6</td>
<td></td>
</tr>
</tbody>
</table>

Bay of Quinte Coastal Wetland Status and RAP Delisting Targets
Table 22. Qualitative rankings of breeding marsh bird community condition in 20 Bay of Quinte Area of Concern coastal wetlands.

<table>
<thead>
<tr>
<th>Wetland Name</th>
<th>2006 IBI</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hay Bay South Marsh</td>
<td>68.3</td>
<td>Very Good</td>
</tr>
<tr>
<td>Hay Bay North Marsh</td>
<td>95.8</td>
<td>Excellent</td>
</tr>
<tr>
<td>Lower Napanee River Marsh</td>
<td>84.9</td>
<td>Excellent</td>
</tr>
<tr>
<td>Forester's Island Marsh</td>
<td>51.3</td>
<td>Good</td>
</tr>
<tr>
<td>Airport Creek Marsh</td>
<td>75.4</td>
<td>Very Good</td>
</tr>
<tr>
<td>Lower Sucker Creek East Marsh</td>
<td>38.6</td>
<td>Fair</td>
</tr>
<tr>
<td>Lower Sucker Creek Marsh</td>
<td>72.6</td>
<td>Very Good</td>
</tr>
<tr>
<td>Solmesville East Marsh</td>
<td>64.3</td>
<td>Very Good</td>
</tr>
<tr>
<td>Marysville Creek Marsh</td>
<td>93.7</td>
<td>Excellent</td>
</tr>
<tr>
<td>Big Island East Marsh</td>
<td>92.7</td>
<td>Excellent</td>
</tr>
<tr>
<td>Big Island West Marsh</td>
<td>93.7</td>
<td>Excellent</td>
</tr>
<tr>
<td>Robinson's Cove Marsh</td>
<td>68.6</td>
<td>Very Good</td>
</tr>
<tr>
<td>Blessington Creek Marsh</td>
<td>86.7</td>
<td>Excellent</td>
</tr>
<tr>
<td>Belleville Marsh</td>
<td>39.3</td>
<td>Fair</td>
</tr>
<tr>
<td>Sawguin Creek North Marsh</td>
<td>88.7</td>
<td>Excellent</td>
</tr>
<tr>
<td>Sawguin Creek Central Marsh</td>
<td>90.3</td>
<td>Excellent</td>
</tr>
<tr>
<td>Sawguin Creek Ditched Marsh</td>
<td>90.6</td>
<td>Excellent</td>
</tr>
<tr>
<td>Carrying Place Marsh</td>
<td>48.2</td>
<td>Good</td>
</tr>
<tr>
<td>12 O'Clock Point Marsh</td>
<td>66.6</td>
<td>Very Good</td>
</tr>
<tr>
<td>Dead Creek Marsh</td>
<td>72.8</td>
<td>Very Good</td>
</tr>
</tbody>
</table>

Discussion and Delisting Criteria Recommendations

The Contribution of Habitat Variables to Breeding Bird Community Condition

In 2006, bird community IBIs were higher in BQ AOC sites than in Durham Region sites. In general, this is thought to be a reflection of habitat quality; BQ AOC sites provide better habitat and can therefore support a higher richness and abundance of bird species – especially ecologically sensitive species. Upon further investigation of available habitat-related variables, SAV and water quality parameters, some relationships have been identified. First, there are fairly strong and statistically significant positive correlations between breeding marsh bird and SAV community metrics and overall SAV IBI (Table 23).

Second, the marsh bird community IBI is correlated with water quality (WQI:Bird IBI, \( r=0.45, n=34, p<0.05 \)). However, Section 4 of this report also describes the effect of water quality on the SAV community. So, given the interrelationship between marsh bird community, SAV community, and water quality, the current level of analysis does not provide sufficient results to decipher the main drivers of the bird community condition. It is most likely water quality and the SAV community both affect the condition of the marsh bird community, but further in-depth analyses are required. It is also recognized that emergent vegetation community attributes drive the suitability of habitat for marsh nesting birds. The characterization of this marsh habitat requires extensive human, financial, and time resources and is beyond the capabilities of this current AOC assessment.
Table 23. Correlations between individual marsh bird and SAV community IBI and constituent metrics. Red numbers in bold denote significant correlations (p<0.05; 2006 data).

<table>
<thead>
<tr>
<th>SAV Community</th>
<th>Area-sensitive richness</th>
<th>% marsh-nesting obligates</th>
<th>% marsh users</th>
<th>% marsh area-sensitive</th>
<th>Bird IBI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of turbidity-intolerant species</td>
<td>0.27</td>
<td>0.41</td>
<td>0.29</td>
<td>0.42</td>
<td>0.44</td>
</tr>
<tr>
<td>Relative % cover of turb.-intolerant. sp.</td>
<td>0.10</td>
<td>0.15</td>
<td>0</td>
<td>0.08</td>
<td>0.11</td>
</tr>
<tr>
<td>Floristic Quality Index</td>
<td>0.30</td>
<td>0.39</td>
<td>0.43</td>
<td>0.41</td>
<td>0.46</td>
</tr>
<tr>
<td>Total coverage</td>
<td>0.42</td>
<td>0.45</td>
<td>0.47</td>
<td>0.51</td>
<td>0.56</td>
</tr>
<tr>
<td>Total number of native species</td>
<td>0.31</td>
<td>0.43</td>
<td>0.53</td>
<td>0.46</td>
<td>0.52</td>
</tr>
<tr>
<td>SAV IBI</td>
<td>0.33</td>
<td>0.43</td>
<td>0.42</td>
<td>0.45</td>
<td>0.50</td>
</tr>
</tbody>
</table>

**Confounding Effects of Small Sites**

The marsh bird IBI developed by EC and CLOCA (2004), and used in this report, incorporates four metrics. Two of the four metrics explicitly use area-sensitive species attributes (i.e., richness and abundance). These species are thought to respond to disturbance because they are sensitive to the area of high quality marsh nesting habitat. Therefore, even large sites that do not contain a sufficient areal extent of high quality habitat are less likely to be inhabited by these species. The development of this IBI incorporated sites across Lake Ontario with a range of sizes. Two of the sites used in the development of the IBI were less than 10 hectares: Pumphouse and Robinson’s Cove marshes.

Since its development, the marsh bird community IBI has been used mainly to report on Durham Region coastal wetlands. In 2005 and 2006, the IBI was used to report on BQ AOC coastal wetlands. In 2006, IBIs were calculated for several sites less than 10 hectares. Further examination of the data suggests smaller sites may be limited in their ability to support marsh bird communities compared to larger sites. To illustrate this point in the Bay of Quinte, marsh bird community IBIs were compared at small sites (≤10ha) and large sites (>45ha) with similar WQIs (Figure 31). The WQI in this case was used as a surrogate of site disturbance. Small sites consistently scored lower IBIs than larger sites with similar WQIs. In most cases the difference is marked, but in the case of Robinson’s Cove Marsh versus Lower Sucker Creek Marsh, it is not as pronounced. This does not represent an in-depth analysis but rather indicates a possible limitation of the IBI. Until this relationship is fully explored and reconciled, IBIs calculated using EC and CLOCA (2004) at sites smaller than 10 hectares should be considered with caution. For the purposes of BQ AOC reporting, this is not a concern because the 10 representative wetlands in the Management Plan are all greater than 25 hectares.
Two other small sites also showed low IBIs in the BQ AOC: Belleville (39.3) and Lower Sucker Creek East (38.6) marshes. These results are not surprising as Belleville Marsh is adjacent to the former Bakelite site and is known to be exposed to high levels of disturbance. Lower Sucker Creek East Marsh is a fringing shoreline wetland – openly exposed to constant wind and wake-related wave action. The site supports only a small area of emergent vegetation (see Figure 8) and sampling of this wetland was a preliminary effort to understand the ability of fringing shoreline wetlands to support wildlife. Nonetheless, these results are still presented as they provide valid information on the state of BQ AOC coastal wetland communities.

Justifying the Delisting Criterion

The 2006 results, including the BQ AOC representative sites, were not available for the February 20, 2007 meeting of the BQ RAP Wildlife Steering Committee. As a result, there was not enough information to refine delisting criterion WP-2 and BQ-RAPRC (2007) described the delisting criterion as:

*Maintenance of wetland bird populations and diversity at or above Great Lakes non-AOC averages (i.e., in Lake Ontario), as determined by the Augmented*
Marsh Monitoring Program using Indices of Biotic Integrity (IBIs; [EC and CLOCA 2004]), in a suite of representative Bay of Quinte coastal wetlands.

Summarizing and analyzing data from 2002-2006 (Figure 32) shows IBIs in BQ AOC sites (\(\bar{x} = 74.1 \pm 18.8\)SD) were higher than Lake Ontario sites outside the AOC (63.3\(\pm\)16.9) but the difference was marginally significant, (t-test, \(t_{20.21} = -1.93, p = 0.061\)). These results confirm that BQ AOC coastal wetlands are not impaired compared to other Lake Ontario coastal wetlands. Although Bay of Quinte sites do not have a statistically higher mean IBI than other Lake Ontario sites, EC-CWS bird community surveyors suggest the Bay of Quinte generally supports some of the best marsh bird communities on Lake Ontario. This view is substantiated through experience gained by visiting and surveying more than 40 Lake Ontario coastal wetland sites over the past five years.

Thus for delisting target WP-2 it is recommended that:

The average marsh bird community Index of Biotic Integrity (IBI) at representative coastal wetlands will be 70 or above using the DRCWMP: Methodology Handbook (EC and CLOCA 2007) protocol to collect data and the IBI average is stable or improving based on multi-year assessments. However, no more than three of the coastal wetland sites can score less than 65 in one year.

The 2006 average breeding bird community IBI at representative BQ AOC wetlands is 78.4 (Table 24). Although Carnachan Bay Marsh is not included in the calculations, if the site was devoid of marsh birds (IBI=0), the average for the representative sites would be still be 70.6 with no more than three sites scoring below an IBI of 60.0.

<table>
<thead>
<tr>
<th>Wetland name</th>
<th>2006 IBI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Big Island Marsh</td>
<td>93.2*</td>
</tr>
<tr>
<td>Blessington Creek Marsh</td>
<td>86.7</td>
</tr>
<tr>
<td>Carrying Place Marsh</td>
<td>48.2</td>
</tr>
<tr>
<td>Carnachan Bay Marsh</td>
<td>NA</td>
</tr>
<tr>
<td>Dead Creek Marsh</td>
<td>72.8</td>
</tr>
<tr>
<td>Hay Bay Marsh</td>
<td>82.1*</td>
</tr>
<tr>
<td>Lower Napanee River Marsh</td>
<td>84.9</td>
</tr>
<tr>
<td>Lower Sucker Creek Marsh</td>
<td>72.6</td>
</tr>
<tr>
<td>Sawguin Creek Marsh</td>
<td>90.0*</td>
</tr>
<tr>
<td>Airport Creek Marsh</td>
<td>75.4</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td>78.4</td>
</tr>
</tbody>
</table>

Even in the absence of data from Carnachan Bay, the status of WP-2 is delisted.

Table 24. Breeding marsh bird community IBIs at representative BQ AOC coastal wetlands. IBIs denoted with an asterisk indicate the IBI is a mean for the site calculated by combining values for sub-sites (see Table 21, e.g., Big Island East and West).
Figure 32. Breeding marsh bird community IBIs for 41 Lake Ontario coastal wetlands. Points are mean IBIs based on data in Table 21 (99 site-years of data). Sites are evenly arranged from west to east so the distance between site labels on the axis is not representative of geographic distance.

**MMP Data Collect Constancy in the BQ AOC**

The BQ-RAPRC should consider the recently completed report: *The Marsh Monitoring Program: Wetland Route Gap Analysis for Canadian Great Lakes Areas of Concern* (EC-CWS 2007). The recommendations from the report are included below.

**Steps to Improving MMP Wetland Coverage and Long-term Volunteer Data**

Wetland coverage within AOCs and the availability of long-term data from the MMP will continue to be determined by the ability and interest of volunteers. Recently, BSC has developed an Ambassador Initiative whereby local MMP enthusiasts are supported by BSC staff to help deliver and coordinate MMP activities in local communities. Although still in its infancy, results from this initiative look promising for promoting and improving wetland coverage and long-term volunteer data in local areas. RAP teams, who rely on MMP data for BUI assessments and reporting, are encouraged to assess the possibility of implementing a MMP Ambassador Initiative or similar program in their AOC. For
example, staff from the local Conservation Authority or naturalist club, in conjunction with BSC, could be supported to help coordinate local MMP volunteers in surveying priority wetlands within an AOC.

**Achieving Long-term MMP Monitoring in Canadian and Binational Great Lakes AOCs**

The following steps are identified that may assist in the collection of long-term MMP data:

1. Identify priority wetlands for long-term MMP amphibian and marsh bird monitoring in AOC wildlife and wildlife habitat management plans. Priority wetlands should include representative sites within the AOC and any potential habitat restoration sites. Secure funding and/or resources for these wildlife management plans;

2. Identify and contact various possible partners that may have jurisdictional authority over lands in that particular region (e.g., National Parks, National Wildlife Areas, Provincial Parks, Conservation Authority lands). Inquire about their potential involvement in monitoring priority wetland sites;

3. Contact other potential partners (e.g., Eastern Habitat Joint Venture, Nature Conservancy of Canada, Ducks Unlimited Canada) about their interest and potential resources available in establishing long-term monitoring in wetlands of mutual interest;

4. Contact MMP staff at BSC regarding their current Ambassador Initiatives. Engage BSC in their readiness and interest in establishing an initiative in a particular AOC. Identify potential funding sources or secure funds for these initiatives;

5. Augment MMP volunteer recruitment efforts by establishing a BSC Ambassador Initiative program in an AOC by working in partnership with BSC staff;

6. Support local Ambassadors and BSC in the organization, coordination, and delivery of the MMP in that particular AOC (e.g., resources, outreach and communication, workshops); and,

7. Based on the recruitment of MMP volunteers, monitor long-term priority wetlands for amphibians and marsh birds with volunteers or paid employees.
7.0 Next Steps

BQ AOC coastal wetlands are generally in better physical (WQ) and biotic condition than other sites in Lake Ontario. Several delisting criteria examined in this report are currently being met. In Great Lakes AOCs, the RAP process is designed to move the AOC toward delisting and maintain that “delisted state”. For aspects of BUIs addressed in this document, a conceptual model (Figure 33) can be used to direct actions throughout the Area in Recovery and Delisted stages of the Bay of Quinte AOC.

![Flowchart](image)

Figure 33. A model to direct actions throughout the Area in Recovery and Delisted stages of the BQ AOC.

This report provided information for steps 1 to 4 of the model. It is the responsibility of the BQ-RAPRC to lead and coordinate steps 5 through 7 of the model (see BQ-RAPRC 2006). The model uses an iterative approach to address the status of BUIs so when the answer to step 7 is ‘yes’, the state of the beneficial use must be re-assessed. Although EC-CWS played a strong role in achieving steps 1 through 4 over the 2005-2007 period,
departmental priorities are prone to shift and there is little assurance EC-CWS would be in a position to lead or co-ordinate the iteration of steps 1 through 4. To this end, EC-CWS has demonstrated field techniques to BQ Conservation Authority staff for much of the data collected in this study.

The purpose of this report was to provide an assessment of BQ AOC coastal wetlands and justify delisting targets supported by the types of data collected. As a next step, it is recommended the BQ-RAPRC assumes a lead coordination role in partnership with BQ Conservation Authorities to perform iterations of steps 1 through 7. In particular, part of the coordination should focus on securing and sustaining a means to gather data on the marsh bird and amphibian coastal wetland communities through the MMP. Priority sites for evaluation during the next steps are specified in BQ-RAPRC (2007; and Table 4 of this report).

Finally, the condition of coastal wetland fish communities may make valuable contributions to delisting criteria involving fish populations (EC-CWS 2006). Fish communities were not sampled through this project in 2006. In 2005, fish community sampling for the pilot assessments was performed by the Central Lake Ontario Conservation Authority (CLOCA) in partnership with EC-CWS. EC-CWS (2006) recommended that if the BQ-RAPRC determines that coastal wetland fish evaluations are merited, partnership opportunities should be sought with capable agencies (i.e., CLOCA, Fisheries and Oceans Canada).
8.0 Summary

In general, water quality and biotic community condition in the Upper and Middle BQ AOC coastal wetlands is 'Good' to 'Excellent' compared to other Canadian Lake Ontario sites (Table 25). The results of this work reveal some sites are experiencing unexpected impacts to biotic communities (e.g., submerged aquatic vegetation at Hay Bay South). Water quality and aquatic macroinvertebrate community condition data provide some insight into the impacts. Continued monitoring is essential to making recommendations to alleviate the impacts as well as adaptively manage any restoration efforts.

Table 25. A summary of index scores and ranks (see shading key) for water quality (out of 5), submerged aquatic vegetation, aquatic macroinvertebrates (Inverts), and marsh bird communities (out of 100) in 21 BQ AOC coastal wetlands.

<table>
<thead>
<tr>
<th>Wetland Name</th>
<th>Water Quality Score</th>
<th>SAV</th>
<th>Inverts IBI</th>
<th>Birds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hay Bay South Marsh</td>
<td>3.60</td>
<td>68.2</td>
<td>75.6</td>
<td>68.3</td>
</tr>
<tr>
<td>Hay Bay North Marsh</td>
<td>3.83</td>
<td>74.5</td>
<td>87.3</td>
<td>95.8</td>
</tr>
<tr>
<td>Lower Napanee River Marsh</td>
<td>3.63</td>
<td>74.9</td>
<td>82.9</td>
<td>84.9</td>
</tr>
<tr>
<td>Forester's Island Marsh</td>
<td>4.33</td>
<td>71.1</td>
<td>69.9</td>
<td>43.3</td>
</tr>
<tr>
<td>Airport Creek Marsh</td>
<td>3.60</td>
<td>88.0</td>
<td>82.1</td>
<td>75.4</td>
</tr>
<tr>
<td>Lower Sucker Creek East Marsh</td>
<td>4.00</td>
<td>34.6</td>
<td>69.9</td>
<td>38.6</td>
</tr>
<tr>
<td>Lower Sucker Creek Marsh</td>
<td>4.33</td>
<td>63.2</td>
<td>71.5</td>
<td>72.6</td>
</tr>
<tr>
<td>Solmesville East Marsh</td>
<td>4.00</td>
<td>79.4</td>
<td>78.6</td>
<td>64.3</td>
</tr>
<tr>
<td>Marysville Creek Marsh</td>
<td>4.33</td>
<td>75.9</td>
<td>70.1</td>
<td>93.7</td>
</tr>
<tr>
<td>Big Island East Marsh</td>
<td>4.00</td>
<td>68.2</td>
<td>47.0</td>
<td>92.7</td>
</tr>
<tr>
<td>Big Island West Marsh</td>
<td>4.33</td>
<td>68.4</td>
<td>62.4</td>
<td>93.7</td>
</tr>
<tr>
<td>Lower Salmon River Marsh</td>
<td>4.67</td>
<td>88.1</td>
<td>90.9</td>
<td>-</td>
</tr>
<tr>
<td>Robinson's Cove Marsh</td>
<td>4.67</td>
<td>89.9</td>
<td>68.4</td>
<td>68.6</td>
</tr>
<tr>
<td>Blessington Creek Marsh</td>
<td>3.33</td>
<td>69.3</td>
<td>81.9</td>
<td>86.7</td>
</tr>
<tr>
<td>Belleville Marsh</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>39.3</td>
</tr>
<tr>
<td>Sawguin Creek North Marsh</td>
<td>4.33</td>
<td>57.0</td>
<td>67.2</td>
<td>88.7</td>
</tr>
<tr>
<td>Sawguin Creek Central Marsh</td>
<td>4.67</td>
<td>65.9</td>
<td>60.5</td>
<td>90.3</td>
</tr>
<tr>
<td>Sawguin Creek Ditched Marsh</td>
<td>3.33</td>
<td>73.4</td>
<td>64.6</td>
<td>90.6</td>
</tr>
<tr>
<td>Carrying Place Marsh</td>
<td>4.00</td>
<td>63.2</td>
<td>74.0</td>
<td>49.2</td>
</tr>
<tr>
<td>12 O'Clock Point Marsh</td>
<td>2.00</td>
<td>69.7</td>
<td>67.6</td>
<td>66.6</td>
</tr>
<tr>
<td>Dead Creek Marsh</td>
<td>3.00</td>
<td>73.5</td>
<td>70.9</td>
<td>72.8</td>
</tr>
</tbody>
</table>

*Shading Key: Poor Fair Good Very Good Excellent*

Data collected from 2001 to 2006 in BQ AOC and other Lake Ontario coastal wetlands contributed to the development and justification of delisting criteria in this document (Table 26).

As next steps, the BQ-RAPRC needs to coordinate the continued monitoring of the biotic condition of the ten representative coastal wetlands.
Table 26. Delisting criteria and status for BUI 3 and 14 (revised from BQ-RAPRC 2007) based on assessments of priority sites.

<table>
<thead>
<tr>
<th>Delisting Criteria Code</th>
<th>Delisting Criteria Description</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>FWH-2</td>
<td>The average submerged aquatic vegetation Index of Biotic Integrity (IBI) at representative coastal wetlands will be 60.0 or above using the DRCWMP: Methodology Handbook (EC and CLOCA 2007) protocol to collect data and the IBI mean is stable or improving based on multi-year assessments. However, no more than three of the coastal wetland sites can score less than 60.0 in one year.</td>
<td>Delisted (conditionally)</td>
</tr>
<tr>
<td>FWH-3</td>
<td>The average water quality scores at representative Bay of Quinte coastal wetlands will be 3.5 (good) or above, and is stable or improving based on multi-year assessments. However, no more than three of the coastal wetland sites can score less than 3.33.</td>
<td>Requires additional work. i.e., Carnachan Bay Marsh water quality assessment</td>
</tr>
<tr>
<td>FWH-8 (proposed)</td>
<td>The average aquatic macroinvertebrate Index of Biotic Integrity (IBI) at representative coastal wetlands will be 65 or above using the DRCWMP: Methodology Handbook (EC and CLOCA 2007) protocol to collect data and the IBI average is stable or improving based on multi-year assessments. However, no more than three of the coastal wetland sites can score less than 65 in one year.</td>
<td>Delisted</td>
</tr>
<tr>
<td>WP-1</td>
<td>Amphibian community condition.</td>
<td>Requires additional work. i.e., Steps 1 through 4 of Figure 33.</td>
</tr>
<tr>
<td>WP-2</td>
<td>The average marsh bird community Index of Biotic Integrity (IBI) at representative coastal wetlands will be 70.0 or above using the DRCWMP: Methodology Handbook (EC and CLOCA 2007) protocol to collect data and the IBI average is stable or improving based on multi-year assessments. However, no more than three of the coastal wetland sites can score less than 65.0 in one year.</td>
<td>Delisted</td>
</tr>
</tbody>
</table>

Finally, it is important to demonstrate the representative sites considered in this study and listed by the BQ-RAPRC (2007) are truly representative of BQ AOC coastal wetlands. The sites were chosen to cover a range of disturbance, size (small sites, <25 ha were excluded), and dominant hydrologic influence (riverine/lacustrine). Although the majority of the representative sites are located in the Upper Bay of Quinte, this is indicative of the overall distribution of wetlands within the Bay.
To determine the *post hoc* suitability of representative sites, water quality and biotic communities were compared between the nine representative sites and the seven 'other' sites that were assessed in 2006. The results confirm there are no significant differences between the groups of sites except for the marsh bird community (Table 27).

The difference in the marsh bird community can be linked to the size criterion for the representative sites. BQ-RAPRC (2007) recommends sites over 25 hectares be considered for representative sites. For the analysis below, representative sites (>25 ha) were compared with all other surveyed Bay of Quinte sites. However, four of the seven other sites were smaller than 10 hectares. This report suggests that smaller sites (<10 ha) are not capable of supporting marsh bird communities with high IBIs. This makes the bird community statistical comparison biased toward the representative sites. This bias is not an overriding issue because it should in the best interest of the RAP to monitor sites that are more capable of supporting extensive marsh bird communities. As such, the selected sites are suitable as representative of the BQ AOC sites.

Table 27. T-test comparisons of water quality ranking (WQ), and IBIs for submerged aquatic vegetation (SAV), aquatic macroinvertebrate (INVERTS), and marsh bird communities between ‘representative’ (See BQ-RAPRC 2007) and ‘other’ assessed coastal wetlands in the BQ AOC.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mean±SD</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Representative BQ AOC Sites*</td>
<td>Other BQ AOC Sites</td>
<td></td>
</tr>
<tr>
<td>WQ</td>
<td>3.49±0.48</td>
<td>3.66±0.88</td>
<td>-0.503</td>
</tr>
<tr>
<td>SAV</td>
<td>69.71±8.73</td>
<td>72.67±18.49</td>
<td>-0.426</td>
</tr>
<tr>
<td>INVERTS</td>
<td>73.01±11.36</td>
<td>73.63±8.43</td>
<td>-0.121</td>
</tr>
<tr>
<td>BIRDS</td>
<td>78.48±13.60</td>
<td>60.34±19.29</td>
<td>2.210</td>
</tr>
</tbody>
</table>

*Does not include Carnachan Bay site.
Literature Cited


Brownell, V.R. 1993. Waterfront Natural Areas- Part II: A Biological Inventory and Evaluation of 28 Natural Areas along the Lake Ontario Waterfront from Newcastle to Trenton. Waterfront Regeneration Trust. vii + 188 pp + 4 maps.


Appendix

Table 28. Twenty-fifth and seventy-fifth percentile for water quality parameters measures in 35 Lake Ontario coastal wetlands in 2006.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units of Measure</th>
<th>25th</th>
<th>75th</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conductivity</td>
<td>mS·cm·¹¹</td>
<td>0.304</td>
<td>0.614</td>
</tr>
<tr>
<td>Turbidity</td>
<td>NTU</td>
<td>3.316</td>
<td>18.251</td>
</tr>
<tr>
<td>Ammonium</td>
<td>mg·L·¹⁻</td>
<td>0.021</td>
<td>0.073</td>
</tr>
<tr>
<td>Nitrate</td>
<td>mg·L·¹⁻</td>
<td>0.300</td>
<td>0.800</td>
</tr>
<tr>
<td>Total Phosphorus</td>
<td>mg·L·¹⁻</td>
<td>0.054</td>
<td>0.158</td>
</tr>
<tr>
<td>Chlorophyll-a</td>
<td>µg·L·⁻</td>
<td>4.753</td>
<td>13.838</td>
</tr>
</tbody>
</table>

Bay of Quinte Coastal Wetland Status and RAP Delisting Targets