Durham Region Coastal Wetland Monitoring Project:

Methodology Handbook

March 2007

Environment Canada / Environnement Canada

Canadian Wildlife Service / Service canadien de la faune

Central Lake Ontario Conservation

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Environment Canada, Canadian Wildlife Service, Ontario
Central Lake Ontario Conservation Authority

This document can be cited as:

Environment Canada and Central Lake Ontario Conservation Authority. 2007. Durham Region Coastal Wetland Monitoring Project: Methodology Handbook. Oshawa, ON: Central Lake Ontario Conservation Authority. March 2007-08.

Cover Photo: S. Pernanen

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EXECUTIVE SUMMARY

The Durham Region Coastal Wetland Monitoring Project was conceptualized in 1999 to examine the health of coastal wetlands in the region. A background summary and project proposal was released in March 2001. Following the release of the report, Monitoring and Implementation Committees were formed. The mandate of the Monitoring Committee, consisting of stakeholders from various governmental and non-governmental organizations, was to develop a set of goals and objectives for the project and to identify and describe the specific protocols for a monitoring program to meet those objectives. Originally, 17 objectives were to be monitored; however, some of the monitoring methodologies were subsequently deemed impractical, while others have since been combined. This handbook is a compilation of the 14 monitoring methodologies that are currently in use.

The primary goal of this project is to apply scientifically-sound, standardized methodologies within a long-term monitoring program that has been designed to assess and compare the health of coastal wetlands in Durham Region. Understanding the current health of these wetlands will enable development of measurable objectives and implementation of conservation activities addressing issues of concern. Continued monitoring will enable assessment of conservation activities in meeting predefined objectives. The project also facilitates resource sharing among organizations involved in the field monitoring to increase the effectiveness and efficiency of monitoring activities.

The methodologies herein will assess the current biological and geophysical conditions of Durham Region coastal wetlands. Plant, fish and wildlife community health are the focus of biological condition assessment, while abiotic wetland and watershed variables are examined to assess the present geophysical condition.

In large part, the Durham Region Coastal Wetland Monitoring Project and this methodology handbook are based on recommendations resulting from the State of the Lakes Ecosystem Conference (SOLEC) coastal wetland health indicator development process. The biennial SOLEC conference, hosted by the U.S. Environmental Protection Agency and Environment Canada, provides a forum for sharing information on the ecological condition of the Great Lakes. The conferences focus on reporting progress being made towards the goals of the *Great Lakes Water Quality Agreement*, i.e. to restore and maintain the chemical, physical and biological integrity of the waters of the Great Lakes ecosystem. To facilitate reporting to the public, a set of indicators have been developed which objectively represent the current condition of ecosystem components.

Additionally, the Durham project parallels a broader initiative to develop indicators of coastal wetland health suitable for use across the Great Lakes. The Great Lakes Commission, a bi-national public agency overseeing the management and protection of Great Lakes natural resources, has convened a coastal wetlands consortium of scientists and policy makers, known as the Great Lakes Coastal Wetlands Consortium initiative. The consortium's work will expand the monitoring and reporting capabilities under the *Great Lakes Water Quality Agreement*. Under this initiative, future plans are to implement a bi-national Great Lakes level coastal wetland monitoring effort. The Durham project will provide a multi-partner implementation model for use in other regions of the Great Lakes and contribute to the Lake Ontario Lakewide Management Plan. Compatibility of these initiatives will allow integration of the Durham Region coastal wetlands monitoring into a Great Lakes monitoring network.

SOMMAIRE

Le projet de surveillance des milieux humides côtiers de la région de Durham a été conceptualisé en 1999 dans le but d'examiner la santé des milieux humides côtiers de la région. Un rapport sommaire d'information et proposition de projet a été publié en mars 2001. Par la suite, des comités de surveillance et de mise en œuvre ont été mis sur pied. Le comité de surveillance, composé d'intervenants de divers organismes gouvernementaux et non-gouvernementaux, avait pour mandat d'élaborer une série de buts et d'objectifs pour ce projet et de cerner et de décrire les protocoles précis d'un programme de surveillance pour répondre à ces objectifs. Le présent guide est une compilation des 14 méthodologies de surveillance précisées par ce comité.

L'objectif premier de ce projet est d'utiliser des méthodologies rigoureusement scientifiques et normalisées dans le cadre d'un programme de surveillance à long terme conçu pour évaluer et comparer la santé des milieux humides côtiers dans la région de Durham. Le fait de comprendre la santé actuelle de ces milieux humides permettra d'élaborer des objectifs mesurables et de mettre en œuvre des activités de conservation abordant les questions préoccupantes. La surveillance continue permettra d'évaluer les activités de conservation par rapport à l'atteinte des objectifs prédéfinis. Le projet facilite également le partage des ressources parmi les organismes qui s'occupent de la surveillance sur le terrain afin d'accroître l'efficacité et l'efficience des activités de surveillance.

Les méthodologies ci-incluses évalueront les états biologiques et géophysiques actuels de milieux humides côtiers de la région de Durham. Pour évaluer l'état biologique, on se concentrera sur la santé des communautés végétales, fauniques et piscicoles, tandis que pour évaluer l'état géophysique actuel, on examinera les variables abiotiques des terres humides et des bassins versants.

Le projet de surveillance des milieux humides côtiers de la région de Durham et le guide des méthodologies se fondent dans une large mesure sur les recommandations issues du processus d'élaboration d'indicateurs de la santé des milieux humides côtiers des Conférences sur l'état des écosystèmes lacustres (CEEL). Les conférences CEEL biennales, organisées par la U.S. Environmental Protection Agency et Environnement Canada, fournissent une tribune d'échange d'information sur l'état écologique des Grands Lacs. Elles mettent l'accent sur les progrès accomplis en vue d'atteindre les objectifs de *l'Accord relatif à la qualité de l'eau dans les Grands Lacs*, c.-à-d. rétablir et conserver l'intégrité chimique, physique et biologique des eaux de l'écosystème des Grands Lacs. Pour faciliter la communication de rapports au public, on a élaboré un ensemble d'indicateurs qui représentent objectivement l'état actuel des composants de l'écosystème.

En outre, le projet de Durham s'accompagne d'une initiative plus vaste d'élaboration d'indicateurs de la santé des milieux humides côtiers qui pourraient être utilisés dans toute la région des Grands Lacs. La Commission des Grands Lacs, un organisme public binational surveillant la gestion et la protection des ressources naturelles des Grands Lacs, a créé un consortium sur les milieux humides côtiers réunissant des scientifiques et des technocrates, connu sous le nom de Consortium binational sur les milieux humides des Grands Lacs. Les travaux du consortium élargiront les capacités de surveillance et de rendre compte en vertu de *l'Accord relatif à la qualité de l'eau dans les Grands Lacs*. En vertu de cette initiative, les plans futurs prévoient la mise en œuvre d'un projet binational de surveillance des milieux humides côtiers au niveau des Grands Lacs. Le projet de Durham fournira un modèle de mise en œuvre pluripartenaires à utiliser dans d'autres régions des Grands Lacs et contribuera au plan d'aménagement panlacustre du lac Ontario. La compatibilité de ces initiatives permettra l'intégration des milieux humides côtiers de la région de Durham dans un réseau de surveillance des Grands Lacs.

ACKNOWLEDGEMENTS

Greg Grabas and Joel Ingram of Environment Canada (EC) and Satu Pernanen of the Central Lake Ontario Conservation Authority (CLOCA) are the primary authors contributing to the first and second approximations of this handbook. Nancy Patterson (EC) and Russ Powell (CLOCA) provided support and guidance for the project. The compilation of monitoring methodologies within this handbook would not have been possible without the contributions of many people. We would like to thank: Jennifer Haslett, Ian Kelsey, and Kathy Luttrell (CLOCA); Scott MacNeill, Mark Peacock, Kathy Tapner, Jesse James, Marc Desjardins, Ken Towle (Ganaraska Region Conservation Authority); Gord MacPherson (Toronto and Region Conservation Authority); Tom Whillans (Trent University); Don Wismer and Allen Torrenueva (Ontario Power Generation); Tÿs Theÿsmeÿer, Tyler Smith and Eric Cleveland (Royal Botanical Gardens); Vic Cairns, Chris Strand, and Ken Chang-Kue (Department of Fisheries and Oceans); Steve Timmermans, Charles Francis, Kerrie Wilcox, and Kathy Jones (Bird Studies Canada); Tim Rance and Mark Heaton (Ontario Ministry of Natural Resources); Allan Hayton and André Vaillancourt (Ontario Ministry of the Environment); Kim Fernie and Shane de Solla (EC); and Brian Henshaw (Gartner Lee Ltd.)

The current version of this handbook was updated primarily by Satu Pernanen of the Central Lake Ontario Conservation Authority (CLOCA) with assistance from Greg Grabas, Christian Friis and Krista Holmes (EC) and Ian Kelsey, Amber Langmuir and Rod Wilmot (CLOCA). Ken Towle and Mike Smith (Ganaraska Region Conservation Authority), Rick Portiss and Gary Bowen (Toronto and Region Conservation Authority), Patricia Lowe (CLOCA) and Krista Holmes and Graham Bryan (EC) provided valuable comments on a draft version of this handbook. Gord Geissberger (CLOCA) assisted with the printing and creation of the CD version of this document.

Financial contributions from the following partners are gratefully acknowledged:

DURHAM REGION

Environment Canada | Environnement Canada

Central Lake Ontario Conservation

GANARASKA REGION CONSERVATION AUTHORITY

ONTARIO POWER GENERATION
Darlington Nuclear

TORONTO AND REGION Conservation for The Living City

1. PROJECT DESIGN AND IMPLEMENTATION

Background

The Durham Region Coastal Wetland Monitoring Project (DRCWMP) has evolved from an initial concept and agreement in principle in 1999, to a detailed monitoring plan that was implemented in 2002. The first step in the process was the development of the project concept and a background on the coastal wetlands within the area of interest. Hughes and Staples (2001) compiled this information, as well as a summary of recent monitoring activities (report included in Appendix A). As discussed in their report, the benefits of a coordinated monitoring approach are many and include:

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

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

This handbook provides the overall project design, monitoring framework and sampling methodologies under which the project is being implemented. An overview of goals, objectives and methodologies is presented in Table 1-1. As with any project that involves field sampling, safety is a major concern. Health and Safety Policies of each Conservation Authority are adhered to during all field activities. All activities are conducted in a manner compliant with applicable health and safety legislation, guidelines and best practices.

Table 1-1. Summary of goals and objectives for the Durham Region Coastal Wetland Monitoring Project.

Goals		Objectives/ Indicators	Method Summary
BIOLOGICAL CONDITION	**Plant Community Condition**	Measure change in wetland plant communities and adjacent land cover	• Wetland and adjacent upland cover will be mapped through current Ecological Land Classification (ELC) methodology to the community unit of Vegetation Type
		Monitor submerged plant community	• Submerged aquatic vegetation (SAV) will be sampled in 20 one-metre square quadrats randomly located within the open water zone of each wetland • Species occurrence, percent cover, water depth, turbidity and substrate type will be recorded for each sample • An Index of Biotic Integrity (IBI) score will be calculated for the SAV at each wetland
	Fish and Wildlife Community Condition	Monitor fish community	• Fish will be collected through electrofishing in various habitat types at points spaced eight metres apart along 44-metre transects • An Index of Biotic Integrity (IBI) score will be calculated for the fish community at each wetland
		Monitor breeding bird community	• Marsh Monitoring Program (MMP) methodology to be used with additional data collection (three visits) • An Index of Biotic Integrity (IBI) score will be calculated for the bird community at each wetland
		Monitor amphibian community	• Marsh Monitoring Program (MMP) methodology to be used • An Index of Biotic Integrity (IBI) score will be calculated for the amphibian community at each wetland
		Monitor macroinvertebrate community	• Aquatic macroinvertebrates will be collected from the water column at three replicate locations using sweep net sampling • An Index of Biotic Integrity (IBI) score will be calculated for the macroinvertebrate community at each wetland

Table 1-1. Continued

Goals		Objectives/ Indicators	Method Summary
GEOPHYSICAL CONDITION	**Wetland**	Measure water quality	• At a minimum, monthly collection of multiple georeferenced samples of turbidity, pH, water temperature, conductivity at each wetland during the growing season • For more intensive study, these measurements can be taken at weekly intervals during the summer growing period to capture temporal variation • At a minimum, once yearly measurements (during late July-early August) of nitrate, ammonium, phosphorus, chlorophyll *a*, alkalinity, dissolved oxygen
		Determine water levels	• Utilize Lake Ontario water level data for wetlands with constant connection to the lake • Install water level data loggers in wetlands that can be disconnected from Lake Ontario
		Determine sediment quality	• Sediment contaminant analysis (Metals, Polychlorinated Biphenyls (PCBs), Organochlorine (OC) Pesticides, Polycyclic Aromatic Hydrocarbons (PAHs), Total Organic Carbon (TOC) and grain size) • At least two homogenized surficial sediment samples stratified across wetland
		Determine wetland bathymetric profile	• Bathymetric monitoring using a boat equipped with depth sounding and GPS equipment • To be completed on an as-needed basis
	Watershed	Measure change in watershed land cover	• Map entire watersheds for land cover using air photos or satellite imagery • Use ELC to Community Series, incorporate all cultural designations when available or land cover types and summarize to subwatershed where appropriate
		Measure land cover change in adjacent uplands	• Land cover within 1000 metres of the Ontario Ministry of Natural Resources (OMNR) evaluated wetland boundary will be identified and monitored for change from previous iterations
		Measure extent of public ownership of watershed lands	• Use digital parcel data (Teranet), if available; liaising with municipalities
		Determine sediment and nutrient loads	• Where available, use calibrated models for each watershed to determine loadings of sediments and nutrients (i.e. phosphorus and nitrogen) entering each wetland

Introduction

In simple terms, the primary goal of the Durham Region Coastal Wetland Monitoring Project (DRCWMP) is to implement a long-term monitoring program that enables reporting on and comparisons of coastal wetland health in the Region. Additionally, the information collected through the monitoring program will be used to help assess the consequences of human activities on the health of these wetlands and provide direction for actions where appropriate. These goals were incorporated into a framework (Figure 1-1), which provides the basis for development of the DRCWMP.

To summarize, biological monitoring requires five types of information (Karr and Chu 1999):

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

Managers, policy makers and society-at-large can use this information to decide if current wetland health is acceptable or not, set biological goals that are appropriate for the wetland, to assist in the development of appropriate conservation activities, and to assess the success or failure of any restoration/rehabilitation measures.

While the Implementation Committee was responsible for defining the project direction, identifying resourcing requirements and publicizing the project, the Monitoring Committee identified and set priorities for specific wetland attributes of importance to the stakeholders (Gartner Lee Limited 2001). These attributes were identified by drawing largely on coastal wetland indicator development from the State of the Lakes Ecosystem Conferences (SOLEC) (Bertram and Stadler-Salt 2000) and Bird Studies Canada's Marsh Monitoring Program (Weeber and Vallianatos 2000). The biennial SOLEC conferences focus on progress being made towards the goals of the *Great Lakes Water Quality Agreement*, which are to restore and maintain the chemical, physical and biological integrity of the Great Lakes ecosystem.

An additional initiative that has direct relevance to this project is the Great Lakes Coastal Wetlands Consortium (GLCWC) project under the leadership of the Great Lakes Commission (GLC). The GLCWC will deliver a Monitoring Plan for coastal wetlands in the Great Lakes basin to the United States Environmental Protection Agency (US EPA) in the near future (http://www.glc.org/wetlands/). Development of the monitoring framework for the Durham project has drawn on the GLCWC initiative and new information has been incorporated into the monitoring design and is reflected in this Methodology Handbook. Compatibility between the Durham project and the GLCWC project will enable comparison of Durham Region coastal wetlands to other wetlands around the Great Lakes. Compatibility will also allow the use of Durham project results in reporting on the state of Great Lakes coastal wetlands. The reciprocal contributions between the DRCWMP and the GLCWC Implementation Plan can be evaluated following GLCWC Implementation Plan delivery.

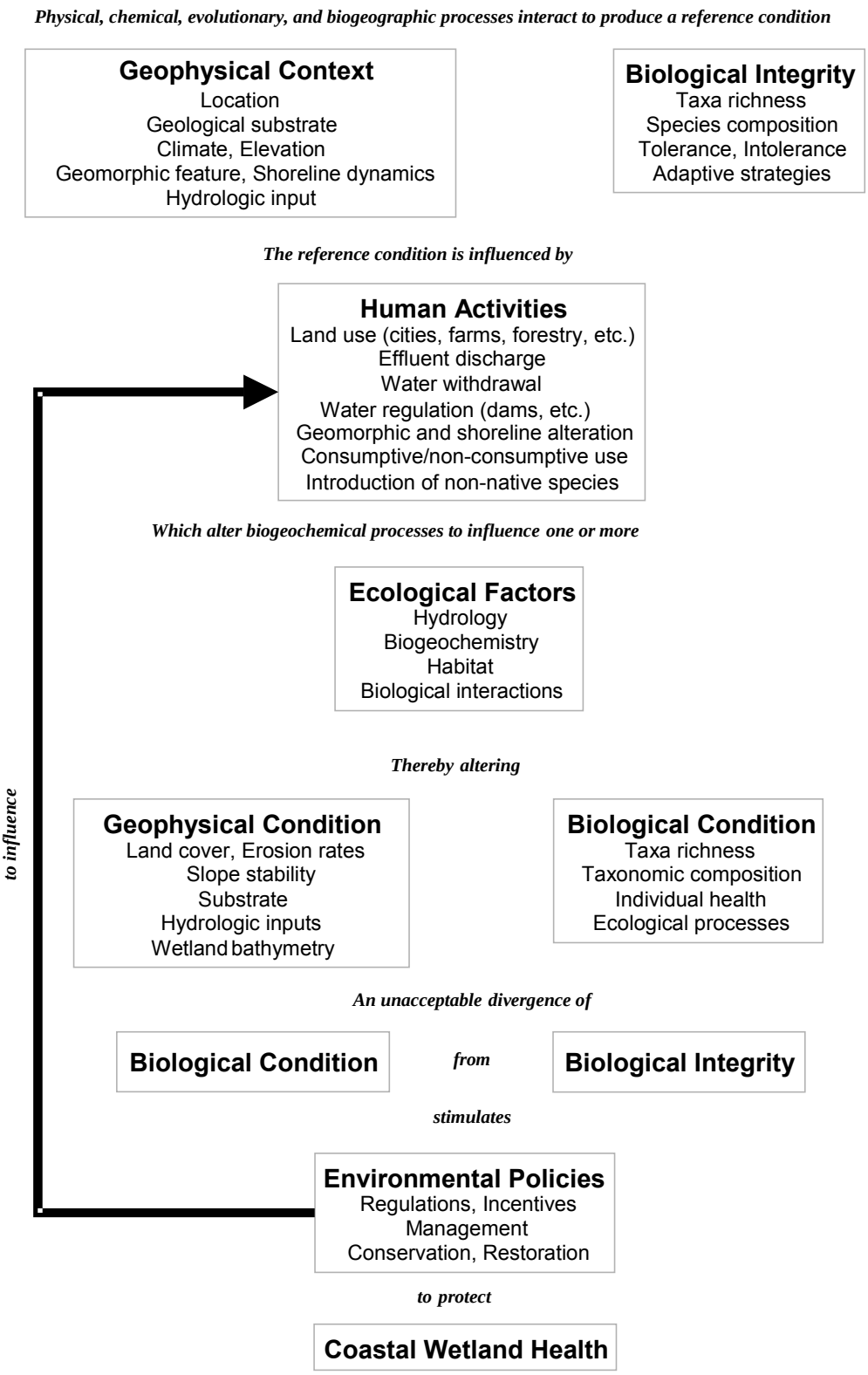

Figure 1-1. Relationships among attributes to be measured, understood, and evaluated through biological monitoring. Biological condition is the endpoint of concern (adapted from Karr and Chu 1999 and Mack et al. 2000).

Project Design

Wetland Sites

In 2002, at the initiation of the field work component for this project, 15 coastal wetlands were identified for monitoring within Durham Region (see figure in Appendix A). In 2006, the Ontario Ministry of Natural Resources (OMNR) evaluated three additional Durham Region coastal wetlands (or wetland complexes) as provincially significant (OMNR 2006, 2007a & b). These wetlands will be assessed in 2007 to determine their suitability for inclusion in this monitoring project.

These 18 coastal wetlands vary in size, level of disturbance and hydrogeomorphic features. The source of hydrologic input to the wetland is an important factor in determining the influence of adjacent human activities on the biological condition of the wetland. For this reason, these coastal wetlands were divided into two classes based on the geomorphic formation and dominant hydrological input, i.e. watershed (drowned river-mouth) or lake-source (barrier beach lagoon). Many other types of coastal wetlands occur along Great Lakes shorelines, but only these two occur within Durham Region.

The following classification is based on Albert et al. (2005):

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

2) **Drowned River-mouth**: These wetlands form where tributary rivers enter the lake; representing a zone of transition from stream to lake. They are characterized by meandering stream channels that are backflooded during high lake levels. A drowned river-mouth wetland can be protected by a barrier beach.

The coastal wetlands in this study have been categorized by type based on their formation during the geological past, but not necessarily their current state (Table 1-2). For example, due to human activities there is no longer a continuous barrier beach protecting the Whitby Harbour wetland; however, it was originally of this type.

Table 1-2. Durham Region coastal wetlands included in the current monitoring program (in geographical order from west to east).

Wetland Name	Wetland Type*	Conservation Authority**	Area (hectares)
Rouge River Marsh	DR	TRCA	59
Frenchman's Bay Marsh	BB	TRCA	23
Hydro Marsh	BB	TRCA	24
Duffins Creek Marsh	DR (BB)	TRCA	110
Carruthers Creek Marsh	DR (BB)	TRCA	141
Cranberry Marsh	BB	CLOCA	47
Lynde Creek Marsh	DR (BB)	CLOCA	157
Whitby Harbour Wetland Complex†	BB	CLOCA	22
Corbett Creek Marsh	DR (BB)	CLOCA	21

Wetland Name	Wetland Type*	Conservation Authority**	Area (hectares)
Gold Point Coastal Wetland†	DR (BB)	CLOCA	4
Pumphouse Marsh	BB	CLOCA	7
Oshawa Creek Coastal Wetland Complex†	DR (BB)	CLOCA	20
Oshawa Second Marsh	BB	CLOCA	133
McLaughlin Bay Marsh	BB	CLOCA	42
Westside Marsh	BB	CLOCA	45
Bowmanville Marsh	DR	CLOCA	29
Wilmot Creek Marsh	DR (BB)	GRCA	26
Port Newcastle Wetland	DR	GRCA	8

* DR = drowned river-mouth; BB = barrier beach lagoon, DR (BB) = drowned river-mouth protected by a barrier beach

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

† Newly evaluated provincially significant coastal wetlands (OMNR 2006, 2007a & b) to be assessed in 2007.

Determining Coastal Wetland Health

As described previously, in order to report on coastal wetland health, the current and reference biological condition of each wetland needs to be determined. Coastal wetland attributes that are sensitive and respond in a known way to human actions are important in estimating wetland health. Responses of wetland community attributes to human disturbance have received significant attention in recent years (Adamus 1996, Karr and Chu 1999, Yoder and Rankin 1999, Chow-Fraser 2006). Biological attributes that are known to respond in specific and predictable ways to changes in landscape condition are known as metrics. By combining several metrics for a specific community, an Index of Biotic Integrity (IBI) score can be calculated and used to evaluate the condition or integrity of that community within a particular habitat or region.

The Durham Region Coastal Wetland Monitoring Project incorporates the current "state of the science" with respect to coastal wetland indicator monitoring and reporting. Year 1 (2002) of project implementation included testing of some methodologies and incorporation of appropriate results from the GLCWC initiative. Following two field seasons, a comprehensive Technical Report was produced that described the results from all the monitoring objectives achieved to that time (Environment Canada and Central Lake Ontario Conservation Authority 2004).

To date, five field seasons (2002-2006) have been completed. The data collected, in conjunction with reference and historical condition data, will be used to establish acceptable goals for the wetland biological community (Figure 1-2). Coastal wetland conservation activities can then be tailored and targeted to each wetland, based on established goals and current biological community conditions. The issues and possible restoration activities for each wetland will be detailed in an upcoming Technical Report.

Some wetlands within this study have undergone significant restoration activities and the on-going monitoring has detected changes in biological condition, facilitating evaluation of the success of these conservation actions.

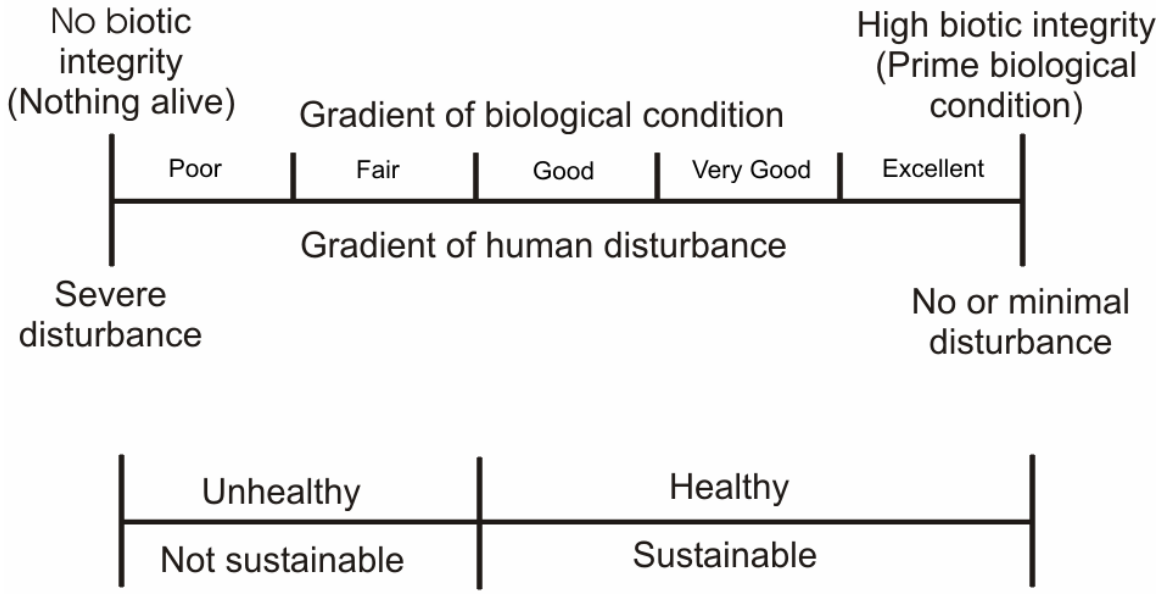

Figure 1-2. Gradient of biological condition in relation to a level of human disturbance (top). By combining the condition of several biological communities, a parallel gradient (bottom) representing the health of the wetland can be determined. Subsequently, a specific range on the health gradient can be set as a goal for each wetland (adapted from Karr and Chu 1999).

The biological communities and geophysical attributes being monitored are as follows:

Biological Condition

1) **Plant Community Condition**: Aquatic plant communities are a critical component of a wetland ecosystem. Aquatic plants are responsible for the conversion of energy and nutrients associated with the sun, water and soil into forms that are readily accessible to other biological communities. As well, the majority of fauna that utilize wetlands rely on specific plant community types for various aspects of their life cycle. For these reasons, the distribution of plant communities by Vegetation Type as defined by the Ecological Land Classification (ELC) system (Lee et al. 1998) is being monitored. The submerged aquatic vegetation community is also being assessed through direct sampling and an IBI score calculated for each wetland.

   Research has also been undertaken to develop correlations between various aquatic plant community attributes (e.g. species richness and relative abundance of invasive plants) and landscape condition (Mack et al. 2000, Lougheed et al. 2001). As part of the GLCWC initiative, indicators of plant community condition will be further tested and a multi-metric approach developed for use in monitoring of Great Lakes coastal wetlands. This development will be closely tracked and results incorporated into the Durham project as warranted.

2) **Fish and Wildlife Community Condition**: Many fishes of the Great Lakes use coastal wetlands for at least part of their life cycle. In a review of several studies, Jude and Pappas (1992) determined that of 113 Great Lakes fish species, 82 were

using coastal wetlands during at least part of the year. Stephenson (1990), in a study of fish usage in Toronto area marshes, determined that 89% of species caught in the wetlands were using them for some stage of reproduction. Some species use the aquatic plant communities as nesting sites, while other species use wetlands as nursery habitat. Likely due to their high levels of primary productivity and habitat diversity (Stephenson 1990), coastal wetlands are critical to many Great Lakes fish populations and to the maintenance of fish species diversity.

A great deal of research went into the development of a fish Index of Biotic Integrity (IBI) for littoral zones of the Great Lakes (Minns et al. 1994). From this, a fish community monitoring program was adapted and is currently in use at Cootes Paradise near Hamilton (Theÿsmeÿer 1998). A protocol derived from those developed by the Royal Botanical Gardens for Cootes Paradise and Fisheries and Oceans Canada for littoral zones is being utilized for this project. The metrics developed for the above-mentioned projects were a starting point for determining suitable metrics for use in Durham coastal wetlands (Environment Canada and Central Lake Ontario Conservation Authority 2004).

Great Lakes coastal wetlands also support hundreds of other wildlife species. Of these, birds and amphibians are the most visible and vocal and have, therefore, received significant attention as potential indicators of ecosystem health. Bird Studies Canada currently administers the Marsh Monitoring Program, which is a bi-national, volunteer-based, Great Lakes basin marsh bird and amphibian monitoring network. Through this program, over 10 years of bird and amphibian data have been collected (Crewe et al. 2006), which can be used to provide comparisons with the Durham Region sites. In addition, the monitoring protocols have been tested and standardized, and so, will be adopted for this project with minor changes to provide improved site-level evaluations.

Geophysical Condition

1) **Wetland**: Several attributes within the wetland provide an indication of geophysical condition and also yield valuable information for interpreting biological condition results and changes through time. For example, wetland water quality, water level, sediment quality and bathymetry all influence the floral and faunal communities within each wetland and, therefore, will be monitored throughout the project.

2) **Watershed**: The land cover within the watersheds of and areas adjacent to coastal wetlands can have significant impacts on a wetland's condition. Monitoring certain attributes/parameters within each watershed not only gives an indication of geophysical condition, it also summarizes human-related activities that are directly impacting wetland condition. This type of information is valuable for interpreting biological condition results and helpful in directing conservation efforts to achieve and/or maintain wetland health objectives.

The monitoring protocols contained within this document are being used to assess a suite of biological and geophysical attributes associated with each coastal wetland. This information is being evaluated individually and in combination (e.g. using IBIs) to provide current and reference biological and geophysical conditions (i.e. coastal wetland health) (Figure 1-1 and 1-2). The combination of results from each wetland biological

community are then used to report on and compare wetland community condition within individual wetlands and across all Durham Region coastal wetlands.

Statistical Analysis

The focus of this monitoring project is to incorporate the best available science as it relates to monitoring and reporting on wetlands; the priority being that monitoring resources are focused on obtaining wetland community attribute measures that are meaningful and have been collected in a standardized and scientifically-robust manner. As described above, the current state of understanding of wetland community responses to disturbance varies considerably by community type (e.g. fish vs. birds).

With respect to the statistical rigour of the DRCWMP, care has been taken in the development of sampling designs for the various wetland biological communities. This is to ensure data are collected in a consistent way and are representative of the wetlands. Natural variability within the wetlands and across years will influence the ability to detect statistically significant differences among the wetlands and over time. Statistical power analyses were performed on biological data that were collected in the early stages of the DRCWMP (Environment Canada and Central Lake Ontario Conservation Authority 2004). This information was used to determine the minimum detectable difference (i.e. statistical difference) in biological attributes and to optimize the monitoring design.

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2. BIOLOGICAL CONDITION

2.1 PLANT COMMUNITY CONDITION

2.1.1 Wetland and Adjacent Upland Ecological Land Classification

Objective

To map and classify vegetation communities within Durham Region coastal wetlands and adjacent upland areas using Ecological Land Classification (ELC) methodology.

Background

The focus of this objective is to monitor changes in shape, size, and composition of wetland and adjacent upland vegetation community units using Geographic Information System (GIS) applications. The vegetation will be mapped and classified, preferably to the level of Vegetation Type, according to the latest edition of the manual, "*Ecological Land Classification for Southern Ontario*".

Three Conservation Authorities (CAs) with jurisdiction in Durham Region (Toronto and Region Conservation Authority - TRCA, Central Lake Ontario Conservation Authority - CLOCA, and Ganaraska Region Conservation Authority - GRCA) have already mapped portions of their natural areas using Ecological Land Classification (ELC) and have developed and employed their own ELC protocols. These protocols all follow the methods established by Lee et al. (1998) for data collection, but differ in the logistic approach through which delineated polygons and associated data are integrated.

ELC mapping of wetlands and adjacent uplands within their jurisdictions will be done by CA staff. Therefore, the methodology used for mapping will reflect the CA jurisdiction in which the wetland occurs. Because the ELC data collection follows the same methodology regardless of CA jurisdiction, the classification of delineated polygons will be standardized for all coastal wetlands in Durham Region.

Methods

ELC field work can be time-consuming, particularly when soil samples are examined in each polygon. The average length of time spent in each polygon is approximately one hour, but can vary considerably. There can easily be 50-100 vegetation communities at and surrounding the larger wetlands. Spreading out this monitoring objective over a number of years will yield the best results in terms of quality data. To update the ELC Vegetation Types if new orthophotography is available, CLOCA should concentrate on two wetlands per year, while GRCA should focus on one wetland every two years or complete the field work at a single wetland over two years, and TRCA should update one wetland per year.

Although the process of ELC data collection for this project follows that set out by Lee et al. (1998), additional information is outlined below. These additions/corrections were discussed during the Ecological Land Classification for Southern Ontario Training Course conducted on behalf of the Ontario Ministry of Natural Resources (OMNR) from June 4 to 8, 2001. In addition, considerations for the integration of polygon data with delineated polygons are discussed.

ELC Data Collection

1. Using the OMNR digital evaluated wetland boundaries, a buffer line at 500 metres around each wetland will be created in a Geographic Information System (GIS). All distinct natural vegetation communities (i.e. to ELC Community Series) within this buffer should be delineated, based on orthophoto interpretation, into individual polygons and labelled with unique identifiers prior to commencing any field work. Field maps can then be created showing ELC polygon lines and identifiers with orthophotography as the background. The polygon boundaries can be corrected, as needed, in the field. The unique polygon identifier will be used to label each ELC data sheet.

2. During the field component, the delineated Community Series polygons will be classified, and potentially split into additional polygons, using the more refined level of ELC Vegetation Type.

3. All of the data sheets should be completed, including Community Description and Classification, Stand and Soil Characteristics, Plant Species List, Management/Disturbance, and Wildlife [pp. 147-151 of Lee et al. (1998)].

4. On the "Plant Species List" data sheet, the first line following the top information box that reads:

   LAYERS: **1** = CANOPY > 10m **2** = SUB-CANOPY **3** = UNDERSTOREY **4** = GROUND (GRD.) LAYER,

   is incorrect and should not include the ">10m" after "CANOPY", i.e. it should read:

   LAYERS: **1** = CANOPY **2** = SUB-CANOPY **3** = UNDERSTOREY **4** = GROUND (GRD.) LAYER.

5. During soil sampling, some attributes such as mottles, gley and/or bedrock may not be encountered using the standard 120-cm auger. In these instances, a value of "200" will be entered in the corresponding depth value on the "Stand and Soil Characteristics" sheet, allowing a numerical value, instead of a blank, to be entered into the database. This is the default value recommended by Harold Lee (pers. comm. 2001) to indicate that the task was completed, but the respective attribute was not found within the sample. Interpreters can then easily distinguish between data not collected (i.e. a blank field) and attributes not encountered (i.e. "200").

6. On the "Effective Texture in Stratified Mineral Soils (Chart A)" flowchart on page 160 of the 1998 ELC guide, there are two references to "Chart A page F14". These refer to page F14 of the Ontario Institute of Pedology (1985) field manual, however, this same table is located on page 164 of Lee et al. (1998).

7. The footnotes on pp. 28 and 117 in Lee et al. (1998) should be disregarded. Instead, wetland designation through plant community attributes should be aided through the use of Appendix 5 - Indicator Plant Species of Wetlands and Uplands in the Ontario Wetland Evaluation System Southern Manual, 3rd Edition (Ontario Ministry of Natural Resources 1993).

Data Management/Analysis

1. Following the field component, the previously delineated polygon boundaries should be updated in a GIS based on field mapping. Fields for the ELC Vegetation Type and for the year in which the field work was completed and by whom should be added to the attribute table.

2. All participating agencies should ensure that their Ecological Land Classification dataset is in an Environmental Systems Research Institute Inc. (ESRI) compatible format. All datasets will be topologically correct and free of attribute errors. The horizontal datum standard is the North American Datum 1983 (NAD83) and the map projection standard is Universal Transverse Mercator (UTM). The UTM zone specific for the study area will be used. The above-mentioned requirements will be met and this and other pertinent information recorded in the metadata of the dataset. Metadata will be ISO 19115 compliant.

3. Figures for each coastal wetland should be created showing the extent of each Vegetation Type within the 500-metre buffer line. A table with the area (in square metres) and percentage of areal coverage for each Vegetation Type within the 500 metres should be produced. These values can be compared with previous iterations if available.

4. If the wetland boundary itself has changed since the previous calculations were made, the area of the 500-m buffer will also change. In this case, it will be necessary to perform two sets of calculations: one using the old buffer line to permit direct comparison of vegetation types within the same area as the previous iteration; and the second using a new buffer of 500 metres around the revised wetland boundary. The second set of calculations should be reported to permit comparison with future iterations.

5. The ELC data could be entered into a separate Microsoft Access-compatible database, but the unique identifiers used in the GIS attribute table must match those in the ELC database so that data integrity is maintained.

6. As polygon boundaries and ELC Vegetation Types are updated with new orthophotography, the previous versions should be retained electronically and their base photography identified in the metadata (e.g. April 2005 colour orthophotos taken by First Base Solutions, Inc.).

Frequency

The frequency of ELC iterations for wetlands and adjacent uplands depends on the availability of updated orthophotography. Ideally, ELC updates should be performed every three to five years.

Additional Data Recording

None

Equipment

As described in Appendix B.

Literature Cited

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2.1.2 Submerged Plant Community

Data Sheet ✓

Objective

To collect submerged aquatic vegetation data to monitor changes in this community through the use of Index of Biotic Integrity (IBI) scores.

Background

Submerged aquatic vegetation (SAV) is an important component of healthy coastal wetlands, in part, by providing food and shelter for a number of fish and wildlife species. A robust SAV community can also improve water quality by stabilizing the substrate, such that sediments are not as readily disturbed by wind or wave action. Conversely, a poor SAV community can be a sign of poor water quality, e.g. high levels of turbidity can decrease light penetration through the water column to such a degree that the vegetation community condition is impaired.

When this project began in 2002, few studies had focused on monitoring Great Lakes coastal wetland SAV, and the monitoring methodology in this field was largely undeveloped. A pilot methodology was tested during the 2002 field season. The following is based on refinements to that field-tested methodology.

Methods

1. SAV sampling will occur during August or early September when SAV communities are at maturity, but have not yet shown signs of senescence.

2. Twenty random sample points located within the open water basin(s) of the target wetland will be predetermined and plotted, using a Geographic Information System (GIS), onto field maps with the aerial photo as the background. According to the Ecological Land Classification system (Lee et al. 1998), only communities with water less than 2 metres in depth are considered “wetland”. For wetlands that have portions of open water that are usually deeper than 2 metres, such as Frenchman’s Bay, those areas should be excluded from SAV sampling.

3. Random points within one or a number of polygons (e.g. all open water polygons within a wetland) can be generated by various extensions to ArcGIS (Environmental Systems Research Institute, Inc.) available free on the Internet (e.g. Minnesota Department of Natural Resources (DNR) - http://www.dnr.state.mn.us/mis/gis/tools/arcview/extensions.html). The random UTM coordinates can then be uploaded to a GPS unit. The Minnesota DNR has also developed a tool to upload waypoints to all Garmin GPS units directly from an ArcGIS shapefile: http://www.dnr.state.mn.us/mis/gis/tools/arcview/extensions/DNRGarmin/DNRGarmin.html.

4. Sample points will not be retained from one sampling period to the next, i.e. new random points will be created each year.

5. Sample points should be located using a GPS unit, preloaded with their locations, and approached by boat (or canoe) or with caution by wading, depending on the depth and substrate at the sample point. A GPS holder that can be attached to the boat or canoe will simplify this by positioning the GPS at the ideal angle for satellite

reception and by allowing hands-free use.

6. The results should not be biased by purposely choosing locations containing vegetation. It is best to have the technician who is not conducting the surveys, decide when the point is reached according to the GPS, since he/she will not be able to see the exact sample location. The decision should be made ahead of time as to which side of the boat/canoe will be sampled in order to minimize bias. It is simplest to sample all quadrats from the same side.

7. The UTM coordinates of each sample point should be entered onto the data sheet (see Appendix C), as it is unlikely that the actual sample location will be identical to the UTM coordinates of the randomly generated point.

8. It is recommended that surveyors sample SAV on relatively calm days (Beaufort Wind Scale 0-2; see Appendix D). For sample points approached by boat or canoe, the vessel will be anchored (if necessary) to eliminate drifting. On windier days, allowing the vessel to stabilize after the anchor has been deployed will simplify maintaining a constant position while using the SAV sampling quadrat.

9. The start time (24-hour clock), wind strength (using the Beaufort Scale), cloud cover (tenths of sky clouded) and air temperature (°C) will be recorded onto the data sheet.

10. A mid-water column turbidity reading will be measured in NTU with an appropriate turbidimeter (the brand name and model should be recorded in the "Notes" field). This measurement should be made prior to completing any other tasks at the point to minimize possible disturbance of sediments, which could increase turbidity readings. **If it is apparent that the sediments have been disturbed at a particular point, the measurement should, instead, be taken from a nearby undisturbed location**.

11. In order to increase the number of samples used to calculate a Water Quality Index (see Water Quality – Section 3.1.1) at each wetland, water temperature, conductivity and pH measurements could also be recorded at each sampling point, if possible. These should be recorded on another sheet (e.g. Monthly Water Quality Sampling data sheet – see Appendix C) or field book with the appropriate sample number associated with these measurements.

    If these additional measurements are determined to be too time-consuming, this may be omitted.

12. Water depth will be measured to the nearest centimetre by using a metre stick or weighted string if the water is greater than 1 metre in depth.

13. A 1-metre square, floating quadrat frame will represent the sample area. The construction of the quadrat frame is at the discretion of the surveyors, but a description of an easily constructed floating quadrat frame follows.

    A quadrat sampling frame could be constructed by attaching four pieces of 1/2-inch CPVC plumbing pipe glued at one side of each 90° elbow (Figure 2.1.2-1) such that the inside dimensions of the quadrat are 1 m x 1 m. The other side of each elbow should be left unglued but can be friction fit to create the square. By

inserting shock cord through the entire frame, it can be easily assembled and disassembled during transport, but all the pieces will stay together. Two sides of the frame should be fitted with polyethylene foam for flotation, which is cut from pipe insulation. This insulation has an existing 1/2-inch hole bored longitudinally through the foam, allowing the foam to be easily fit onto the quadrat frame.

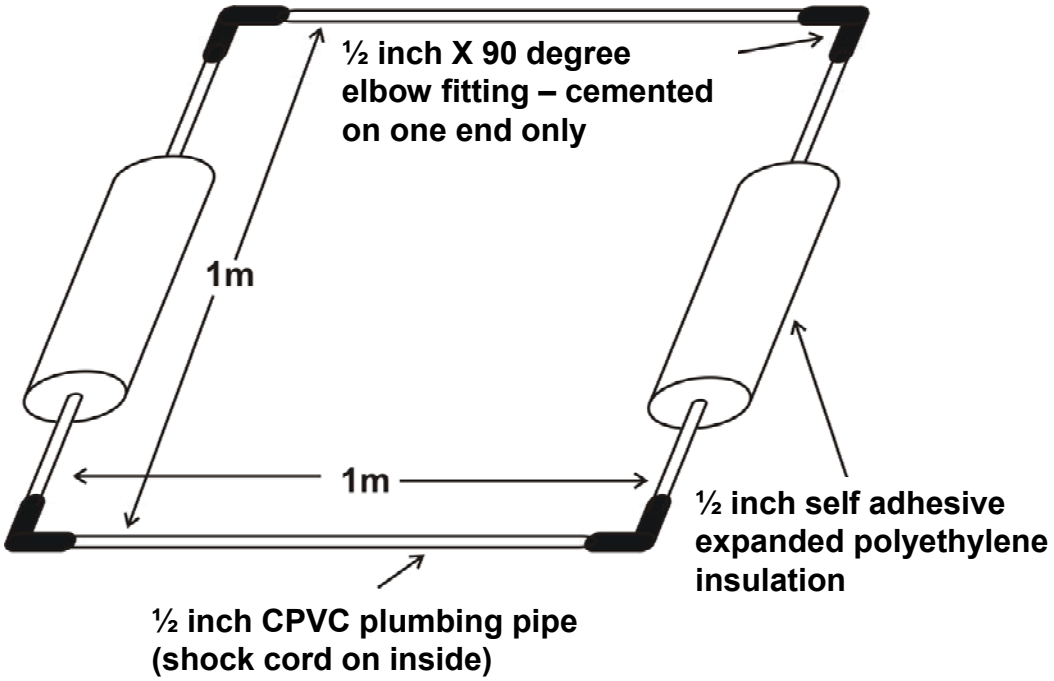

Figure 2.1.2-1. A floating quadrat sampling frame made from 1/2-inch CPVC pipe, with glued and friction-fit elbows, and pipe insulation foam floats.

14. The quadrat will be floated on the water surface at the sampling point. To secure its location, a paddle can be carefully inserted in the sediment at one corner adjacent to the canoe and held in place by the surveyor. Being mindful of parallax, the **total areal coverage** (total percent cover) of all vegetation in the quadrat (**maximum of 100%**) will be estimated and recorded. The individual cover for each species of SAV including all floating-leaved species (e.g. *Nuphar, Lemna, Spirodela* spp.), plant-like algae (e.g. *Chara* or *Nitella* spp.) and any emergent species (usually very few occur within quadrats) will then be estimated. For sampling points that have dense SAV, surveyors should look under large floating leaves or amongst stems for additional species and make estimates of the percent cover of the species within the quadrat.

    Note that the **sum of the individual percent covers for all species can exceed 100%**, because more than one individual may occupy the same area in the two-dimensional sampling plane created by the quadrat. For example, when the quadrat is placed in an area with dense floating-leaved plants, the coverage of a floating-leaved plant species in the quadrat could be 75%. In addition, submerged macrophytes may be present under the floating leaves at a density of 50%. The resulting summed coverage would then be 125%. However, for the "Total Areal Coverage" field on the data sheet, the surveyors would enter the total coverage of all species (see explanation above) as observed *in situ* within the quadrat – not the

sum of individual coverages (see Sample Data Sheet in Appendix C).

15. A specimen of each unidentified species will be retained and labeled to reflect the quadrat from which it was taken. Sealable plastic bags (e.g. Zip-loc®) work well for temporary storage. The data sheet must be updated when the specimen has been identified.

16. In addition to SAV, an estimate of filamentous algal coverage within the quadrat is required. Surface algae and submerged algae cover will be estimated separately (as on the data sheet). In most quadrats with substantial SAV coverage, filamentous algae are absent or readily observable in small amounts. For quadrats that are devoid of SAV, filamentous algae often cover the barren sediment. These algae are difficult to observe – mostly due to high turbidity. To get an estimate of algal coverage in these quadrats, surveyors will use a garden-style fan rake to collect the algae.

    Note: Estimates of algal cover should **not** be included in the "Total Areal Coverage" estimate (except for *Chara* or *Nitella* species). Therefore, it is possible to have 0% total areal coverage, but 100% cover of submerged filamentous algae, for example.

17. Surveyors should attempt to characterize the substrate by the dominant feature; as either clay, silt, fine or coarse sand, gravel, cobble or organic. Substrate characteristics can be determined using the metre stick or paddle to gather sediment or sediments can usually be obtained from the anchor.

18. Water depth, turbidity, substrate characteristics and SAV data will be collected in the same manner at the remaining sampling plots.

19. "End time" will be recorded when sampling is completed.

Frequency

Annually

Additional Data Recording

- Monthly water quality sampling at standard sampling locations (i.e. inlet, middle, outlet) – see Section 3.1.1
- Wildlife observations in **Notes** section of data sheet

Equipment

As described in Appendix B.

Literature Cited

Lee, H.T., W.D. Bakowsky, J. Riley, J. Bowles, M. Puddister, P. Uhlig and S. McMurray. 1998. Ecological Land Classification for Southern Ontario: First Approximation and Its Application. Ontario Ministry of Natural Resources, Southcentral Science Section, Science Development and Transfer Branch. SCSS Field Guide FG-02.

2.2 FISH AND WILDLIFE COMMUNITY CONDITION

2.2.1 Fish Community

Data Sheet ✓✓

Objective

To assess fish community condition in Durham Region coastal wetlands through sampling and by calculating an Index of Biotic Integrity (IBI).

Background

Overview

The methods described herein have been developed as a result of the proceedings of the August 31st, 2001 meeting of the Fish Community Health Methodology Committee associated with this project. At the meeting, presentations were given by:

1. Vic Cairns, Department of Fisheries and Oceans (DFO), on the use of an Index of Biotic Integrity (IBI) for the assessment of Lake Ontario coastal wetland fish communities
2. Eric Cleveland, Royal Botanical Gardens (RBG), on the fish community monitoring program at Cootes Paradise in Hamilton
3. Tim Rance, Ontario Ministry of Natural Resources (OMNR), on the fish sampling methodology previously used at Oshawa Second Marsh.

At this meeting, it was decided that the proposed methodology would include the following three main steps:

1. Fish collection – Fish will be collected at points along transects
2. Fish processing – Following collection, various characteristics will be recorded and the fish will be released
3. Documentation of habitat conditions – Several physical habitat conditions along the transects will be recorded.

The original Durham Region Coastal Wetland Monitoring Program protocol has been modified to resolve issues that arose during subsequent field testing of the methodology.

The following section provides a background justification for protocols described in this methodology. Some of this sampling methodology is based on work conducted at Cootes Paradise (Theÿsmeÿer 1998).

Training Requirements

Please refer to the guidelines and requirements as stipulated in the Electrofishing Guidelines and Procedures (Ontario Ministry of Natural Resources Policy No. FI.3.01.01) adopted in 1986 (Goodchild 1986).

Electrofishing vs. Netting

A number of studies have advocated using both netting and electrofishing to capture the most complete sample of fishes using a wetland (e.g. Chow-Fraser et al. 2006, Fago 1998). Hoop and fyke nets are biased toward catching smaller fish (Chow-Fraser et al. 2006). On the other hand, electrofishing may be biased toward slow-moving or cover-seeking fish (Stephenson 1990). Nets are time-consuming to set up and take down and with a large number of wetlands to be sampled within a relatively short time frame, a netting-based protocol would be difficult to complete. In wetland habitats there is a high probability of catching large snapping turtles, which are difficult to remove and can create large holes in the nets (I. Kelsey, pers. comm. 2003). Fago (1998) stated that if the goal is to sample all fish species, then one method would not be sufficient. However, in this study the objective is to obtain a sample of the fish species and relative abundances at each wetland to enable the calculation of an Index of Biotic Integrity (IBI) score. Electrofishing is an efficient way of collecting samples of fish from many different habitats within a wetland in a relatively short period of time and the effort is readily standardized.

Electrofishing Technique

The goal of electrofishing is to capture the best sample possible while attempting to minimize biases in fish size and species generated by the gear. To achieve this, transects are electrofished in a modified form of point sampling. Both transect and point sampling methods have been used in previous studies. For example, continuous transect electrofishing is used by the DFO as a field sampling procedure (Valere 1996), while point sampling by electrofishing has been successfully used for evaluating habitat use by Copp and Garner (1995) and Garner (1997). There are two reasons for the hybridization of these techniques; both are based on attempting to prevent fish size and behaviour from biasing the sampling results.

The first reason relates to fish behaviour within an electroshocking field. An electroshocking field has a gradient of intensity, with the most intense portion of the field at the anode. As the distance from the anode increases, the strength of the electrical field diminishes such that fish at the periphery feel it, but are not stunned. The escape behaviours of fish are variable; some fish (pelagic species) flee, while structure-preferring species tend to hide. Also, although larger fish are more easily shocked, they are better able to escape the field since the distance a larger fish can travel within the second before the electrofisher stuns them can carry them out of the field. If a transect is electrofished with a constant shock the result can be biased toward those fish whose escape behaviour is to hide and/or which are not fast enough to escape the field.

The second reason for using this sampling technique is related to the number of fish typically present within a transect. When using a continuous transect method of electrofishing, catches of fish are typically a few hundred individuals per transect, and can be as high as 900 fish per transect in healthy wetlands. With such high numbers of fish, the time required to remove all the fish from the field would result in a high degree of mortality if the electrofisher were continually shocking. Furthermore, the rate of progress through the transect would be so slow that most fish on the periphery of the approaching field would escape. The result would be a biased sample along the transect except for the location where the electrofisher was initially activated. In addition, recent research by the DFO has concluded that significantly less sampling effort was required

to achieve a specified level of precision using point rather than transect sampling, thus reducing the cost of field surveys (Vic Cairns, pers. comm.).

Fish Sampling Window

Fish movement data from Cootes Paradise suggest that the highest number of species and total individuals in Lake Ontario coastal wetlands are present in August. By August, the vast majority of fish remaining in the wetland are young of the year (YOY); most of the adult fish have spawned and left the wetland. The preferred fish sampling window occurs within the last two weeks of August, since both the earlier and later spawns will be present in the wetlands. However, time constraints may require that sampling will also be conducted earlier in August or at the beginning of September.

Users of this methodology handbook outside of the Durham Region Coastal Wetland Monitoring Project (DRCWMP) should note that the Great Lakes Coastal Wetlands Consortium (GLCWC; see Introduction) has developed and is promoting a fyke net sampling methodology and analysis procedure for reporting on fyke net-generated samples. This is in contrast to methods used in the DRCWMP. The DRCWMP supports the use of electrofishing for reasons discussed above, whereas the GLCWC has chosen fyke netting mainly because of the modest cost of sampling equipment compared to electrofishing. The DRCWMP plans to link electrofishing and fyke netting-based results through comparisons in published literature and by conducting sampling using both methods in close temporal and spatial proximity.

Methods

Fish Collection

The fish collection methods have been designed to ensure consistency within and among marshes over time with regard to effort and precision. At the same time the dynamic nature of the wetlands has been taken into account. The rationale behind these methods is based on a few important factors:

- Fish collection is designed to provide a **sample** of the fish population at each wetland to permit the calculation of an IBI score, not a complete species inventory
- To reduce the variability of effort as much as possible
- To permit individual wetland sampling to be completed in one day.

1. Transects will have six sample points located 8 m apart on centre along a generally linear path (Figure 2.2.1-1). The resulting transect has 4-m diameter sample points along its 44-m length.

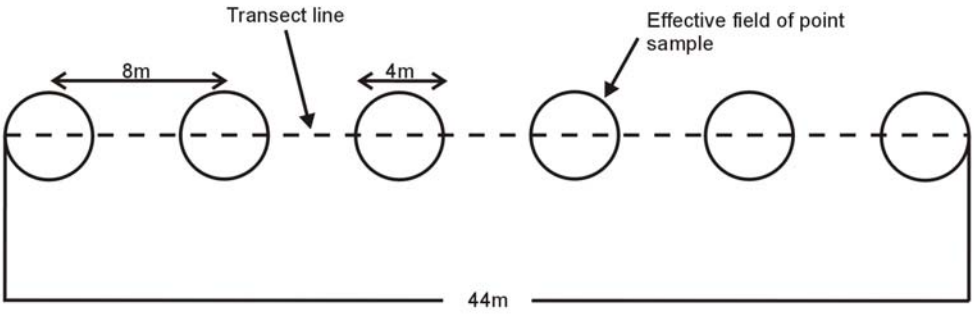

Figure 2.2.1-1. A schematic plan view of an electrofishing transect illustrating the size and location of point samples.

2. Different fish species can be associated with different habitats in Great Lakes coastal wetlands (Stephenson 1990). Fish collection will be conducted in all possible distinct habitats within the coastal wetland, where habitat area and transect dimensions permit. The habitat type descriptions below are based on types sampled by Theÿsmeÿer (1998) in the Cootes Paradise Fish Community Monitoring Program, but have been modified based on results of DRCWMP field work to date. By sampling the following types, it can be ensured that a diversity of habitats will be assessed.

   Shoreline (Open Water Edge) – An area within 10 m of the definable shoreline that typically consists of vegetation or exposed substrate. The "shoreline" does not have to be an actual wetland/dryland boundary. For example, it can be the edge between open water and an emergent cattail stand that is growing in water. The shoreline habitat type can include a variety of subtypes: emergent vegetation; patches of woody debris serving as structure; exposed sand or gravel; or a combination of all three; etc. The actual transect can pass through stands of submerged or floating-leaved aquatic vegetation. Consideration should also be given to including representative areas of all subtypes within the transects.

   Open Water – Defined as an area 50 m or more away from the shoreline (see description above), exposed to the prevailing wind, with a depth generally between 0.5 – 2 m. Open water transects may have submerged aquatic or floating-leaved plants present.

   Inlet Region – Defined as the low gradient portion of the inlet (stream or river) that is under lake level influence, characterized by depths of 0.5 – 2 m, a lack of pools and riffles, with predominantly transported sediment substrate. Shoreline vegetation may be dense (i.e. shrubby), and considerable woody debris may be present. In some wetlands, it may not be possible to access the defined inlet region due to the width of the stream or debris (e.g. tree trunks or limbs). In these cases, the inlet will be the furthest accessible point upstream. Some wetlands (e.g. Wilmot Creek Marsh and Port Newcastle Wetland) may include creek habitat,

resulting in multiple "inlets", since it is difficult to distinguish where the creek/wetland boundary occurs.

Outlet Region – An area of the wetland that outlets directly or indirectly to Lake Ontario. Unlike the Inlet Region, typically this habitat type does not have well defined borders. In this case a 44-m radius circle should be used to roughly define the habitat type. This habitat type should not be sampled as an Outlet Region if it is completely disconnected from Lake Ontario, which happens periodically along barrier beaches; instead, the area would then default to the Barrier Beach or Shoreline habitat type.

Barrier Beach – A depositional area generally comprised of sand and gravel material that separates or protects the wetland from Lake Ontario. These areas are generally dynamic, changing dramatically with storm events. Transects should be sampled within 10 m of the definable shoreline and not overlap Outlet Region habitat types. Barrier Beach habitat types should take precedence over Shoreline habitat types where overlap occurs. Field observations will be needed to confirm which habitat type is more appropriate when vegetation separates the shoreline of the barrier beach and the fishable area of the wetland. It is feasible that enough vegetation could preclude sampling the Barrier Beach habitat type despite the fact that a barrier beach is present.

3. Ideally, mapping for each wetland should be created through Geographic Information System (GIS) applications using current digital 1:10 000 or better air photos (i.e. orthophotos), with subsequent ground-truthing. If digital air photos are not available, a GPS could be used to locate the fishable area and islands in the wetland. A mapping guideline is described below:

   - Prior to electrofishing a wetland for the first time, the total fishable area (minus area of islands) should be mapped and measured.
   - Habitat types as defined above should also be identified and mapped.
   - For small wetlands, a minimum of one transect per habitat type is required. For large wetlands, field work from the DRCWMP to date suggests a maximum of 10-11 transects is generally achievable in one day of electrofishing. The transects should be proportionately divided among the habitat types (ensuring that each habitat type present has at least one transect).
   - Habitat units that are not large enough to accommodate a 44-m transect should be omitted from sampling.
   - The habitat type will be identified on the data sheet.
   - The shape and area of habitat types within the wetlands are dynamic and will change with long-term water level fluctuations. Therefore, transect locations will be maintained from year to year in generally the same areas. If circumstances arise that make the transect location unsuitable, then it should be moved to another area, in close proximity, staying within the appropriate habitat type.

4. Fish sampling will generally occur from mid-August to early September during good weather conditions (i.e. calm with no precipitation). After storm events, sampling in the Inlet Regions should be postponed until peak flows have subsided.

5. The UTM coordinates will be obtained using a GPS at the start and end of each transect and recorded on the data sheet. A floating rope, knotted at 8-m intervals can be anchored at the start and released as the boat travels. This will serve two purposes: 1) determine the point sample locations and 2) visually delineate the transect such that the habitat conditions (see below) can be measured at the appropriate location. At the end of the transect a canoe paddle can be inserted into the substrate to facilitate locating this point (unless the water is too deep or substrate too coarse).

6. Fish sampling will be conducted with a 16-foot, flat-bottomed, single boom 2.5 GPP electrofishing boat. Electrofishing will be conducted in accordance with Ontario Ministry of Natural Resources Electrofishing Guidelines and Procedures (OMNR Policy No. FI.3.01.01; Goodchild 1986). Boat operations will be conducted in accordance with Transport Canada regulations.

7. Each point along the transect will be fished for 20 seconds, while one crew member nets the immobilized fish. The netter should wait until fish are observed before putting the net into the water, unless the turbidity is high in which case he/she should wait 5-10 seconds and then start blindly sweeping the net around in the appropriate area. If fish are netted while electroshocking is ongoing, the net should be taken out of the water while watching for additional fish. This will prevent the already captured fish from being exposed to more electricity. All fish netted in a transect will be placed in a live well located on the electrofishing boat. Once the transect has been completed the captured fish should be transferred to the fish processing boat.

8. Electrofisher Settings - The objective of electrofishing is to get the best sample possible, while minimizing the degree of fish mortality within a transect. Due to the range of fish types and sizes, the gear will be set to a level that will shock all of the most resistant fish within 2 m of the anode. The target electrofishing effort has been determined to be approximately 2000 watts at 60 Hz (DC) at Durham Region coastal wetlands using this particular electrofishing boat.

   Due to the potentially high numbers of fish and the differential resistance to electroshocking of different species, not all individuals can be removed from the field before mortality occurs. Cyprinid species, particularly bluntnose minnow, captured during the warm summer temperatures often suffered significant mortality (up to 50% of the catch) during RBG work at Cootes Paradise. However, total fish mortality for a transect rarely exceeded 5% of the total catch (T. Theÿsmeÿer, pers. comm.).

Fish Processing

Earlier versions of this protocol state that young-of-the-year (YOY) fish should be separated in the field and identified as such on the field records. However, while it would be relatively easy to do so for some species, for other small fishes it is difficult and time-consuming to separate YOY from other age groups. The increased time handling these individuals could increase their mortality. Young-of-the-year can be segregated using the length measurements recorded in the field and comparing these to length-at-age data in the literature (Stephenson 1990).

1. The catch will be processed immediately following sampling at each transect. The fish should be sorted by species.

2. Measure the **fork length** in millimetres using a fish measuring board, and **weight** to the nearest 0.1 grams (if possible, depending on the scale used) is recorded for a maximum of 10 individuals of each species.

3. Fish are weighed using an appropriate scale: a low capacity, high resolution portable scale for individual small to medium-sized fish (e.g. up to 600 g ±0.1 g); a portable scale for batched fish (e.g. up to 6000 g ±1 g); or a hanging scale for large fish (e.g. up to 50 kg ±20 g). Fish will be weighed using the most precise scale for the weight range of the fish.

4. If the number of individuals of a species captured in a transect exceeds 10, the remaining individuals will be counted and weighed as a group or "batch" (record the total weight and number of individuals under **Batches** on the data sheet).

5. Any anomalies (e.g. eroded fins, tumours, lesions, etc.), or if the specimen is dead or being preserved as a voucher, will be recorded under **Condition** on the data sheet. The fish will be released as they are processed, except for those being preserved as voucher specimens or individuals of exotic, invasive species, which will be humanely euthanized (except for larger specimens, e.g. common carp).

Documentation of Habitat Conditions

At the completion of each transect, fish species and measurements, time of day, electroshocking effort and settings (i.e. voltage, current, frequency and shocking time), and habitat conditions will be recorded on a field data sheet (see Appendix C). In some wetlands (e.g. larger ones or those with a large catch), using an additional boat or canoe permits technicians to measure and record the habitat variables while the fish are being sorted and measured in the processing boat. In this case, a second data sheet is required (see Appendix C), from which data will be transcribed onto the "main" data sheet. The conditions to be recorded include the following:

Barrier Beach Condition –The appropriate box indicating barrier beach condition, i.e. open, closed or not applicable, will be checked off. If the barrier beach is open, a description of the extent of connectivity to the lake should be recorded in the **Notes** field (e.g. is water just flowing out of the wetland or is lake water also entering).

Habitat Type – The appropriate habitat type, i.e. inlet, outlet, shoreline, (barrier) beach, open water, will be checked off. Habitat subtypes (e.g. emergent, woody, exposed shoreline) can be described in the **Notes** field.

Air Temperature – Ambient air temperature will be measured using any thermometer and expressed as degrees Celsius.

Wind Direction – Wind direction will be estimated and expressed in azimuthal direction (e.g. N, NE, W).

Wind Strength – Wind strength will be estimated using the Beaufort Wind Strength Scale (Force 0-12). See Appendix D for definitions.

Cloud Cover – Cloud cover will be estimated and expressed as the proportion, in tenths, of the sky covered with cloud (e.g. $5/10^{ths}$).

Water Temperature – Water temperature is measured in degrees Celsius either using a digital thermometer or from another meter that measures temperature (e.g. YSI multimeter or conductivity meter).

Conductivity – Water conductivity is measured using a multimeter or conductivity meter and expressed in microSiemens per centimetre (μS/cm). The brand and model of meter should be recorded in the **Notes** field.

pH – The pH of the water is measured using an appropriate pH meter or multimeter. The brand and model of meter should be recorded in the **Notes** field.

Turbidity – Turbidity will be measured in NTU from the mid-water column using an appropriate multimeter or turbidimeter. The brand and model of meter should be recorded in the **Notes** field.

Dissolved Oxygen – Dissolved oxygen will be measured using an appropriate meter and expressed in mg/L. The brand and model of meter should be recorded in the **Notes** field.

Water Depth – Water depth will be measured to the nearest centimetre by using a metre stick or weighted string if the depth is over 1 m.

Other Data – If a multimeter that records additional measurements is used, these data can be noted in the appropriate location on the data sheet.

Aquatic Plant Cover – The total percent cover of all plants and the percent cover of emergent, submerged aquatic vegetation and floating-leaved (% of the transect) will be visually estimated and recorded for the entire transect length, covering an area approximately 2 m on either side. In addition, the percent cover of the dominant and subdominant aquatic plants will be recorded. Other observed aquatic plants are noted. The height of the aquatic plants will be **estimated** in centimetres if appropriate (e.g. lesser duckweed, *Lemna minor*, would not have a height) and taken as the distance from the base of the plant at the growing substrate to the upper tip of the plant as it exists in the water (i.e. it should not be "stretched out" to take a measurement). The dominant substrate along the transect will also be recorded (i.e. clay, silt, fine sand, coarse sand, gravel, cobble or organic).

Frequency

Annually if possible.

Additional Data Recording

- Monthly water quality measurements (i.e. turbidity, conductivity, pH, water temperature) at their usual locations (e.g. inlet, middle, outlet) – see Section 3.1.1.
- Wildlife observations

Equipment

As described in Appendix B.

Literature Cited

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Chow-Fraser, P., K. Kostuk, T. Seilheimer, M. Weimer, T. MacDougall, and T. Theÿsmeÿer. 2006. Effect of wetland quality on sampling bias associated with two fish survey methods for coastal wetlands of the lower Great Lakes. In T. P. Simon and P. M. Stewart (eds.) Coastal Wetlands of the Laurentian Great Lakes: Health, Habitat, and Indicators, pp. 239-262. Bloomington, IN: AuthorHouse.

Copp, G.H. and P. Garner. 1995. Evaluating the microhabitat use of freshwater fish larvae and juveniles with point abundance sampling by electrofishing. Folia Zoologica 44(2):145-158.

Fago, D. 1998. Comparison of littoral fish assemblages sampled with a mini-fyke net or with a combination of electrofishing and small-mesh seine in Wisconsin lakes. North American Journal of Fisheries Management 18:731–738.

Garner, P. 1997. Sample sizes for length and density estimation of 0+ fish when using point sampling by electrofishing. Journal of Fish Biology 50:95-106.

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Stephenson, T. 1990. Fish reproductive utilization of coastal marshes of Lake Ontario near Toronto. Journal of Great Lakes Research 16(1):71-81.

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2.2.2 Breeding Bird Community

Objective

To assess breeding bird community condition in Durham Region coastal wetlands through monitoring and by calculating an Index of Biotic Integrity (IBI) score.

Background

The marsh-nesting bird community, especially those species nesting in emergent marsh habitat, has been shown to be an indicator of wetland habitat quality (Meyer et al. 2006).

This methodology follows the Marsh Monitoring Program (MMP) protocol to monitor breeding bird communities. The MMP was implemented in 1994 by Bird Studies Canada and Environment Canada. Since 1994, the MMP has been expanded, aided by additional support from the U.S. Environmental Protection Agency and the Great Lakes Protection Fund. In this time the MMP has gathered a substantial amount of data collected by hundreds of volunteers (Crewe et al. 2006).

For the purposes of the Durham Region Coastal Wetland Monitoring Project (DRCWMP), the current MMP protocol will be implemented, but with some changes. The MMP protocol was designed for use within a geographically large-scale study, while this project deals with assessing biological communities at a site level. Meyer et al. (2006) found that adding a third visit and interior stations to the MMP protocol resulted in significantly higher indices of abundance and species richness of most marsh bird guilds at a site level, especially emergent marsh nesting obligates. Adding interior stations at most Lake Ontario coastal wetlands also produced higher Indices of Biotic Integrity (IBIs). However, for already established routes, this may not be possible without omitting the existing stations, which would otherwise be too close.

Meyer et al. (2006) also recommend that if only two surveys are conducted, they should be completed at the beginning (first two weeks) and at the end (last two weeks) of the prescribed survey period (i.e. May 20 to July 5) due to the seasonal timing of emergent marsh nesting birds' vocalizations in this region.

Most coastal wetlands in Durham Region are comprised of marsh and swamp areas. Of these wetlands, only four have more than one-third of their area as swamp habitat: Rouge River Marshes (41%), Carruthers Creek Wetland Complex (75%), Lynde Creek Marsh (40%) and Port of Newcastle Wetland Complex (43%). The MMP was designed for use in marsh habitats only and cannot be easily extended to survey wooded areas. Therefore, wooded wetlands will not be surveyed specifically for breeding birds in this project.

Methods

1. The following methods elaborate and augment the current MMP methodology for surveying breeding birds. Surveyors must have received and be familiar with the current MMP training kit and instructions prior to completing this monitoring task. The package contains training and broadcast CDs, location identification tags, an instruction manual and data sheets, and is available from:

Bird Studies Canada
Marsh Monitoring Program
P.O. Box 160
Port Rowan, Ontario N0E 1M0 Canada
Toll free: 1-888-448-2473
Fax: 519-586-3532
Email: aqsurvey@bsc-eoc.org

2. In 2002, survey station locations at each wetland were predetermined by examining air photos of the wetlands and positioning the survey stations within the wetland to maximize the number of stations per wetland. Bird survey stations should be separated by at least 250 m.

3. Point count stations can be located using a hand-held GPS unit with a horizontal accuracy of 15 m or better. If possible, laminated field maps should be created showing the points and semi-circular stations on an aerial photo (see Figure 2.2.2-1). These are a reminder as to which direction the surveyor should face and are also useful when assessing the habitat features within each station. However, they should not be relied on solely, especially if the aerial photography is several years old.

4. Point count stations will not be surveyed if they contain more than 50% open water or more than 25% tree and/or shrub cover as per MMP protocol. The decision to survey the station based on these criteria should be made in the field.

5. The azimuthal direction that MMP surveyors face during the survey is at their discretion, but should remain constant among visits to the survey station. This can be easily done on plots along the edge of the wetland but may be difficult in areas within dense cattail stands. Note that the direction in which the surveyor is facing may influence whether a point count station is surveyed based on the criteria stated above. For example, this would occur in a location where water levels had recently changed, thus affecting the open water and emergent vegetation ratio around the focal point. Where a point count station would otherwise not be surveyed due to excess open water, the surveyor can change the direction that they face such that the point may be surveyed.

6. As noted above, surveys should only be conducted in marshes. The following definitions of marsh habitats are based on Ecological Land Classification (ELC) Community Class and Series (see Lee et al. 1998) designations (Table 2.2.2-1).

Table 2.2.2-1. Ecological Land Classification (ELC) Community Class and Series designations for marsh habitats.

Class	Series	Habitat Type	General Vegetation Characteristics*
Marsh	MAM	Meadow marsh	- Tree and shrub cover < 25% - Soils flooded in spring, moist to dry by summer - Hydrophytic grass, sedge and forb species
	MAS	Shallow marsh	- Tree and shrub cover < 25% - Emergent vegetation (bulrush, cattail and burreed) dominated - Water depth < 2 m

* Consult current ELC field guide for additional vegetation characteristics

7. Before the initial survey, all point count stations will be staked and marked with the station and route identifiers. Station tags that are included in the MMP training package will be used to label the stakes.

   In some heavily used areas, installing stakes may not be warranted due to the likelihood of vandalism or removal of the stakes. In these areas vegetation landmarks, in conjunction with a GPS unit, can be used to find the stations (e.g. two metres to the south of the large willow tree).

8. If it is not possible to visit each station three times, then the two visits should be conducted during the first two weeks and the last two weeks of the survey period (i.e. between May 20 and July 5).

9. The MMP data collected for the Durham Region Coastal Wetland Monitoring Project will be sent to Bird Studies Canada following the data submission instructions provided in the MMP training package.

Frequency

Annual

Additional Data Recording

Ensure that a "Habitat Description Form" from the MMP package is completed for each point count station. However, if a station is surveyed for both birds and amphibians by the same surveyor, only one Habitat Description Form needs to be submitted.

Equipment

As described in Appendix B.

Literature Cited

Crewe, T., S. Timmermans and K. Jones. 2006. The Marsh Monitoring Program 1995-2004: A Decade of Marsh Monitoring in the Great Lakes Region. Bird Studies Canada, Environment Canada – Ontario Region and the United States Environmental Protection Agency – Great Lakes National Program Office.

Lee, H.T., W.D. Bakowsky, J. Riley, J. Bowles, M. Puddister, P. Uhlig and S. McMurray. 1998. Ecological Land Classification for Southern Ontario: First Approximation and Its Application. Ontario Ministry of Natural Resources, Southcentral Science Section, Science Development and Transfer Branch. SCSS Field Guide FG-02.

Meyer, S.W., J.W. Ingram and G.P. Grabas. 2006. The Marsh Monitoring Program: Evaluating Marsh Bird Survey Protocol Modifications to Assess Lake Ontario Coastal Wetlands at a Site-level. Technical Report Series 465. Canadian Wildlife Service, Ontario Region, Ontario.

The Marsh Monitoring Program – Training Kit and Instructions for Surveying Marsh Birds, Amphibians and Their Habitats. 2003 Revised Edition. Bird Studies Canada in cooperation with Environment Canada and the U.S. Environmental Protection Agency. February 2003.

Figure 2.2.2-1. Marsh Monitoring Program survey locations at Corbett Creek Marsh, including 100-m radius semi-circle.

2.2.3 Amphibian Community

Objective

To assess the amphibian (anuran) community condition in Durham Region coastal wetlands through monitoring and by calculating an Index of Biotic Integrity (IBI) score.

Background

This methodology follows the Marsh Monitoring Program (MMP) protocol to monitor calling amphibian (i.e. frog and toad) communities. The MMP was implemented in 1994 by Bird Studies Canada and Environment Canada. Since 1994, the MMP has been expanded, aided by additional support from the U.S. Environmental Protection Agency and the Great Lakes Protection Fund. In this time the MMP has gathered a substantial amount of data collected by hundreds of volunteers (Crewe et al. 2006).

Most coastal wetlands in Durham Region are comprised of marsh and swamp areas. Of these wetlands, only four have more than one-third of their area as swamp habitat: Rouge River Marshes (41%), Carruthers Creek Wetland Complex (75%), Lynde Creek Marsh (40%) and Port of Newcastle Wetland Complex (43%). The MMP was designed for use in marsh habitats only and cannot be easily extended to survey wooded areas. Therefore, wooded wetlands will not be surveyed specifically for amphibians in this project. However, since detection limits for amphibian calls extend well beyond the survey plot area, amphibians will be monitored to some degree in wooded areas of the wetlands.

Methods

1. The following methods elaborate and augment the current Marsh Monitoring Program methodology. Surveyors must have received and be familiar with the current Marsh Monitoring Program training kit and instructions to perform this monitoring task. The package contains location identification tags, an instruction manual and data sheets, and is available from:

   Bird Studies Canada
   Marsh Monitoring Program
   P.O. Box 160
   Port Rowan, Ontario N0E 1M0 Canada
   Toll free: 1-888-448-2473
   Fax: 519-586-3532
   Email: aqsurvey@bsc-eoc.org

2. Point count station locations at each wetland were predetermined by examining air photos of the wetlands and positioning the surveys stations within the wetland to maximize the number of stations per wetland.

3. Because the survey station separation distance is 250 m and 500 m for breeding bird and amphibian stations, respectively, only every second point count station will be surveyed for amphibians.

4. Point count stations can be located using a hand-held GPS unit with a horizontal accuracy of 15 m or better. If possible, laminated field maps should be created showing the points and semi-circular stations on an aerial photo (see Figure 2.2.2-1). These are a helpful reminder as to which direction should be faced and also aid in assessing the habitat features within each station (although they should not be relied on solely especially if the aerial photography is several years old).

5. Point count stations will not be surveyed if they are located in areas with more than 50% open water or more than 25% tree and/or shrub cover as per MMP protocol. The decision to survey the station based on these criteria will be made in the field.

6. The azimuthal direction that MMP surveyors face during the survey is at their discretion, but should remain constant among visits to the survey station. This can be easily done on plots along the edge of the wetland but may be difficult in areas within dense cattail stands. Note that the direction in which the surveyor is facing may influence whether a point count station is surveyed based on the criteria stated above. For example, this would occur in a location where water levels had recently changed, thus affecting the open water and emergent vegetation ratio around the focal point. Where a point count station would otherwise not be surveyed due to excess open water, the surveyor can change the direction that they face such that the point may be surveyed.

7. As noted above, surveys should only be conducted in marshes. The definitions of marsh habitats are based on Ecological Land Classification (ELC) Community Class and Series (see Lee et al. 1998) designations (Table 2.2.2-1).

8. Before the initial survey, all point count stations will be staked and marked with the station and route identifiers. Station tags that are included in the MMP training package will be used to label the stakes. Adding pieces of highly reflective tape near the top of the stakes can aid in relocating them in the dark.

   In some heavily used areas, installing stakes may not be warranted due to the likelihood of vandalism or removal of the stakes. In these areas vegetation landmarks, in conjunction with a GPS unit, can be used to find the stations (e.g. two metres to the south of the large willow tree).

9. The MMP data collected for the Durham Region Coastal Wetland Monitoring Project will be sent to Bird Studies Canada following the data submission instructions provided in the MMP training package.

Frequency

Annual

Additional Data Recording

Ensure that a “Habitat Description Form” from the MMP package is completed for each point count station. However, if a station is surveyed for both birds and amphibians by the same surveyor, only one Habitat Description Form needs to be submitted.

Equipment

As described in Appendix B.

Literature Cited

Crewe, T., S. Timmermans and K. Jones. 2006. The Marsh Monitoring Program 1995-2004: A Decade of Marsh Monitoring in the Great Lakes Region. Bird Studies Canada, Environment Canada – Ontario Region and the United States Environmental Protection Agency – Great Lakes National Program Office.

Lee, H.T., W.D. Bakowsky, J. Riley, J. Bowles, M. Puddister, P. Uhlig and S. McMurray. 1998. Ecological Land Classification for Southern Ontario: First Approximation and Its Application. Ontario Ministry of Natural Resources, Southcentral Science Section, Science Development and Transfer Branch. SCSS Field Guide FG-02.

The Marsh Monitoring Program – Training Kit and Instructions for Surveying Marsh Birds, Amphibians and Their Habitats. 2003 Revised Edition. Bird Studies Canada in cooperation with Environment Canada and the U.S. Environmental Protection Agency. February 2003.

2.2.4 Macroinvertebrate Community

Data Sheet ✓

Objective

To monitor and calculate an Index of Biotic Integrity (IBI) score for macroinvertebrates as an indicator of water and habitat quality in Durham Region coastal wetlands.

Background

Macroinvertebrates are widely used as biological indicators in aquatic environments. Being ubiquitous and relatively sedentary, they are ideal for use in biomonitoring. Since some species are extremely sensitive to pollution, while others are more tolerant, macroinvertebrates can provide a good assessment of water quality.

Macroinvertebrates are defined as those invertebrates that are retained in a 500 μm mesh net and include insects, crustaceans, molluscs, annelids, and flatworms. By identifying these organisms, assessments can be made of water and habitat quality in the wetland. Macroinvertebrate sampling reveals cumulative effects of changes in water quality as opposed to the chemical analysis of water, which provides a measure of conditions at the time of sampling.

The field methods described below were developed through the Great Lakes Coastal Wetlands Consortium (GLCWC) and follow the field collection methods used in Burton et al. (1999).

Methods

1. Prior to starting field work, a sufficient number of glass vials (~ 40 mL capacity) for the three samples per wetland will be prepared by filling each two-thirds full of 70% ethanol. Each vial will be labeled with a unique ID number.

2. Sweep net sampling of aquatic invertebrates will be conducted at three locations within each prominent emergent wetland vegetation zone on one occasion during late July or early August in conjunction with annual Water Quality sampling (Section 3.1.1). Durham Region coastal wetland emergent zones are generally dominated by cattails (*Typha* sp.). As such, most sites will only require three samples from the cattail vegetation/open water interface. If possible, the sample locations should correspond roughly to the inlet, middle and outlet regions of the wetland.

3. Supporting information to be recorded on the data sheet (see Appendix C), includes UTM coordinates using a GPS, water depth (cm), turbidity (NTU), water temperature (°C) and air temperature (°C). The plant community will be described in detail at each replicate location. Descriptions will include dominant (>75% cover), subdominant (5-75% cover) and incidental (< 5% cover) emergent and submerged plant species within a 5-metre buffer of the sampling area**. Water quality data should be collected at the sampling starting point before invertebrate collection**, because the sweeping process disturbs the sampling area and can result in erroneous temperature and turbidity readings. See Water Quality section for additional details (Section 3.1.1).

4. Macroinvertebrate samples will be collected at the emergent vegetation/open water interface at locations representative of the wetland as determined by the sampling technician. A D-frame net with 500-μm mesh will be used to sweep the entire water column from immediately above the sediment layer to the surface, thereby including all microhabitat types. The net will be used to "shake" the emergent (and adjacent submerged) vegetation below water level to dislodge any macroinvertebrates using these surfaces.

5. The sweeps will be conducted from a canoe or flat-bottomed boat. The most efficient method is for two technicians to sweep simultaneously at either end of the canoe.

6. The net contents from each sweep will be transferred to a uniquely numbered, white plastic bin (dimensions approximately 30L×20W×12D cm). Both technicians should use the same centrally-located bin.

7. The number of plastic bin used at each sample location will be recorded on the data sheet.

8. A subsample of 150 macroinvertebrates is required from each sampling location. The number of sweeps required to collect a suitable number of invertebrates such that 150 can be removed in a timely manner will differ among sampling locations within the wetland and among wetlands. As a result, the total time required to collect one sample will vary. The number of sweeps completed at each sampling site will be left to the samplers' discretion. After finishing the first replicate, the samplers will move to the next sampling location.

9. After three replicate samples are collected (in three separate, numbered bins) from representative areas of the emergent vegetation zone, the samples will be taken to shore to complete subsampling and preservation. A total of 150 invertebrates will be removed from each of the bins using forceps and placed directly into labeled vials containing 70% ethanol. The use of a hand-held counter is recommended for keeping track of numbers. Each vial number will be recorded on the data sheet (see Appendix C).

10. A sampling technician will pick the invertebrates ensuring a representative sample of all types of macroinvertebrates, i.e. not only large individuals are included in the sample. This process will continue until a minimum of 150 organisms is collected.

11. All samples will be labeled according to wetland name, date, vegetation type and replicate number. Invertebrates will be classified to functional group (Burton et al. 1999), as per forthcoming GLCWC recommendations. Environment Canada has developed a taxonomic key for invertebrates found in Lake Ontario coastal wetlands during 2002 sampling. This key is the primary means of identifying the collected invertebrates and is based on taxonomic keys in Thorp and Covich (1991) and Merritt and Cummins (1996).

Frequency

Annually

Additional Data Recording

- Annual water quality sampling (Section 3.1.1)
- Monthly water quality measurements at standard locations (i.e. inlet, middle, outlet) (Section 3.1.1)

Equipment

As described in Appendix B.

Literature Cited

Burton, T.M., D.G. Uzarski, J.P. Gathman, J.A. Genet, B.E. Keas and C.A. Stricker. 1999. Development of a preliminary invertebrate index of biotic integrity for Lake Huron coastal wetlands. Wetlands 19:869-882.

Merritt, R.W. and K.W. Cummins (eds.). 1996. An Introduction to the Aquatic Insects of North America (3rd. ed.). Dubuque, IA: Kendall/Hunt Publishing Co.

Thorp, J.L., and A.P. Covich. 1991. Ecology and Classification of North American Freshwater Invertebrates. New York, NY: Academic Press.

3. GEOPHYSICAL CONDITION

3.1 WETLAND

3.1.1 Water Quality

Objective

Data Sheet ✓✓

To measure water quality at Durham Region coastal wetlands.

Background

A number of natural and anthropogenic sources can affect water quality: storms, wave action, wildlife activity, agricultural and residential runoff, and point source pollution. Wetland water quality describes the condition of the aquatic environment that wetland flora and fauna inhabit. Water quality parameters can also be used to help create disturbance measurements for Durham Region coastal wetlands.

Both physical (e.g. conductivity and turbidity) and chemical (e.g. pH and total phosphorus) parameters are sampled to obtain as broad an understanding of water quality conditions as possible. The overall water quality can be an indication of the exposure level of aquatic communities to disturbance. Water quality data can help provide insight into the observed scarcity or richness of certain biological guilds.

Turbidity is a measure of water clarity, which is important to aquatic plant and animal health. High turbidity reduces the depth of light penetration, which is necessary for primary production by aquatic macrophytes and algae. A decrease in primary production could negatively impact wetland invertebrates and, subsequently, their predators. A loss of emergent vegetative structure generally results in fewer invertebrates produced in the wetland. Sight-feeding fish species, e.g. piscivores, can also be negatively impacted by turbid waters (Jude and Pappas 1992).

Increased turbidity can result from high levels of suspended solids, such as sediments, plankton and other microscopic organisms, and industrial wastes in the water or from a disturbance of the sediment layer (either as a result of human activity or natural factors, e.g. wind/wave action, carp). Turbidity measurements will permit characterization of the impacts on the wetlands.

Patricia Chow-Fraser (2006) has developed a Water Quality Index (WQI) for assessing effects of land cover change on Great Lakes coastal wetlands. The simplest version of this Index uses four water quality parameters: turbidity, pH, water temperature and conductivity. By adding pH, water temperature and conductivity measurements to the previously collected monthly turbidity measurements, WQI scores can be calculated for each wetland on a monthly basis (from May to September). Using the WQI will permit comparisons between Durham Region wetlands and those sampled by other researchers in the Great Lakes.

Nutrients, such as nitrogen and phosphorus, can enter water courses through a number of pathways: agricultural or lawn fertilizers; livestock; septic tanks; sewage treatment plant discharge; etc. Elevated nutrient levels can impact wetland biotic communities both directly and indirectly. For example, nitrogen in the form of nitrate can be toxic to amphibians at relatively low concentrations (Rouse et al. 1999). In addition, high

nutrient levels can lead to eutrophic conditions in wetlands, resulting in sufficiently low dissolved oxygen concentrations such that certain fish species can not survive.

Methods

Monthly Water Quality Sampling

1. A minimum of 3 samples per wetland per sampling effort is required. A field map with a base aerial photo, showing the turbidity locations can assist field staff in locating the sampling locations.

   For simple sites with one basin (e.g. Lynde Creek Marsh), samples should be distributed linearly from inlet to outlet. However, there may be more than one inlet per wetland: both Lynde Creek and Corbett Creek marshes have two main tributaries. In these cases, measurements should be taken at each inlet location.

   For multi-basin wetlands (e.g. Duffins Creek Marsh), three samples per basin should be measured. During the next measurement period, the same general area will be sampled (by referring to the original UTM coordinates).

2. Additional water quality measurements located throughout each wetland are recommended. These values can be used to model water quality within a wetland of interest. See Figure 3.1.1-1 for an example of turbidity modeling produced from measurements taken at Bowmanville Marsh. This was used to determine high turbidity "zones" within this wetland for its management plan and can be used to help prescribe rehabilitation activities.

   Other wetlands, however, have consistent turbidity throughout (e.g. McLaughlin Bay Marsh) and there would be little benefit derived from additional measurements.

3. As a minimum, monthly water quality measurements will be taken from each wetland during the growing season (May to September inclusive). Additional readings may be taken following significant rainfall, high winds and if the barrier beach condition changes (i.e. open or closed) in order to capture peak events.

4. The following will be recorded on the data sheet (see Appendix C):

   Once at each wetland

   - Date/Time
   - Field crew
   - Weather conditions:
     - Air temperature (°C)
     - Wind direction (e.g. N, SE)
     - Wind strength (use Beaufort Scale – see Appendix D)
     - Cloud cover (tenths of sky obscured, e.g. 5/10)
     - Rainfall during the previous 48 hours; note if heavy or light rainfall
   - Equipment used (e.g. Hach 2100P Turbidimeter, Oakton PCSTestr 35)
   - Barrier beach condition (i.e. whether open or closed, if applicable).

At each sample location

- Sample ID if needed (e.g. Basin A-1)
- General location within marsh (e.g. inlet, middle, outlet)
- GPS ID if needed (e.g. A1R for sampling point 1 in Basin A at Rouge River Marsh)
- UTM Coordinates (using NAD83) if needed
- Water depth (cm)
- Turbidity (NTU) – two measurements at each location
- Water temperature (°C)
- Conductivity (µS/cm)
- pH
- If applicable, wildlife (or other) activity that would impact turbidity readings (e.g. carp spawning, waterfowl feeding).

5. Turbidity, conductivity, pH and water temperature measurements should be taken from a boat or canoe and care taken not to disturb sediments at the measurement location. If readings have to be made while wading, the sample must be taken quickly before the sediment disturbance from walking reaches that location**. If it is apparent that the sediments have been disturbed, resulting in unnaturally high turbidity levels, then a nearby, undisturbed location should be sampled instead.**

6. Each turbidity sample will consist of an average of two mid-water column (or as close as possible) depth turbidity readings (in Nephelometric Turbidity Units - NTU) using a turbidimeter or equivalent.

7. Conductivity, pH and water temperature will be measured from a mid-water column location (or as close as possible). Conductivity should be measured in µS/cm and water temperature in degrees Celsius. Multimeters are available that can measure all three of these parameters.

8. Measure the water depth to the nearest centimetre by using a metre stick or weighted string if the depth is over 1 metre.

Annual Water Quality Sampling (Nutrients)

Note: Prior to conducting any sampling, technicians should have read and be familiar with the MSDS information for the chemicals being used in the following methodology (see Appendix F).

Note: There is no intention to suggest that the companies listed below are "preferred" suppliers. Providing the specific catalogue number is the simplest means of giving exact details about required equipment. Participants should purchase supplies from the company of their choosing.

Sample and Data Collection

1. Prior to conducting field work, a minimum of 12 plastic centrifuge tubes (or equivalent) will be cleaned with deionized water and labeled "N1, N2, …, N12".

2. A sufficient number of 125-mL flint-glass bottles to permit sampling at three locations per wetland will be prepared by first filling them with 1.35 mL of 37%

sulphuric acid (H_2SO_4) and then adding deionized water to the rim and letting them sit for three days. Each bottle and cap should be triple rinsed with deionized water and, once on location, sample water.

Equipment Details:

125-mL flint-glass bottle	Richards Packaging Cat. No. 10-3095
linerless cap	Richards Packaging Cat. No. 23-2755

(http://www.richardspackaging.com/home.htm)

3. Water quality samples will be taken within each wetland, along the emergent vegetation/open water edge. At least three samples will be collected in each wetland. An effort should be made to collect samples that are representative of the wetland as a whole. For example, sample stations should be located near the inlet, in the middle, and near the outlet of the wetland. Stations will coincide with locations selected for macroinvertebrate sampling (Section 2.2.4). If sampling for water quality (i.e. nutrients) occurs only once during the season, the **samples should be collected at the end of July or early August**. Collection of water quality samples can be completed while field crews are on site with a boat for other sampling purposes (e.g. submerged aquatic vegetation or macroinvertebrate sampling).

4. Samples are to be collected at mid-depth in the water column. It is important to remember not to disturb vegetation or sediment upon approach to a replicate location, as this will lead to a biased sample.

5. Data will be collected at each replicate location according to the Water Quality and Macroinvertebrate Collection Data Sheet (see Appendix C): The following weather and sample site conditions are recorded:

   - Date/Time
   - Field Crew
   - Wind strength using the Beaufort Scale (see Appendix D)
   - Cloud cover in tenths (e.g. 7/10 of sky clouded)
   - Air temperature (°C)
   - Dominant emergent vegetation (greater than 75%)
   - Subdominant emergent or submerged vegetation (5-75%)
   - Other emergent or submerged vegetation (less than 5%)

6. For each replicate, the UTM coordinates of the approximate centroid of the water quality sampling area will be recorded using a GPS unit. These locations will be mapped onto a Geographic Information System (GIS) digital layer, to be used as a reference when water quality is reassessed in the future, i.e. approximately the same sites will be revisited each year.

7. Data can be collected using a multiprobe (e.g. Hydrolab Quanta or Hydrolab DS5) at each replicate location, or other equivalent equipment. Record equipment used on the data sheet. Follow the instructions provided with the unit for set up, calibration and field data collection. Multiprobe units are advantageous, because they can measure many different parameters in one reading. Some multiprobes can store data directly on the unit's associated hand-held unit, which can then be downloaded directly to a computer. However, due to the possibility of equipment

malfunction, it is strongly recommended that the data be recorded onto the data sheet.

Note: The multiprobe or equivalent equipment must be calibrated correctly prior to field work. Furthermore, ensure the units on the readout display are correct and correspond to those specified on the field data sheets.

Note: If a chlorophyll *a* sensor is not available, a separate sample will be required for analysis and should be collected at each replicate location (see step 14 below).

8. Turbidity, conductivity, pH, dissolved oxygen, redox and water temperature should be measured from the mid-water column if possible.

9. Water depth will be measured in centimetres using a metre stick. The stick should be allowed to fall through the water column until it touches the bottom, being careful not to measure only to submerged vegetation.

10. Alkalinity will be estimated using total alkalinity test strips (e.g. Fisher Cat. No. 23-292-757). A new test strip should be placed half way into the water column and removed immediately. Hold the strip level, with the pad up. After 30 seconds, score the resulting colour according to the scale provided with the test strips. For colours that fall in between colours provided on the scale, estimate to the nearest whole number.

11. Water samples for analysis of ammonium (NH_4), nitrate (NO_3) and total phosphorus (TP) will be collected at each replicate location. The plastic centrifuge tubes labeled ahead of time should be used to collect ammonium and nitrate samples. These tubes can be reused after being triple rinsed in wetland water.

    For total phosphorus bottle labelling, the laboratory submission standard format will be followed: *three-letter wetland code-YYMMDD-TP replicate number* (e.g. the first replicate at Oshawa Second Marsh collected on July 19, 2006 would be OSM-060719-TP1). Labels for these bottles should be durable and waterproof (e.g. Fisher Cat. No. 11-855B).

12. At each replicate location, one sample for ammonium analysis and one sample for nitrate analysis are collected in clean, deionized water-rinsed, tubes. From the boat or canoe, rinse each tube three times with sample water. Ensure there is no debris that may inadvertently be collected by inverting the sample tube while inserting it into the water column. At about half way into the water column, fill the tube entirely, by turning it right-side up and remove from the water. Place the cap on the sample tube and store in a cool (4^{o}C), dark location, such as a small cooler with ice packs, until analyzed. Record the tube number used for each sample collected on the data sheet. Storage should not exceed six hours.

    Note: The water column should not be disturbed upon approach to the sample station by stirring up sediment or disturbing submerged aquatic vegetation.

13. One sample for total phosphorus will be collected in a 125-mL flint-glass bottle at each replicate location. Collect and store the samples in a similar fashion as

described in step 12 for the time being (see sample preservation – total phosphorus below). Record the sample ID (e.g. *three-letter wetland code-YYMMDD*-TP1) on the data sheet.

14. If the multiprobe used does not measure chlorophyll *a*, a sample must be collected at each replicate location. Using a 1-L or 500-mL polypropylene bottle, 500 mL of water should be collected approximately 20-30 cm below the water surface, if possible. By using a hand vacuum pump, filter 500 mL of water through a 0.45 µm glass fibre filter, using tweezers/forceps to handle the filter, which should not be touched (oil could be transferred).

    Equipment details:

4.7 cm GC/F filter paper	Fisher Cat. No. 09-874-35
Reusable Filter Holder	Fisher Cat. No. 09-740-23D
Nalgene Hand Vacuum Pump	Fisher Cat. No. 01-070A
50 mm Filter Slide	Fisher Cat. No. PD15 047 00

    While filtering the water, the pressure should be kept low (no more than 180 mm Hg) so as not to rupture the algal cells. If the filter becomes clogged due to excessive chlorophyll, it may not be possible to filter any more water through it. The exact volume filtered (either 500 mL or less) should be recorded on the data sheet. The filter paper should be carefully removed (it can tear) from the vacuum pump and placed in a 50-mm plastic filter slide.

    For chlorophyll *a* sample identification, the laboratory submission standard format is as follows: *three-letter wetland code-YYMMDD-CH replicate number* (e.g. the first replicate at Oshawa Second Marsh collected on July 19, 2006 would be OSM-060719-CH1). This ID code should be written on the filter slide using a permanent marker and recorded on the data sheet. The chlorophyll *a* samples should then be stored in a cooler until all the samples from the wetland have been collected.

    See "Sample preservation – Chlorophyll *a*" below when sampling is complete at each wetland.

15. Repeat steps 6-14 for each of the replicate locations in the wetland.

Following sample collection for the day, the following steps can be completed at a convenient location close to the wetland (e.g. a park picnic table). However, the analyses and stabilizations must be done as soon as possible after the samples were collected (i.e. within a few hours).

Sample Preservation

Note: For the following steps, chemical resistant safety glasses, latex gloves (or equivalent) and protective clothing must be worn.

Total Phosphorus

1. Stabilize the total phosphorus samples using 0.8 mL 37% (or 1 mL 30%) H_2SO_4. Record the use of H_2SO_4 on the data sheet. The samples can now be stored in the light, at room temperature for up to one year prior to analysis.

2. Send the samples to the contracted laboratory for analysis within one year of collection.

Chlorophyll a

1. Stabilize each chlorophyll *a* sample with 0.8 mL of 1% w/v magnesium carbonate ($MgCO_3$) suspension in the plastic filter slide. Shake the $MgCO_3$ solution to resuspend.

2. Record the use of $MgCO_3$ on the field data sheet. Store the sample in the cooler and freeze immediately upon return from the field.

3. Send the samples to the contracted laboratory for analysis within one week, as samples begin to deteriorate after that time.

Sample Analysis

Note: For the following steps, chemical resistant safety glasses, latex gloves (or equivalent) and protective clothing must be worn.

Ammonium

1. Using a Hach DR/890 colorimeter or equivalent, prepare the samples for ammonium (NH_4) analysis using the Salicylate Method. The Hach reagents used in analysis meet USEPA protocols for the analysis of surface water as they are generated from Standard Methods.

2. Follow the methods provided with the colorimeter for the analysis of ammonium (NH_4). Ensure NH_4 is the form used when setting up the program for analysis.

3. Record the concentration of ammonium obtained and repeat for each replicate from the wetland.

4. Collect the reagent and sample water in an appropriately labeled waste bottle and dispose of according to its MSDS instructions.

5. The tubes should be triple rinsed with deionized water and the rinseate disposed of in the waste bottle.

Nitrate

1. Using a Hach DR/890 colorimeter or equivalent, prepare the samples for nitrate (NO_3) analysis using the Cadmium Reduction Method (using powder pillows). The Hach reagents used in analysis meet USEPA protocols for the analysis of surface water as they are generated from Standard Methods.

2. Follow the methods provided with the colorimeter for the analysis of nitrate (NO_3). Ensure NO_3 is the form used when setting up the program for analysis.

3. Record the concentration of nitrate obtained on the data sheet and repeat for each replicate from the wetland.

4. Collect the reagent and sample water in an appropriately labeled waste bottle and dispose of according to its MSDS instructions.

5. The tubes should be triple rinsed with deionized water and the rinseate disposed of in the waste bottle.

Frequency

- A minimum of once per month from May to September inclusive for the monthly water quality sampling. Turbidity will also be measured during other sampling activities, such as Submerged Plant (Section 2.1.2) or Fish (Section 2.2.1) community monitoring.
- Annually during late July or early August for the annual water quality sampling.

Additional Data Recording

- Wildlife observations
- It is recommended that Macroinvertebrate Community (Section 2.2.4) sampling occur concurrently with annual water quality sampling.

Equipment

As described in Appendix B.

Literature Cited

Chow-Fraser, P. 2006. Development of the Water Quality Index (WQI) to assess effects of basin-wide land-use alteration on coastal marshes of the Laurentian Great Lakes. In T.P. Simon and P.M. Stewart (eds.), Coastal Wetlands of the Laurentian Great Lakes: Health, Habitat, and Indicators, pp. 137-167. Bloomington, IN: AuthorHouse.

Jude, D.J. and J. Pappas. 1992. Fish utilization of Great Lakes coastal wetlands. Journal of Great Lakes Research 18(4):651-672.

Rouse, J.D., C.A. Bishop, and J. Struger. 1999. Nitrogen pollution: An assessment of its threat to amphibian survival. Environmental Health Perspectives 107(10):799-804.

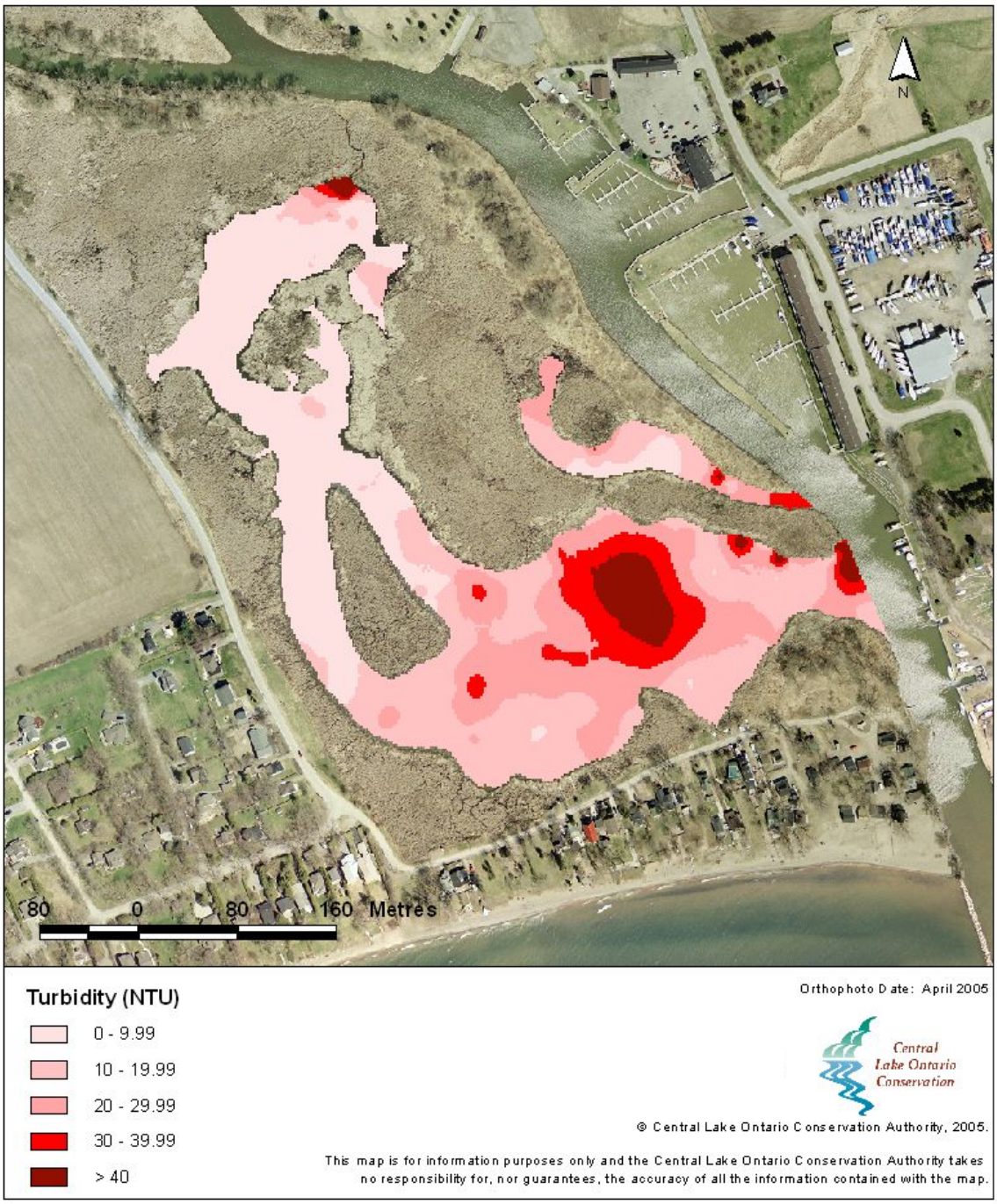

Figure 3.1.1-1. Model of turbidity measurements (in NTU) from Bowmanville Marsh (2002-2005). The kriging method was used to model these data.

3.1.2 Water Levels

Objective

To monitor water levels within Durham Region coastal wetlands during the growing season.

Background

Great Lakes coastal wetlands depend primarily on fluctuating water levels to maintain high levels of biodiversity. When lake levels are high for an extended period, some plant species will be eliminated, and often, more open water areas become established in the wetland (i.e. interspersion). These pockets of open water mixed in among the vegetation are thought to provide important breeding habitat for several marsh-nesting bird species.

Water levels in the Great Lakes have been recorded since 1860. These data show that levels in Lake Ontario have naturally fluctuated by up to two metres since that time. In 1958, however, lake level regulation was implemented, resulting in the moderation of high and low levels. While lake levels still fluctuate, they do not do so to the extent that occurred prior to regulation. This has impacted many coastal wetlands that have historically depended on greater water level fluctuations to maintain high levels of biodiversity.

The International Joint Commission (IJC) is currently evaluating the results of a five-year study (International Lake Ontario – St. Lawrence River Study Board 2006) that provided alternative criteria for regulating water levels on Lake Ontario and in the St. Lawrence River. Both human (e.g. boating, electricity production, etc.) and natural interests in water level regulation were considered as part of the study. The IJC will make the decision, based on the various interests, as to whether a change in the criteria for regulation will be implemented.

For those wetlands that periodically close off from the lake due to natural sand bar formation, e.g. barrier beach wetlands, monitoring water levels is important as they can deviate over one metre from lake levels. This magnitude of fluctuation can have dramatic effects on aquatic plant communities and water level-sensitive fauna (e.g. black tern floating nests), which would not be apparent from Lake Ontario water level data.

Collection of water level information provides insight into possible stressors or diagnostic understanding of changes that occur within the biota of a wetland and insight into the temporal lag in the biotic responses to these changes. Water levels within Great Lakes coastal wetlands can fluctuate significantly over short periods of time (hours or days) due to the effects of lake seiches and closures at the outlet of a wetland to the lake.

Methods

1. Lake Ontario water levels are monitored on a continuous, year-round basis from fixed monitoring stations and these data are available from the Canadian Hydrographic Service (http://www.charts.gc.ca/pub/en/). For those wetlands that remain open to the lake during the monitoring period (e.g. Bowmanville and

Frenchman's Bay marshes), the existing Lake Ontario water level monitoring will suffice.

2. For wetlands that periodically become disconnected from the Lake, continuous water level data loggers will be installed. If possible, the logger should be programmed to record water levels at least every hour. A barometric pressure logger (barologger) must be installed nearby (e.g. hidden in a tree) for the entire time that the water level logger is collecting data. The data from the barologger will be used to compensate for air pressure, resulting in corrected water level data. Ideally, a barometric pressure logger would be installed near each water level logger; however, the barometric data from relatively distant loggers can be used for compensation, but the results may be somewhat less accurate.

3. Water level data loggers should be installed as early as possible (preferably in April) in a relatively deep part of the wetland that can be safely accessed to ensure that they will collect water level information even in the driest part of the summer.

4. The data logger can either be surveyed in using known elevation benchmarks (vertical control points) nearby or the elevation of the wetland water level can be obtained as described in point 7 below. Surveyors should be aware of historical changes in vertical datums used and the potential for discrepancies between International Great Lakes Datum 1985 (IGLD 1985) elevations and those marked on older benchmarks.

   See http://geodesy.noaa.gov/PUBS_LIB/NAVD88/navd88report.htm for more information on this topic.

5. If the data logger is to be surveyed in and the nearest benchmark is not close by, consideration should be given to installing a benchmark near the logger. The benchmark could be a long steel bar pounded in close to ground level in an area not heavily used by people. Prior to installation, the surveyors will ensure there are no underground utilities in the area. Alternatively, if there are other suitable immovable structures within surveying distance (e.g. concrete box culverts or well casings) they may be marked with permission from the owner, as necessary. Recording the UTM coordinates of this benchmark using a highly accurate GPS (e.g. Trimble GeoXT) would simplify future logger installations.

6. At the time of installation and removal, the depth of the water above the logger measuring point (a small hole near the bottom), should be recorded to provide a verification of the downloaded water levels.

7. Prior to removing the data loggers, the wetland water level must be referenced to the current Lake Ontario level or to another known elevation (e.g. benchmark). Referencing wetland water levels to known Lake Ontario levels is best done using a rotating laser level, receiver and grade rod on calm days (alternatively, a standard theodolite can be used). Set up the laser level where both lake and wetland levels can be measured without moving the laser beacon (e.g. on the beach barrier). The difference in the water levels represents the correction factor applied to water level logger readings. At the time of measurement, call the Toronto or Cobourg Voice Announcing Water Level Gauging Stations at (416) 868-6026 or (905) 372-6214 to get the current lake level above IGLD 1985. The time of

measurement needs to be recorded accurately to allow determination of the water level logger reading at that time and to ensure an accurate correction factor.

8. Data loggers need to be retrieved annually after September, but prior to freeze-up and data downloaded to a computer using the appropriate software. Corrections should be made to the data using readings from an appropriate barometric correction unit (e.g. a barologger as described above). Water levels in the wetland will be expressed in metres above sea level (IGLD 1985).

Frequency

Annual logging during breeding/growing season (i.e. April to September inclusive).

Additional Data Recording

None

Equipment

As described in Appendix B.

Literature Cited

International Lake Ontario - St. Lawrence River Study Board. 2006. Options for managing Lake Ontario and St. Lawrence River water levels and flows. Final Report by the International Lake Ontario - St. Lawrence River Study Board to the International Joint Commission (IJC), March 2006.

3.1.3 Sediment Quality

Data Sheet ✓

Objective

To measure sediment quality in Durham Region coastal wetlands.

Background

Contamination of wetland sediments can result from a variety of sources: industrial emissions; pesticides from agriculture, golf courses, or lawns; lead sinkers or shot from anglers and hunters. Wildlife can bioaccumulate chemical contaminants to varying degrees depending on their trophic level. Waterfowl can directly ingest lead shot and sinkers from sediments, which can result in toxic exposure. Some contaminants may biodegrade, but others are more persistent and accumulate in sediments. This monitoring will determine the extent and magnitude of recent sediment contamination in each wetland and follow any changes in contaminant levels over time.

This protocol was developed in part by Environment Canada's Ecosystem Health Division, Ontario Region (EHD-OR) based on a methodology created by the United States Geological Survey for the U.S. National Water-Quality Assessment (NAWQA) Program (Shelton and Capel 1994). EHD-OR has conducted extensive sediment sampling at Lake Erie and Ontario tributaries (Dove et al. 2003). By using the same methodology, comparisons can be made between Durham Region wetlands' sediment quality and results obtained from other areas along the Lake Ontario shoreline.

Methods

1. Sediments will be analyzed for a number of parameters (see Appendix E for a complete list):

    - Metals (by ICP analysis) and Mercury
    - Polycyclic Aromatic Hydrocarbons (PAHs)
    - Organochlorine (OC) Pesticides
    - Polychlorinated Biphenyls (PCBs)
    - Grain Size (i.e. percentages of clay, silt and sand in sediment)
    - Total Organic Carbon (TOC)

2. Additional pesticides, such as atrazine or 2,4-D, should be analyzed for depending on usage rates within watersheds.

3. Sediment samples will be collected where organic deposition is occurring in each wetland. This assessment will be made based on the knowledge of staff experienced with the wetland. If organic deposition locations are unknown, sample locations will be stratified linearly from the inlet to the outlet. Timing of sample collection is not restricted to a specific window. Collection of sediment samples can be completed while field crews are on site with a boat for other sampling purposes (e.g. submerged aquatic vegetation or fish sampling).

4. In general, at least three homogenized, surficial sediment samples will be collected in the wetland. At small wetlands, or where the inlet and outlet are in close proximity, only two samples will be collected (e.g. Cranberry, Pumphouse,

McLaughlin Bay marshes). For a multi-basin wetland, such as Duffins Creek Marsh, each basin will have a minimum of one homogenized sample comprised of sediments collected from three locations. For single basin wetlands, such as Lynde Creek Marsh, the wetland can be stratified whereby homogenized samples are collected within three zones: near the inlet, in the middle, and near the outlet. If a wetland has more than one inlet, samples should be taken at each appropriate location.

5. For each wetland, the sample taken closest to the inlet will be analyzed for PCBs/pesticides/PAHs, grain size/total organic carbon (TOC), and metals (i.e. 3 sample bottles required). The remaining two samples will only be analyzed for metals and grain size/TOC (i.e. 2 sample bottles required). However, if funding permits, all samples should be analyzed for all parameters to permit the best characterization of sediment quality and/or contaminant removal capability of each wetland.

6. For each sample, the approximate UTM centroid of the sediment sampling area will be obtained using a GPS and recorded onto the data sheet (see Appendix C). These locations will be mapped onto a Geographic Information System (GIS) digital layer, to be used as a reference when sediment quality is reassessed in the future.

7. Prior to sampling, all equipment and glassware must be rinsed in the wetland water. A stainless steel spoon (e.g. a large serving spoon) will be used to gently scoop up the top 1-2 cm of fine-grained sediments (i.e. silt and clay). If possible, sampling should not occur where the sediment is sandy. Removing only the top layer of sediment will better represent recent, rather than historic, deposition. Since the sampling location will be underwater, care should be taken when raising the spoon, such that the sediments are not washed away. Sediments will be deposited into a glass mixing bowl (~3-L capacity).

8. In locations where the water is too deep to sample sediments with a spoon, the following are acceptable:
   - Stainless steel Ekman dredges (6 x 6 inches or 15 x 15 cm) are preferred in moderately consolidated, fine-textured sediments (i.e. soft mud, silt, or fine sand)
   - Stainless steel Ponar (9 x 9 inches or 23 x 23 cm) or petite Ponar (6 x 6 inches or 15 x 15 cm) samplers are preferred where the sediments are consolidated fine to coarse textured (i.e. gravel, marl, clay, rock or litter)

   Note: If stainless steel dredges are not available, surveyors must ensure that sediments included in the sample have not come in contact with the metal surfaces of the dredge.

9. From a boat or canoe, lower the sampler to either 10-15 cm (Ekman/Petite Ponar) or 5 cm (Ponar) above the sediment surface and then drop it to the sediment.

10. The jaw release mechanism on the Ekman sampler is triggered by lowering a messenger down the line or by depressing the button on the extension handle. For the Ponar samplers, the slackness of the line will release the trip bar, but the line must be pulled up sharply to close the dredge.

11. Raise the sampler and slowly decant any free liquid through the top of the sampler, taking care to retain the fine sediments.

12. Open the dredge into a large, rectangular glass baking dish (e.g. 4-litre capacity – 26 cm x 37 cm). Using the stainless steel spoon, sample only the top 1-2 cm from the sediment and place in the glass bowl. Take a minimum of two more samples from other areas within the sampling unit and combine all samples from the sampling unit in the glass bowl.

13. From one depositional zone, collect enough subsamples (~1 L) from various locations to half-fill the glass bowl. Samples should be collected within 10 m of the sampling location centroid.

14. Mix the sample thoroughly (by stirring with the spoon) and then pour the contents of the bowl through a 2-mm stainless steel sieve into the other glass bowl (3-L capacity) to remove the larger size fractions and to assist with homogenization. Some sediments will not pass easily through the sieve and will need to be forced using the stainless steel spoon.

15. Using a stainless steel spoon, the sediments that passed through the sieve should be transferred into sample containers supplied by the laboratory. Two or three sample jars will be filled at each site, depending on its location:

    - one 125-mL container filled with approximately 2 cm of sediment for metals and mercury analysis;
    - one 125-mL container filled approximately ½ full for TOC and grain size analysis;
    - one 250-mL glass container with Teflon-lined screw cap filled approximately ¾ full for PCB, OC pesticide and PAH analysis.

16. Label each sample jar with permanent marker on both the lid and on the label provided (or on tape affixed to its side) with the following: the site name, sample number, date, organization, and parameters for analysis (e.g. “PCBs, OCs + PAHs”, “metals + Hg”, “TOC + grain size”). After the appropriate sample jars are filled, thoroughly rinse **all** the sampling equipment in the wetland water.

17. Fill in the data sheet (see Appendix C), taking care to use the same Sample Number as in Step 16. Also, describe the sampling location using the same designation as in Step 4 (i.e. inlet, middle, or outlet).

18. Repeat steps 6-17 within each of the sampling units of the wetland. Samples should be placed in a cooler with ice packs while in the field. After the sediments have settled within the containers, the excess standing water should be decanted. They can then be frozen at -10°C (samples in glass bottles should be frozen on their sides to prevent bottle breakage) or left in a refrigerator. Check with the contracted laboratory for proper storage and shipping instructions.

19. Prior to analysis, the TOC/grain size and metals samples can be freeze-dried to permit longer storage. Samples being analyzed for metals by ICP analysis can be stored for 28 days in the fridge, but if mercury content is being assessed they can

only be stored for 14 days. Freezing the samples does not prolong storage time (J. Edwards, Caduceon Labs, pers. comm., 2006). Send the samples to the contracted laboratory for analysis in a timely fashion. Chain of custody forms must be filled in and included with the sample shipment to each contracted lab.

Frequency

Every five years

Additional Data Recording

None

Equipment

As described in Appendix B.

Literature Cited

Dove, A., S. Painter and J. Kraft. 2003. Sediment Quality in Canadian Lake Ontario Tributaries: Part One (West of the Bay of Quinte) A Screening-Level Survey. Ecosystem Health Division, Ontario Region, Environmental Conservation Branch, Environment Canada, Report No. ECB/EHD-OR/03-01/I, April 2003.

Shelton, L.R. and P.D. Capel. 1994. Guidelines for Collecting and Processing Samples of Stream Bed Sediment for Analysis of Trace Elements and Organic Contaminants for the National Water-Quality Assessment Program. Sacramento, CA: U.S. Geological Survey Open-File Report 94-458.

3.1.4 Wetland Bathymetry

Objective

To map wetland bathymetry in Durham Region coastal wetlands.

Background

Wetland bathymetry is used to create wetland profiles, contouring and basin models. These models require high vertical resolution and accuracy in order to capture what are often low gradient systems; where a difference in 10 cm in elevation can create a quantitatively different environment. Currently, the availability of detailed, accurate nearshore data required for wetland studies is extremely limited. Part of the problem has been limitations to traditional terrestrial airborne elevation capture and aquatic depth sounding methods due to shallow water and turbidity.

Wetland bathymetry is used to provide information about wetland basin shape and/or contouring. These morphological differences within a wetland basin can influence both coastal processes and biological community responses. From bathymetry, scientists can derive physical parameters for the wetland under study, which are often key components in developing predictive models.

Previous bathymetry methodology testing has included the use of Scanning Hydrographic Operational Airborne LiDAR (Light Detection and Ranging) Survey (SHOALS), evaluated by the International Joint Commission (IJC) for its ability to provide bathymetric data on Great Lakes coastal wetlands. Although there has been no formal report discussing the efficacy of using SHOALS on these coastal wetlands, it was apparent that turbid waters greatly reduce the effectiveness of this technology.

Recently, improvements in depth sounding technology have shown to be effective in shallow water estuaries. A pilot project was initiated in support of the Durham Region Coastal Wetland Monitoring Project (DRCWMP) to test the effectiveness in freshwater coastal wetlands. If the data were found to be suitable, the DRCWMP would take steps toward implementing this methodology.

Methods

Bathymetry collection required an innovative approach using technology in development. The Hydrobox (Ocean Data Corp.), a high-resolution, shallow water echo sounder, was designed for inshore marine coastal hydrographic surveys up to 750 m. This product uses a low Q transducer (200 kHz) that was claimed to collect data in less than one metre of water with a depth resolution of 10 cm, making it appropriate for wetlands. Environment Canada staff worked with the product designers and engineers to adjust the product for data collection in turbid, freshwater environments.

The Hydrobox is meant as a stand alone product used on a large vessel, therefore the data capture system had to be altered for use within a wetland monitoring program, namely, compatibility with a high-accuracy GPS, with a Geographic Information System (GIS) and for use on a small, flat-bottomed boat. The innovative system utilizes the NMEA input/output capabilities of the Hydrobox, and a Trimble GeoXT, connected to a laptop and Microsoft Windows HyperTerminal. Bathymetric data were collected in linear

arrays at approximately 1 m/second. To assist model interpolation, data were collected following the shoreline and around islands, followed by transects spaced 50 m apart across the widths. A centre channel was also collected. Collections only occurred on days of minimal wind to reduce pitch and rolling effects.

All post-processing of the data was performed in ArcGIS 9.1 (Environmental Systems Research Institute, Inc.) and included filtering erroneous spikes and dips, which can be caused from waves or sudden shallow spots, and removing logistically incorrect or questionable points. The data were then corrected to the water level (0 m) and transformed to provide a continuous elevation surface with high resolution digital elevation models (30-40 centimetre resolution) available from the Ontario Ministry of Natural Resources. Exploratory data analyses help audit the data and supported a kriging interpolation method to create wetland bathymetry maps.

Results - Preliminary

The pilot data permitted bathymetric mapping for the wetland basin at 10-cm contours. Geostatistics were utilized to interpolate the bathymetric and topographic data across the study area to create a surface representation of the wetland and its surrounding landscape (Figure 3.1.4-1). From this digital elevation model, topographic attributes, such as slope and aspect, can be calculated. The detail of the mapping appears to be representative of the basin, but true accuracy requires a field verification protocol.

The pilot methodology was employed to determine the efficacy of bathymetric monitoring using new technology in depth-sounding. The shallow water transducer was capable of bathymetric collection up to 30 cm of water, a vast improvement over what has previously been investigated. Water depths were taken periodically and concurrently with the bathymetry collection to verify the output. Visually the basin models meet logical considerations, however, a more formal accuracy assessment that incorporates survey-grade topological collection measures is advised.

Drawbacks to this method are highest in post-processing efficiency. Field collection varies with wetland size, but is weather dependent; i.e. conditions must be calm during collection. Data post-processing can be very time-consuming and requires both site knowledge and technical expertise. Investigations into data corrective measures for pitch and roll, as well as automated editing tools could improve the cost to processing.

Options in existing bathymetry mapping at a usable scale for monitoring wetland changes are selective. Specific hydrographic surveys, such as described using a shallow water depth-sounding system, can provide data to complete a bathymetry model with reasonable accuracy and vintage. A standardized collection method and model development will support comparisons between wetland basins. The potential for LiDAR continues to be investigated as an efficient and comprehensive modeling tool for wetland elevations on a mass scale, but advancements need to occur in data collection of near-shore and turbid environments.

Implications for Management

Wetlands are dynamic environments. Wetland plant and animal communities are adapted to, and depend on, the variability and unpredictability of wetland physical changes. For example, variable hydrological fluctuations tend to result in greater overall biodiversity in coastal wetlands. Scientists are interested in near-shore bathymetric data

to provide information about the shape of the wetland landscape; a three-dimensional picture of where land meets water and wetlands persist. Nearshore bathymetry is of importance because wetland biological communities are primarily driven by water levels and topography. Accurate wetland models provide a means of evaluating land-water interactions and field observations can be implemented as scenario modeling to derive linkages between hydrodynamics, vegetation response and available habitat for wetland species. This improves scientific understanding of the natural and crucial functional responses of coastal wetlands. The ability to identify potential vulnerabilities ensures proper management of these valuable ecosystems.

On a broader scale, coastal wetlands exist surrounded by a landscape mosaic of other habitats. Combining wetland information with landscape, lake and watershed information can determine how wetlands, both structurally and biologically, are formed and are changing. These spatial and temporal patterns may be correlated to environmental stressors, such as current and historical land-use activities and/or climatic shifts such as climate warming. The surrounding landscape can be crucial for water quality (e.g. sediment control) and for wetland habitat condition, especially for wildlife that use wetland margins. Wetland shape and slope will determine how wetland vegetation will respond, e.g. the lakeward movement of vegetation with decreasing water levels, or sediment flow rates into the lake. This knowledge supports improved land management planning and monitoring programs by ensuring the essential lake and landscape factors, those that support healthy ecosystems, are conserved and protected.

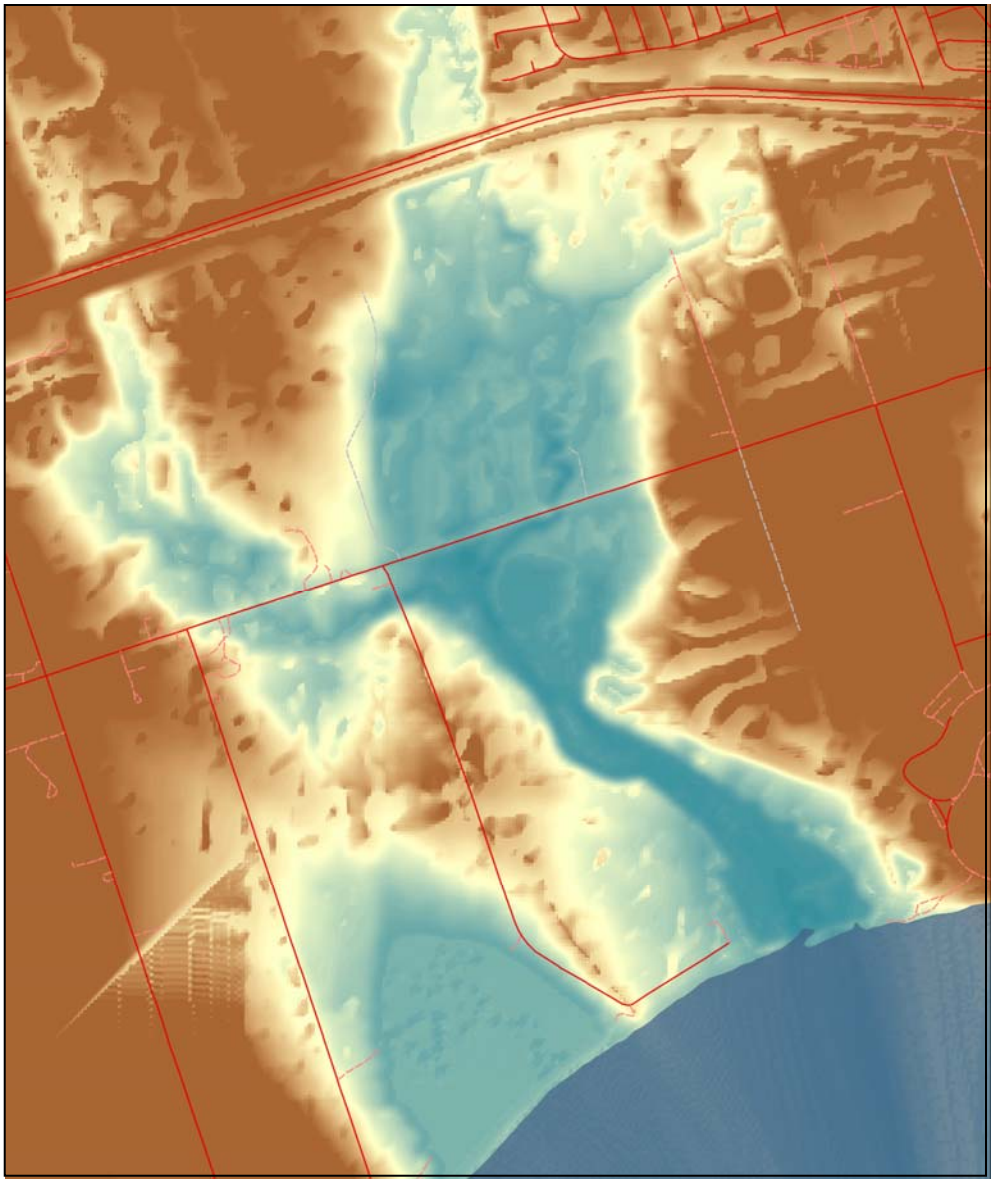

Figure 3.1.4-1. Wetland bathymetry at Lynde Creek and Cranberry marshes interpolated with adjacent topographic data to create a continuous elevation model for the wetland basin. Elevations greater than 85 cm have been blended together. Vertical exaggeration is 3.

Frequency

Unless a remote system becomes available, this task will be completed on an as-needed or project-specific basis. Note: For some sites bathymetry has recently been completed.

Additional Data Recording

None

Equipment

As described in Appendix B.

3.2 WATERSHED

3.2.1 Watershed Natural and Cultural Land Cover

Objective

To identify change in watershed natural (using Ecological Land Classification) and cultural land cover for Durham Region coastal wetlands.

Background

Lands within Durham Region watersheds have a variety of land cover types; both natural and cultural (i.e. as a result of human activity). The proportions of the various cover types continue to change as more development activities take place or as abandoned agricultural lands become revegetated. Changes in land cover and use within watersheds can greatly affect wetland health, particularly in terms of water and sediment quality and/or quantity.

In earlier versions of this manual, natural cover, using the Ecological Land Classification (ELC) system (Lee et al. 1998), and cultural land cover were to be reported on separately. However, with the widespread use of on-screen polygon delineation using Geographic Information System (GIS) applications, such as ArcGIS (Environmental Systems Research Institute, Inc.), both natural and cultural land cover can readily be displayed in the same mapping products and so these two objectives have been combined.

The entire watershed will be classified according to the ELC and the cultural land cover categories as described below. The percentages of these various categories will be monitored for change throughout the project (i.e. as new orthophotos become available).

Methods

Ecological Land Classification (Natural Cover)

1. Current land cover within the entire watershed of each wetland will be identified and delineated through air photo interpretation. Natural areas will be identified to the "Community Series" level in the ELC (e.g. Deciduous Forest, Coniferous Forest, etc.). Currently the ELC does not contain a complete cultural land cover classification system, resulting in "white space" on the map where the land cover is not classified. Cultural classifications under the ELC system are under development and will be incorporated when available. Until that time, the designations described under "Cultural Land Cover" below will be used (see Appendix G for details of CLOCA's current classification system).

2. The minimum polygon size should be 0.5 ha except in unusual circumstances such as a very rare habitat type.

3. All partner Conservation Authorities (CAs) have the capability to delineate polygons directly on-screen using digital, georeferenced orthophotos. Delineation should be done at a recommended scale of 1:3000. Each polygon must be classified in an attribute table as a particular ELC Community Series, so that

queries can be made to summarize the natural cover by watershed. The year of the photography should be specified in the associated metadata.

4. If a Digital Elevation Model (DEM) is available for the watershed, using this layer in a GIS would assist with polygon classification and delineation, especially when trying to distinguish wetlands from uplands.

5. Ground-truthing can be undertaken to verify the Community Series designation obtained through air photo interpretation, but it is not mandatory. However, it could be particularly useful in verifying the existence of certain wetland communities, such as swamps.

6. Through queries, the area and percentage of each ELC Community Series as it occurs over a selected area (e.g. watershed) should be determined. An example is shown in Table 3.2.1-1.

7. As new orthophotos become available, the polygons will be updated as needed. However, a digital copy of the GIS layer, and its associated metadata, for each iteration of polygon classification and delineation should be retained for reference purposes.

Table 3.2.1-1. Ecological Land Classification (ELC) Community Series areas and percentages for the Westside Marsh watershed.

ELC Community Series	Area (ha)	% of Watershed
Cultural Meadow (CUM)	70.0	12.2
Cultural Thicket (CUT)	18.0	3.1
Cultural Woodland (CUW)	11.6	2.0
Deciduous Forest (FOD)	1.0	0.2
Meadow Marsh (MAM)	5.8	1.0
Shallow Marsh (MAS)	30.1	5.3
Open Aquatic (OAO)	10.8	1.9
Deciduous Swamp (SWD)	1.0	0.2
Thicket Swamp (SWT)	4.6	0.8
Total Watershed	**572.8**	**26.7**

Note: Shading indicates community series with largest area.

Cultural Land Cover

1. Using the same orthophotography as above, with the year noted in the metadata, identify and delineate cultural land cover (that associated with human activities) in the watershed through air photo interpretation. The natural cover will already be classified by polygon to the ELC Community Series (or this will be done concurrently). Again, if capabilities exist, these should be delineated on-screen in a GIS using digital orthophotos.

2. Cultural land cover will be delineated on-screen at a scale of 1:3000 and classified according to each CA's own land cover designations (see Appendix G for an example), but should include the following or permit querying of the GIS layer, such

that the following broader categories of land cover can be created by combining the detailed land cover classifications:

Residential (both urban and rural)

Non-residential Development (includes commercial, industrial, institutional, aggregate extraction, landfill)

Utility and Transportation Corridor (includes roads, railway)

Crop and Improved (including intensive crop-based agriculture, golf courses, sod farms, nurseries, orchards, manicured parks/lawns, athletic fields)

Pasture/Idle Field (including grazing lands, fallow fields)

Pond (stormwater management, irrigation and other man-made ponds, unless classified through ELC)

3. As new orthophotos become available, the polygons will be updated as needed. However, a digital copy of each iteration of polygon classification and delineation should be retained for reference purposes along with the associated metadata.

Watershed Natural and Cultural Land Cover

1. The percent cover of each land cover category will be obtained through GIS queries using the following groupings of both cultural and natural land cover classifications:

Residential

Non-residential Development

Utility and Transportation Corridor

Crop and Improved

Pasture/Idle Field (including grazing lands, fallow fields, and ELC designations CUM, CUW, CUS and CUT)

Pond (stormwater management, irrigation and other man-made ponds, unless classified through ELC)

Woodlot and Forest (including ELC designations FOD, FOC, FOM and CUP)

Wetland (including ELC designations SWD, SWC, SWM, SWT, FEO, FES, FET, MAM, MAS, SAS, SAM, SAF and OAO)

Bluff/Beach (including ELC designations BLO, BLS, BLT, BBO, BBS, BBT)

2. When updates are made with the arrival of new aerial photography, the percent of each land cover type will be recalculated to determine the change since the previous iteration.

3. A table listing the area and percent of each type of natural and cultural land cover (listed above) for each watershed will be produced (see Table 3.2.1-2 for an example). A figure depicting the locations of each cover type will be created (see Figure 3.2.1-1).

Table 3.2.1-2. Area and percentage by land cover type for the Lynde Creek Marsh watershed.

Land Cover Type	Total Area (ha)	% of Watershed
Residential	1660.1	12.7
Non-residential Development	534.9	4.1
Utility and Transportation	493.1	3.8
Crop and Improved	4848.1	37.0
Pasture and Idle Field	3032.9	23.2
Pond	50.6	0.4
Woodlot and Forest	1121.0	8.6
Wetland	1358.3	10.4
Beach and Bluff	0.4	0.0
Total	**13099.4**	**100.0**

Note: Shading indicates land cover type with largest area.

Frequency

Watershed land cover will be reviewed approximately every six years, subject to the availability of new imagery for the watershed. As new technology becomes available (e.g. IKONOS satellite imagery), this methodology will be reviewed and altered as needed. Also, when the ELC for cultural lands has been developed, it will be adopted as the standard for all cultural land cover designations.

Additional Data Recording

None

Equipment

As described in Appendix B.

Literature Cited

Lee, H.T., W.D. Bakowsky, J. Riley, J. Bowles, M. Puddister, P. Uhlig and S. McMurray. 1998. Ecological Land Classification for Southern Ontario: First Approximation and Its Application. Ontario Ministry of Natural Resources, Southcentral Science Section, Science Development and Transfer Branch. SCSS Field Guide FG-02.

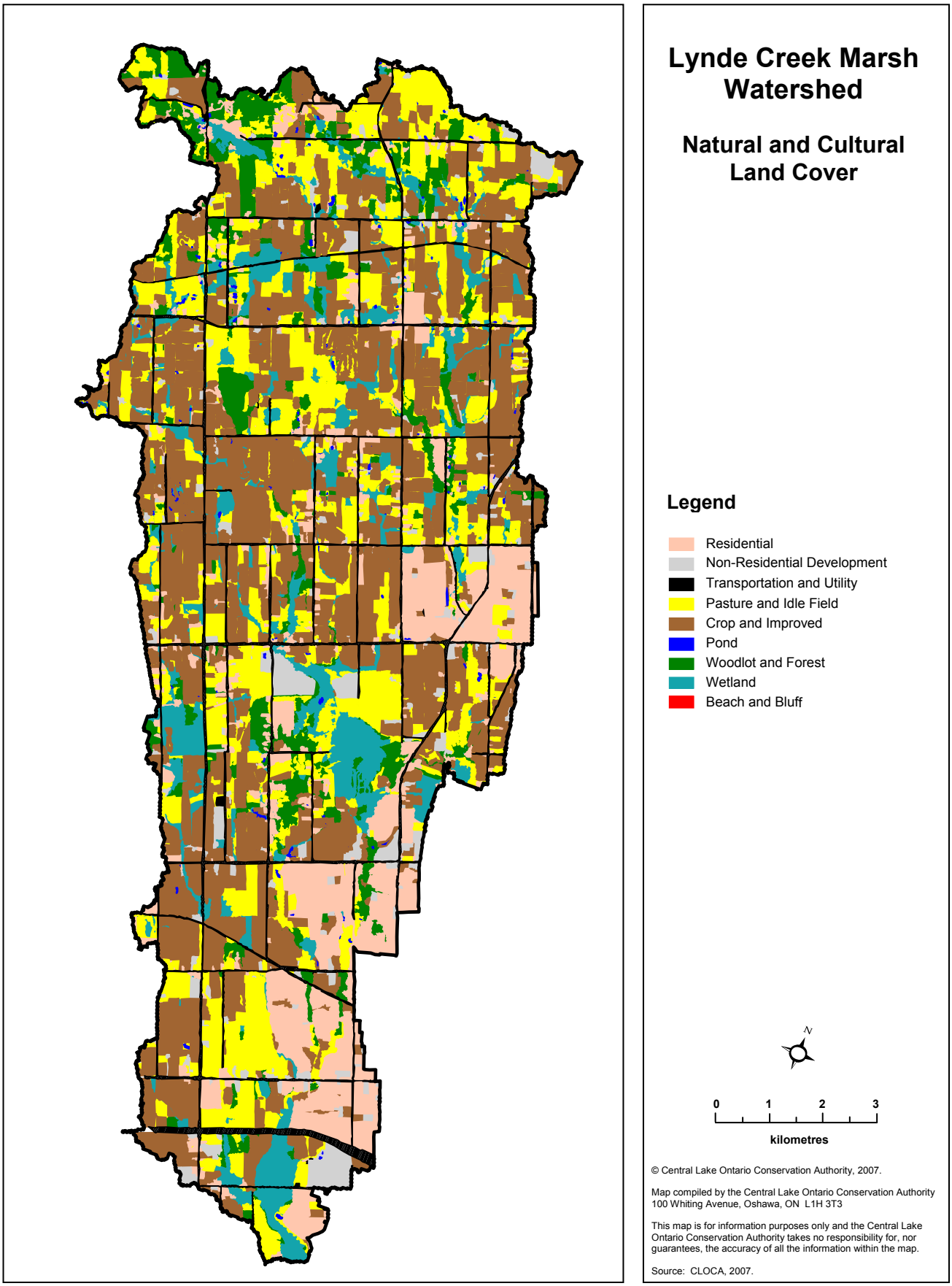

Figure 3.2.1-1. Lynde Creek Marsh watershed natural and cultural land cover mapping.

3.2.2 Land Cover Change in Adjacent Uplands

Objective

To identify and quantify current land cover and any change that has occurred within lands adjacent to or within Durham Region coastal wetlands.

Background

Development has encroached on Durham Region wetlands extensively since European settlement. Activities on lands adjacent to wetlands can greatly affect wetland health. Land cover will be identified digitally using a Geographic Information System (GIS) and monitored for change throughout the project as new orthophotos become available. This monitoring is most effectively completed in concert with the Wetland and Adjacent Upland Ecological Land Classification (ELC) component of this project (Section 2.1.1) or with Watershed Natural and Cultural Land Cover (Section 3.2.1).

Methods

1. Current land cover within 1000 metres of the Ontario Ministry of Natural Resources (OMNR) evaluated boundary of each coastal wetland will be identified and delineated through air photo interpretation and classified as follows (or this can be done through GIS spatial queries of existing watershed ELC and land cover delineation if this is available):

   Residential (including rural residential)

   Non-residential Development, includes aggregate extraction, landfills and the following subclasses that can be used if the type of development can be interpreted from the air photo or is known by the interpreter:
   Industrial
   Commercial
   Institutional

   Utility and Transportation Corridor (including roads, railway lines)

   Crop and Improved (including intensive crop-based agriculture, golf courses, sod farms, nurseries and orchards, manicured parks/lawns, athletic fields)

   Pasture/Idle Field (including grazing lands, fallow fields, and ELC designations CUM, CUW, CUS and CUT)

   Pond (stormwater management, irrigation and other man-made ponds, unless classified through ELC)

   Woodlot and Forest (including ELC designations FOD, FOC, FOM and CUP)

   Wetland (including ELC designations SWD, SWC, SWM, SWT, FEO, FES, FET, MAM, MAS, SAS, SAM, SAF and OAO [excluding Lake Ontario])

   Bluff/Beach (including ELC designations BLO, BLS, BLT, BBO, BBS, BBT)

2. All partner Conservation Authorities have the capability to delineate polygons directly on-screen using digital orthophotos (recommended scale is 1:3000). Through spatial queries, the area and percentage of each land cover type around and within each wetland can be determined (Figure 3.2.2-1 provides an example of current land cover mapping).

3. As updates are made with the arrival of new orthophotography, the percent of each land cover type will be recalculated to determine the percent change since the previous iteration.

4. If the wetland boundary itself has changed since the previous calculations were made, the area of the 1000-m buffer will also change. In this case, it will be necessary to perform two sets of calculations: one using the old buffer line to permit direct comparison of land cover within the same area as the previous iteration; and the second using a new buffer of 1000 metres around the revised wetland boundary. The second set of calculations should be reported to permit comparison with future iterations.

Frequency

To be completed/updated following ELC iterations (Section 2.1.1) or when Watershed Natural and Cultural Land Cover (Section 3.2.1) has been updated using new aerial photography.

Additional Data Recording

None

Equipment

As described in Appendix B.

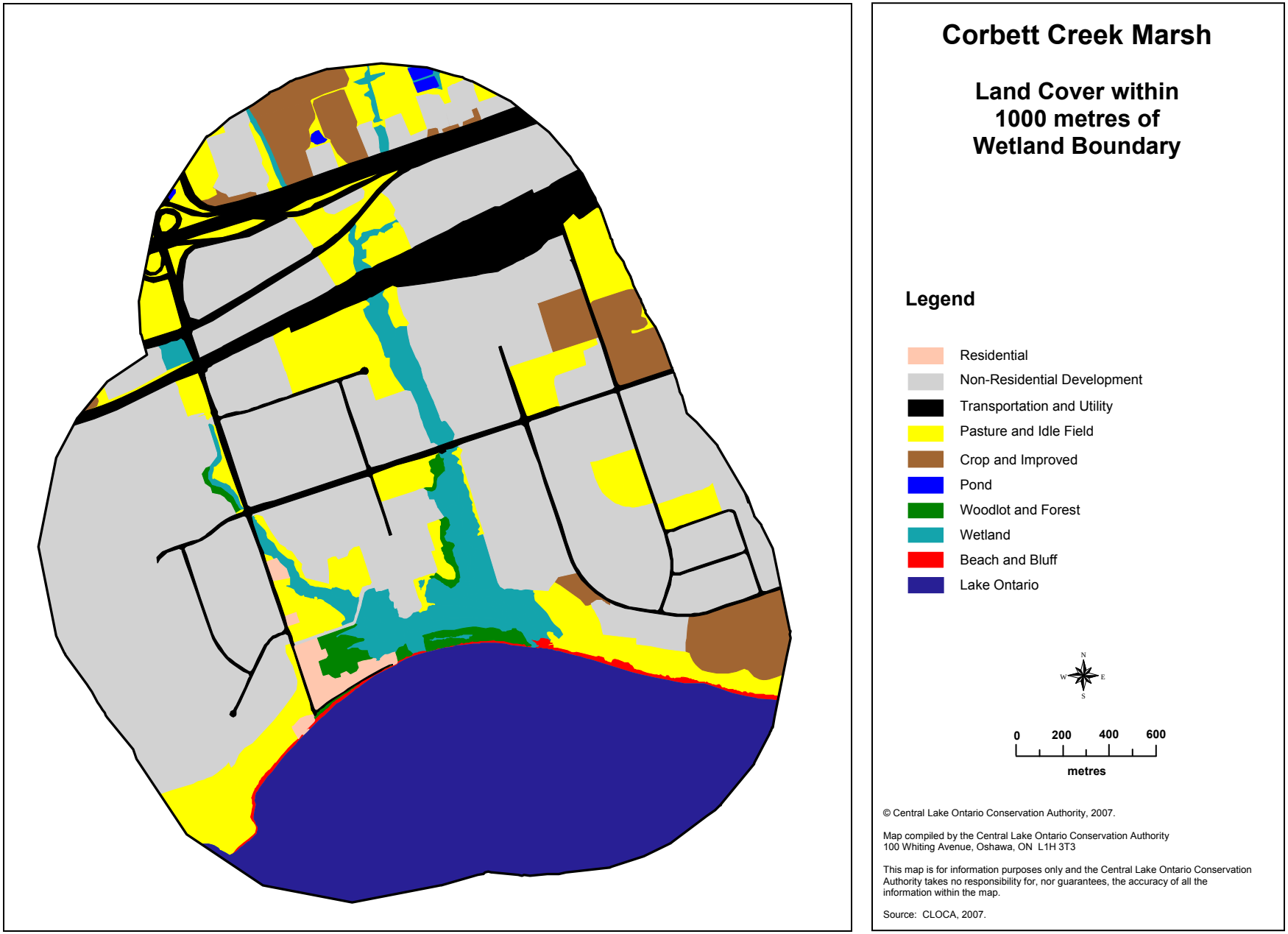

Figure 3.2.2-1. Current land cover within the 1000-m buffer at Corbett Creek Marsh and within the delineated wetland boundary.

3.2.3 Public Ownership of Watershed Lands

Objective

To identify and summarize the amount of land in public ownership and map its distribution in each coastal wetland's watershed.

Background

The location and area of public lands in Durham Region should be monitored to ascertain the extent of "protected" parcels. Public land, although not entirely free of development pressure, may be more likely than private land to remain in a natural or semi-natural state. These lands could be prime candidates for natural restoration efforts aimed at decreasing erosion and improving water quality downstream and in the coastal wetlands.

Methods

1. Digital parcel data or digital mapping of property ownership (available from Teranet Inc.), are available to most local municipalities, but currently not to their partner Conservation Authorities (CAs).

2. These data are available as a geospatial dataset showing land parcel locations and containing ownership information in the associated attribute table.

3. If digital property ownership data are not available for the watershed, manually searching through tax rolls for ownership information would be too time-consuming. It is recommended that CAs wait until the information is available electronically before completing this task.

4. The parcel layer can be clipped in a GIS by watershed. Through queries, the locations and percentage of publicly-owned land (i.e. owned by CAs; municipalities; regional, provincial or federal governments and their agencies) for each watershed can be determined.

5. In order to understand the type of land under public land ownership, these data should be overlaid with the land cover layer. The percentage of public land by type can then be summarized for each of the watersheds. A figure of the watershed showing locations of public lands by type could then be created.

Frequency

When digital property ownership data are available; then to be reviewed every six years.

Additional Data Recording

None

Equipment

As described in Appendix B.

3.2.4 Sediment/Nutrient Loading

Objective

To determine a relative estimate of the quantity of sediment and nutrient deposition from the watershed into Durham Region coastal wetlands and to identify areas of high loading.

Background

High sediment loads generally result from erosion occurring upstream of coastal wetlands, with consequent problems in the wetlands themselves. For example, agricultural cultivation, other disturbed lands, stream bank erosion, or urbanized areas may increase sedimentation in wetland basins resulting in a decrease in original water depths. Suspended sediments also result in turbid water that can adversely affect plant growth and plant species diversity. This is especially true for submerged aquatic plant species. Deep sediment deposition can also smother seed banks and eggs of various wildlife species.

Nutrients can enter the system from a variety of sources: animal waste; human sewage; industrial waste; fertilizers used in agriculture, golf courses, residential lawns; etc. Increased phosphorus and nitrogen loading can result in eutrophication and algal blooms, which can lead to low levels of dissolved oxygen and even faunal mortality in wetlands.

Understanding the levels of sediment and nutrient loading into each wetland from its watershed is important to understanding the health of biological communities within the wetland and to mitigating or potentially controlling any excess inputs. Advances in detailed digital base data for southern Ontario watersheds (e.g. soils, land cover, digital elevation models) and Geographic Information System (GIS) applications have enabled models to be created that can estimate the amount of nutrient and sediment loading within a watershed and even pinpoint potential source locations.

Methods

Currently, the three Conservation Authorities (Toronto and Region Conservation Authority - TRCA, Central Lake Ontario Conservation Authority - CLOCA, and Ganaraska Region Conservation Authority - GRCA) are using different models for determining nutrient and sediment loading, some of which are more complex than others and require a certain level of field data measurements to improve the current functionality.

TRCA, in partnership with Environment Canada and the University of Waterloo, has developed and calibrated a non-point source model (Agricultural Non-Point Source Pollution Model - AGNPS) for the Duffins and Carruthers watersheds and has used this tool to gain an understanding of wet weather flow contributions to coastal wetlands and Lake Ontario. AGNPS was initially developed by the United States Department of Agriculture to model the behaviour of runoff, nutrient and sediment transport in primarily agricultural watersheds (Finn 2003).

Recently, TRCA has set up a Soil and Water Assessment Tool (SWAT) model for Duffins Creek. This continuous model provides a good understanding of loadings and provides an estimate for a range of water quality parameters. The SWAT model can incorporate a number of components including weather; hydrology; soil temperature and properties; plant growth; nutrients; pesticides; bacteria and pathogens; and land management (Gassman et al. 2007). Evaluation of the outputs of this model will provide useful information on the transport of materials to coastal wetlands, i.e. how and when nutrients and contaminants are delivered.

CLOCA is presently using two modeling systems: Precipitation-Runoff Modelling System (PRMS) and Canadian ArcView Nutrient and Water Evaluation Tool (CANWET). The PRMS model was developed by the United States Geological Survey (Leavesley 1983) and CLOCA is expected to have preliminary results in 2007. CANWET, developed by Greenland International, assists with identifying the sources of nitrogen and phosphorus and in the assessment of various best management practices. At this time, CLOCA has uncalibrated results for the Oshawa Creek watershed, but calibration efforts are underway. The remainder of the CLOCA watersheds will be modeled using the CANWET system in the near future.

GRCA is using the CANWET model, which is currently being calibrated.

There will likely not be a standard approach taken by the three CAs in estimating sediment and nutrient loadings.

Frequency

To be determined.

Additional Data Recording

None

Equipment

N/A

Literature Cited

Gassman, P. W., M. R. Reyes, C. H. Green, and J. G. Arnold. 2007. The Soil and Water Assessment Tool: Historical development, applications, and future research directions. Ames, IA: Working Paper 07-WP 443, Center for Agricultural and Rural Development, Iowa State University, February 2007. Downloaded from: http://www.econ.iastate.edu/research/webpapers/paper_12744.pdf, March 2007.

Leavesley, G. H., R. W. Litchy, M. M. Troutman, and L. G. Saindon. 1983. Precipitation-runoff modeling system user's manual: U.S. Geological Survey Water-Resources Investigations Report 83-4238.

Finn, M. P., D. J. Scheidt, and G. M. Jaromack. 2003. User's guide for the Agricultural Non-Point Source (AGNPS) Pollution Model Data Generator. Open-File Report 03-130, U.S. Department of the Interior, U.S. Geological Survey. Downloaded from: http://carto-research.er.usgs.gov/watershed/pdf/ADGen_uGuide.pdf, March 2007.

APPENDIX A - BACKGROUND REPORT, MARCH 2001

Durham Region Coastal Wetlands Monitoring Project

Proposal and Background Report

March 2001

Environment Canada / Environnement Canada

Canadian Wildlife Service / Service canadien de la faune

Central Lake Ontario Conservation

Executive Summary

Outright losses as well as a variety of stressors have affected coastal wetlands in the Regional Municipality of Durham (Durham Region) over the past 150 years. Specifically, an estimated 60 to 80 percent of coastal marshes in the Region have disappeared due to various human influences including urban development. Remaining coastal wetlands continue to be threatened by anthropogenic activities.

While many stakeholders are involved in monitoring and stewardship activities at coastal wetland sites, there are wetlands in the Region where no monitoring activities have been implemented. At the sites that are monitored, there are a wide variety of approaches that have been adopted. The Durham Region Coastal Wetland Monitoring Project has been initiated to coordinate monitoring efforts that seek to examine the state of wetland health in the Region. It is hoped that this Project will be based on sound science, the involvement of many stakeholders and a pooling of resources and expertise among those who wish to establish an effective program with minimal duplication of effort, while capitalizing on the strengths of individual organizations.

This report, commissioned by Environment Canada and the Central Lake Ontario Conservation Authority, contains a comprehensive review of current and proposed monitoring activities at coastal wetlands in Durham Region. This will serve as supporting information to develop the Durham Region Coastal Wetlands Monitoring Project. This report also includes a provisional action plan with which to implement the Project. This plan envisages four phases: the first is a preliminary assessment and meeting of interested partners; the next step is a needs assessment; followed by a gap analysis; and finally an implementation plan that will be applied over the next ten months. This Project may also serve as a template for implementing similar projects in other regions of the Great Lakes.

Acknowledgements

K. Hughes of Environment Canada and J. Staples of the Central Lake Ontario Conservation Authority (CLOCA) were the primary authors involved in compiling this report. N. Patterson (Environment Canada) and R. Powell (CLOCA) provided support and guidance for this project. Compilation of this report would not have been possible without the assistance of many people who contributed information on recent monitoring activities in Durham Region. We would like to give our thanks to: J. Andersen, K. Heib & J. Utter (CLOCA), D. Barry, M. Carney & R. Pye, D. Boyd (Ontario Ministry of the Environment), C. Conti (Friends of Second Marsh), C. Darling (Regional Municipality of Durham), L. Davidson (Blue Circle Cement), K. Dion (Ontario Streams), C. Hart (Town of Ajax), M. Heaton, T. Rance & S. Mason (Ontario Ministry of Natural Resources), B. Henshaw, D. Leadbeater & J. Kamstra (Gartner Lee Ltd.), M. Horwood (Lynde Shores Environmental Monitoring Committee), N. Hutchinson & K. Williams (City of Oshawa), J. Ingram & O. Steele (Ducks Unlimited Canada), A. Littlefield (G.L. Roberts Collegiate and Vocational Institute), G. MacPherson, G. Bowen & P. Lowe (Toronto and Region Conservation Authority), M. Peacock & W. Coulter (Ganaraska Region Conservation Authority), M. Powers (Town of Whitby), J. Richards (General Motors of Canada Ltd.), E. Sarpkaya (The Aquatic Environment), C. Strand (Department of Fisheries and Oceans), C. Strike & J. Swartz (Municipality of Clarington), T. Whillans (Trent University) and D. Wismer & A. Torrenueva (Ontario Power Generation). Thanks also to B. Henshaw (Gartner Lee Limited) for helpful comments and suggestions in the preparation and review stages of this report.

Cover photo: J. Mitchell

Introduction

Wetlands are dynamic systems and represent an important transition zone between aquatic and terrestrial environments. Wetlands, of which marshes are the one of the more common types in the Great Lakes basin, can serve a variety of functions (see below). Coastal wetlands differ from other wetlands in that they are shaped largely by lake processes which include waves, seiches, and most notably seasonal and long-term changes in water levels. Coastal wetlands are also influenced by loadings of nutrients and sediments brought in by creeks and rivers that originate upstream in the watershed. It is largely as a result of human influences that coastal wetlands have been subjected to continual stresses and degradation. Consequently, despite their ecological value, wetlands have continued to decrease in size and/or quality or have disappeared completely at an alarming rate in the Great Lakes basin over the last century.

Values of wetlands

Wetlands serve to:

- provide flood control and allow for replenishment of groundwater supplies;
- provide habitat for plants, spawning, nursery and feeding areas for fish and breeding, nesting and feeding areas for birds and other fauna including amphibians and reptiles;
- provide sediment control by reducing water velocity;
- attenuate flood flows and reduce erosion;
- improve water quality by removing pollutants and excess nutrients;
- provide recreational sites for human activities such as canoeing, fishing, hunting, wildlife viewing and nature photography;
- provide aesthetic or spiritual qualities including an appreciation of nature and a sense of well-being, and;
- provide educational and research opportunities.

Coastal Wetland Monitoring Programs in the Great Lakes Basin

Monitoring programs can address a variety of goals and objectives. For example, data collected over the short-term (i.e., a few years), can contribute to baseline information with which to compare future environmental changes observed at the site. Over longer periods, monitoring data can provide information on stressors that impact the wetland environment. This can help inform management decisions that relate to the mitigation of these impacts. Monitoring programs can also serve as early warning systems to identify potential problems that may arise. Additionally, information from appropriately designed monitoring programs can be used as a management tool to assess the impact of future actions or additional stressors that may threaten the integrity of the study site. Data from well-conceived, consistent and scientifically reliable monitoring programs provide evidence of the “state of the environment”, so that rehabilitation and conservation projects can proceed based on sound science and appropriate priorities.

Given the losses of wetlands and their general decline in quality, many public agencies and non-governmental organizations have identified the urgent need to monitor wetland health. Some wetland monitoring programs are large-scale, encompassing the entire Great Lakes basin. In 1992, the Government of Canada and the Government of the United States established The State of the Lakes Ecosystem Conference (SOLEC). This conference identified coastal wetland ecosystems as one of seven ecosystem components considered necessary in studying the state of health of the Great Lakes basin. The remaining six ecosystem components from which indicators were selected were grouped as follows: nearshore and open waters, nearshore terrestrial, land use, human health, societal and an unbounded category. A total of 13 indicators were selected with which to monitor coastal wetland health. These included:

- Coastal and wetland invertebrate community health
- Coastal wetland fish community health
- Deformities/eroded fins/lesions/tumours (DELT) in coastal wetland fish
- Amphibian diversity and abundance
- Wetland-dependent bird diversity and abundance
- Coastal wetland area by type
- Gain in restored coastal wetland area by type
- Presence, abundance and expansion of invasive plants
- Habitat adjacent to coastal wetlands
- Contaminants in snapping turtle eggs
- Sediment flowing into coastal wetlands
- Nitrates and total phosphorus into coastal wetlands
- Water level fluctuations

Bird Studies Canada, in partnership with Environment Canada, developed the volunteer-based Marsh Monitoring Program (MMP). This program was designed to examine bird and amphibian distribution and abundance on a basin-wide scale in both Canada and the United States. Other monitoring programs have been established on a smaller scale. Some governmental and non-governmental agencies have developed monitoring programs following the remediation of wetland sites that are known to be degraded, particularly at Areas of Concern (AOCs) along the Great Lakes shoreline. Many conservation authorities have developed, or are in the process of developing, watershed management strategies which may include the monitoring of wetland sites. Some community groups and businesses have also established independent monitoring programs in their communities.

In general, currently, wetland monitoring programs are largely independent of each other, have varying approaches, as well as different focal points of interest, goals and objectives.

Coastal Wetlands in Durham Region

An estimated 60 to 80 percent of the coastal marshes in Durham Region have been lost to development (Reid 2001); most of the remaining remnant coastal wetlands are surrounded by residential or industrial development, or are under threat. Coastal wetlands in Durham Region have faced a variety of stressors over the years which have included: urban development, agricultural inputs and extreme changes in Lake Ontario water levels. Structural modifications have included: draining, filling and dredging of wetland sites. Exotic species, such as common carp, have also played a role in wetland degradation. While marshes are generally resilient to relatively small scale environmental changes, many of these stressors have had such significant impacts that a number of these wetlands have been unable to recover lost functions. Currently, a number of these sites face ongoing stress to varying degrees, from either local sources or from sources originating within their watersheds. In total, 16 coastal marshes, either publicly or privately owned and in three conservation authority jurisdictions (Toronto and Region Conservation Authority, Central Lake Ontario Conservation Authority, and Ganaraska Region Conservation Authority) are found within Durham Region (Figure 1). These are as follows (from west to east):

- Rouge River Marshes
- Frenchman’s Bay Marshes (Frenchman's Bay and Hydro Marsh)
- Duffins Creek Marsh
- Carruthers Creek Wetland Complex
- Cranberry Marsh
- Lynde Creek Marsh
- Corbett Creek Mouth Marsh
- Pumphouse Marsh
- Oshawa Second Marsh
- McLaughlin Bay Marsh
- Raby Head Wetland #1
- West Side Beach Marsh
- Port Darlington Marsh (Bowmanville Marsh)
- Wilmot Rivermouth Wetland
- Port Newcastle Wetland Complex

Durham Region Coastal Wetlands Monitoring Project

Given the relatively large number and large total area of coastal wetlands in Durham Region compared to other jurisdictions, the rate of loss in either the quantity and/or quality of wetlands and the environmental stressors which continue to face them, Environment Canada and the Central Lake Ontario Conservation Authority have initiated the development of a region-wide coastal wetlands monitoring project.

The overall/general purpose of this initiative is to develop a coastal wetlands monitoring project in Durham Region that:

- provides scientifically relevant data in relation to coastal wetland status and trends set in a regional context;
- meets stakeholder needs;
- is sustainable; and
- can be delivered in an efficient, cost-effective manner.

Many stakeholders are currently involved in monitoring activities at wetland sites in the Region, some as collaborative projects, while others work independently. In order to carry out the overall/general purpose of this initiative, the intent is to pool resources and build on monitoring activities that are currently underway, using a standardized and coordinated approach. Benefits to developing a network of partners as part of a cooperative monitoring project include:

- sharing of resources and costs;
- sharing of technical expertise;
- data-sharing among agencies, thereby achieving minimal duplication of effort;
- the ability to implement a monitoring program over the long term (i.e., decades) may be realized, and;
- the evaluation of coastal wetland health on a regional level provides a unique and detailed analysis at a landscape scale that is usually not attainable.

The proposal to develop a Durham Region Coastal Wetlands Monitoring Project (hereby referred to as “the Project”) was first launched at a meeting held on February 9, 1999 at the Central Lake Ontario Conservation Authority Conference Centre. This was attended by representatives from various organizations and agencies interested in wetland monitoring in the Region. At this meeting, a list of ideas and actions on which to base the investigations for a potential regional program were developed. These included:

- There is conceptual support for a comprehensive long term monitoring program of Lake Ontario coastal wetlands within Durham Region as a geographic base.
- Scientifically defensible monitoring protocols need to be established.
- Long-term financial and/or in-kind support commitments and an ongoing coordinating structure are essential.
- There must be a realistic balance between volunteers and paid help.
- A lead agency(s) for data management must be put in place along with data sharing arrangements.

To ensure the success of the Project, all of these points must be addressed prior to implementation.

This document serves as background report to identify monitoring activities and protocols performed in the recent past and those planned for the future at Durham Region coastal wetland sites; also included are the stakeholders involved in these activities. Given the common interest among agencies in Durham Region regarding coastal wetlands, the overall interest in development of this initiative, and the wide-range of technical experiences among agencies, the potential for development of this Project as a coordinated, multi-partner initiative needs to be explored further. Once stakeholders have committed to the Project, an action plan should be agreed upon and implemented over the next ten months.

Description of Each Coastal Wetland in Durham Region

General site descriptions, site types, areas, and principal owner(s) of coastal wetlands in Durham Region are outlined below. Site descriptions and site types are from the Natural Heritage Information Centre (NHIC) database generated from the NHIC website (copyright Queen's Printer for Ontario, 2001). See "Glossary of Terms" at the end of this report for a description of wetland terms used in this report. The current status of each wetland includes a general description of management plans and/or rehabilitation efforts currently underway at the site as well as some volunteer programs that have been implemented. Monitoring activities at these sites are described in the following section.

Aerial photographs from the mid- to late-1990s are provided for each wetland. An evaluated wetland boundary determined using the Ontario Wetland Evaluation System, wetland status, location and other details are also provided for each site. The digitized boundaries on maps may reflect more recent information than the year of evaluation (e.g., updated mapping used during the digitization process). These photos were provided through a collaborative effort by the Toronto and Region Conservation Authority, Central Lake Ontario Conservation Authority, and Ganaraska Region Conservation Authority.

Rouge River Marshes

Description: The Rouge River Marshes is a provincially significant coastal wetland complex, composed of two wetland types (41% swamp, 59% marsh) (Forder *et al.* 1995).
Site Type: 100% lacustrine at rivermouth (Forder *et al.* 1995)
Principal Owner: Toronto and Region Conservation Authority
Area: 59.6 hectares
Status: The Rouge River Rehabilitation Initiative Working Group Committee guides rehabilitation and monitoring in the Rouge River Marshes with representatives from a number of agencies including Ontario Ministry of Natural Resources, Ontario Streams, City of Toronto, Toronto and Region Conservation Authority and Environment Canada among others. In terms of rehabilitation activities, a parking lot naturalization plan has been developed which will create a buffer zone between the marsh and the parking lot (and thereby reduce the size of the parking lot by one-third), prevent the transfer of sediments and

contaminants from the parking lot to the marsh, and enhance fish and wildlife habitat as a result of planting of aquatic vegetation and adding woody debris. Other habitat restoration activities which have been undertaken in the Rouge River Marshes in 1999 and 2000 include installation of carp barriers and experimental exclosures planted with native vegetation. One hundred bird boxes have been installed and have been maintained (1998-2000) and a snake hibernaculum has been constructed. Thousands of purple loosestrife plants have also been removed at this site. Over 5000 volunteer hours were contributed in 2000. A bathymetric survey was conducted by the Ontario Ministry of Natural Resources and Ontario Streams in 1998.

Frenchman's Bay Marshes (Frenchman's Bay & Hydro Marsh)
Description: Frenchman's Bay Marshes is a provincially significant coastal wetland complex made up of five individual wetlands and is composed of two wetland types (12% swamp, 88% marsh) (McCullough and Wilson 1983a). One of these wetland sites, Hydro Marsh, is located east of Frenchman's Bay and flows into Frenchman's Bay.
Site Type: 44% lacustrine at rivermouth, 56% lacustrine on enclosed bay (McCullough and Wilson 1983a)
Principal Owners: Toronto and Region Conservation Authority (TRCA), Ontario Power Generation (OPG), City of Pickering, private
Area: 47 hectares
Status: One component of the Frenchman's Bay Watershed Rehabilitation Project involves carrying out volunteer-based monitoring initiatives at Frenchman's Bay and Hydro Marsh. In 2001, these activities will include examining water quality (using standard Hach kits to measure nutrients, pH, temperature, conductivity, turbidity, and total suspended solids); performing visual surveys of turtle nesting and basking activities; surveys of snake and butterfly abundance and diversity; and collections of invertebrates. These five programs will complement ongoing water quality, fish community, sediment and other monitoring programs conducted by the TRCA (see monitoring sections for details). One flow gauge was installed at Hydro Marsh in 2000.

In 1998, OPG developed a general plan for site management of wildlife and biodiversity conservation at the Pickering Nuclear facility, including Hydro Marsh. In 1999, the TRCA in partnership with OPG implemented a local monitoring program for Hydro Marsh, the results of which are documented in a report entitled "Biodiversity Monitoring Program for the Pickering Nuclear Site", produced by the TRCA. The goal of this monitoring program was to provide baseline environmental data for Hydro Marsh in support of the OPG's biodiversity and natural areas management plan. A bathymetric survey of the Marsh was undertaken using a portable Global Positioning System (GPS) unit and a portable depth sounder. Variables monitored in 1999 as part of this report are outlined in the following monitoring section.

Duffins Creek Marsh
Description: Duffins Marsh is a provincially significant coastal wetland composed of two wetland types (10% swamp, 90% marsh) (McCullough and Wilson 1983b).
Site Type: 100% lacustrine at rivermouth (McCullough and Wilson 1983b)
Area: 69 hectares
Principal Owner: partially Toronto and Region Conservation Authority (TRCA)
Status: As part of the Duffins Creek Watershed Management Strategy, the Duffins Creek Marsh Restoration Plan is in the process of being developed by TRCA and other partners with implementation scheduled in 2001. This Plan will focus on initiatives pertaining to wetland restoration and creation, forest restoration and management, meadow management, habitat features, and trail management; specific initiatives at these sites have not yet been identified. At Duffins Creek and Bayly Road, automatic samplers collect integrated large water samples on a monthly basis throughout the year and analyze samples for organochlorine pesticides, PCBs, metals, conductivity, suspended solids and turbidity as part of Ontario Ministry of the Environment's Tributary Toxics Monitoring Program. Grab samples are also taken at this site on a monthly basis and analyzed for urban pesticides (in collaboration with Environment Canada) One flow gauge has also been installed at this station.

The Duffins Creek Marsh Rehabilitation Project, coordinated by Errol Sarpkaya of The Aquatic Environment, has been in operation since 1996 and has involved a number of restoration initiatives including purple loosestrife control, carp control (using exclosures), planting to improve fish habitat, buffer enhancement and barrier beach improvements. In 1999, The Aquatic Environment partnered with Citizens Environmental Watch (CEW) which uses school aged children to monitor water quality in Duffins Creek (see monitoring section for parameters measured).

Carruthers Creek Wetland Complex
Description: Carruthers Creek Wetland Complex is a provincially significant complex made up of five individual wetlands and is composed of two wetland types (approximately 75% swamp, 25% marsh) (B. Henshaw pers. comm.; D. Leadbeater pers. comm.)
Site Type: palustrine, riverine and lacustrine
Area: 141 hectares
Principal Owner: Toronto and Region Conservation Authority (TRCA)
Status: As part of the Carruthers Creek Watershed Management Strategy, a Carruthers Creek Marsh Restoration Plan is in the process of being developed by the TRCA. As part of the Provincial Water Quality Network examining water quality, one water quality collector is located at Carruthers Creek and Shoal Point Road. One flow gauge has also been installed at Carruthers Creek north of Squire’s Beach Road.

Cranberry Marsh
Description: Cranberry Marsh is a provincially significant coastal wetland, composed of two wetland types (32% swamp, 68% marsh) (McCullough *et al.* 1983a).
Site Type: 100% lacustrine on enclosed bay (McCullough *et al.* 1983a)
Area: 47.2 hectares
Principal Owner: Central Lake Ontario Conservation Authority (CLOCA)
Status: The Central Lake Ontario Conservation Authority completed the Lynde Shores Conservation Area Management Plan in 1999 which includes recommendations for management of Cranberry Marsh. Lead by Ducks Unlimited Canada and CLOCA, the Marsh will be drained in the spring of 2001 in an attempt to regenerate vegetation and fish habitat. Once more favourable aquatic vegetation have become established, the Marsh will be refilled in the fall to a specified level to ensure the survival of desirable plants and/or target drowning of undesirable vegetation species. As part of an annual program, the Marsh may be drained and refilled in subsequent years to promote survival of desired vegetation. The Central Lake Ontario Conservation Authority plans to monitor water quality (chemical analyses) in subsequent years at this site. Further details of management of Cranberry Marsh are outlined in "Cranberry Marsh Management Zone Strategy" produced by the CLOCA. Controlled releases of the beetles Galerucella calmariensis and G. pusilla (6,000 beetles have been released to date) as a means of purple loosestrife control have been ongoing at Cranberry Marsh since 1999.

Lynde Creek Marsh
Description: Lynde Creek Marsh is a provincially significant coastal wetland, composed of two wetland types (40% swamp, 60% marsh) (McCullough *et al.* 1983b).
Site Type: 100% lacustrine at rivermouth (McCullough *et al.* 1983b).
Area: 129.8 hectares
Principal Owner: Central Lake Ontario Conservation Authority (CLOCA)
Status: As part of a condition of development approval for residential construction on the east side of the marsh, the Lynde Shores Environmental Monitoring Committee (LSEMC) was established in 1995 to assess the long term impacts of development on the major open space lands for the Lynde Shores area. This Committee consists of representatives from the Town of Whitby, CLOCA, developers and members of the public, with technical input from governmental agencies and consultants. Environmental monitoring will continue for 10 to12 years; variables monitored are listed in the following section. Monitoring costs are paid by the subdivision developers; monitoring is performed by hired consultants and Committee members. An approximately 1 600 metre vegetation barrier was created through naturalization plantings along the eastern shoreline of the Marsh to act as a buffer zone between the residential development and the Marsh.

The Central Lake Ontario Conservation Authority is currently developing an

Aquatic Management Resource Plan for the Lynde Creek watershed, scheduled for completion in 2001.

Corbett Creek Mouth Marsh
Description: Corbett Creek Mouth Marsh is a provincially significant coastal wetland composed of two wetland types (17% swamp, 83% marsh) (Reid and Ronda 1987).
Site Type: 70% lacustrine at rivermouth, 30% lacustrine on enclosed bay (Reid and Ronda 1987)
Area: 21.2 hectares
Principal Owners: The Regional Municipality of Durham, Town of Whitby and the Thickson Woods Heritage Foundation
Status: No monitoring activities appear to have taken place in the last few years at this site; no activities appear to have been proposed.

Pumphouse Marsh
Description: Pumphouse Marsh is a provincially significant wetland composed of two wetland types (20% swamp, 80% marsh) (Smith and Petrie 1983).
Site Type: 100% lacustrine on enclosed bay (Smith and Petrie 1983)
Area: 7.2 hectares
Principal Owner: City of Oshawa
Status: G. L. Roberts Collegiate and Vocational Institute, located adjacent to Pumphouse Marsh, has developed an environmental program for the purpose of, among of other things, raising environmental awareness of the importance of wetlands and wetland monitoring. Small groups of students, along with monitoring experts, were involved in bird and amphibian monitoring at Pumphouse Marsh in 2000; a program for monitoring water quality at this site is currently in the developmental stages.

Oshawa Second Marsh
Description: Oshawa Second Marsh is a provincially significant wetland composed of two wetland types (29% swamp, 71% marsh) (McCullough *et al.* 1983c)
Site Type: lacustrine at rivermouth, lacustrine on enclosed bay, palustrine (B. Henshaw pers. comm.)
Area: 132.5 hectares
Principal Owner: City of Oshawa
Status: In 1992, the Oshawa Second Marsh Management Plan was adopted by the City of Oshawa to provide guidance for future restoration and ecological management activities within the Marsh and surrounding landscape. From 1993 to 2000, Oshawa Second Marsh became a demonstration project of Environment Canada's Great Lakes 2000 Cleanup Fund and many rehabilitation activities were undertaken to mitigate some of the stresses apparent at this site, which included high water levels, excessive turbidity and high carp populations. Furthermore, extensive monitoring of vegetation and wildlife was performed during that period (see monitoring section). At the present time, Ducks Unlimited

Canada, the City of Oshawa, Friends of Second Marsh, Environment Canada and a number of other partners are involved in rehabilitation at this site. Proposed rehabilitation initiatives include water level manipulations within the Marsh in an attempt to restore natural vegetation and wildlife communities. This will be achieved using a dyke separating the main wetland basin from the waters of Harmony/Farewell Creek; water from the Creek will be redirected to the outlet into Lake Ontario. This work is scheduled for 2002, pending city, provincial and federal approval. Led by Ducks Unlimited Canada, vegetation monitoring using a transect method will proceed in the fall of 2002 and both vegetation and fish monitoring is scheduled in 2003. Additional future monitoring activities have not yet been identified.

McLaughlin Bay Marsh
Description: McLaughlin Bay Marsh is a provincially significant coastal wetland composed of two wetland types (13% swamp, 87% marsh) (Little and Sutherland 1984a).
Site Type: 100% lacustrine (exposed to lake) (Little and Sutherland 1984a).
Area: 41.7 hectares
Principal Owner: Darlington Provinical Park (Ontario Ministry of Natural Resources) and General Motors of Canada Ltd.
Status: The McLaughlin Bay Wildlife Reserve is located on land adjacent to the Marsh and is maintained by General Motors of Canada Limited. The Reserve offers a variety of trails that take visitors through a wide variety of habitats including open fields, sedge meadows, forested areas, shrub thickets and the lakeshore. Over the past ten years, over 35 000 trees and shrubs have been planted on site by both volunteers and McLaughlin Bay Wildlife Reserve managerial staff. Three storm water ponds (Dogwood Pond, Jim's Pond and Wilkinson's Pond) are also present; aquatic plants were planted in these ponds in 1999 and 2000. Bird houses and feeders have been built and are maintained by volunteers. Trail clean-ups (on a weekly basis) are also volunteer driven.

Darlington Provincial Park staff and volunteers were involved in a monarch butterfly tagging program in September of 1998 to 2000. A proposal to conduct a life science inventory of wildlife and vegetation in 2001 at the Marsh and within Darlington Provincial Park is currently being reviewed.

Raby Head Wetland #1
Description: Raby Head Wetland #1 is a locally significant coastal wetland composed of two types (35% swamp, 65% marsh) (Batty and Petrie 1984).
Site Type: 100% lacustrine on enclosed bay (Batty and Petrie 1984).
Area: 5.3 hectares
Principal Owner: Blue Circle Cement
Status: Currently, Blue Circle is involved in a dock expansion project at this site.

West Side Beach Marsh
Description: West Side Beach Marsh is a provincially significant coastal wetland composed of two wetland types (6% swamp, 94% marsh) (McCullough *et al.* 1983d).
Site Type: 100% lacustrine at rivermouth
Area: 45.1 hectares
Principal Owners: Blue Circle Cement and the Central Lake Ontario Conservation Authority
Status: Blue Circle has held a license to extract aggregate beneath the Marsh for a number of years. In 1998, approval was given to Blue Circle to divert West Side Creek from its eastern inflow site, around a future quarry area, through a hydro corridor and into a newly reconfigured West Side Beach Marsh from the north end. Reconfiguration of the Creek and Marsh will begin in 2002. Currently, CLOCA and the Municipality of Clarington have begun an Environmental Management Plan for the wetland complex consisting of the reconfigured portion of West Side Beach Marsh, Port Darlington Marsh and the upland area (link land) between these two Marshes. Completion of this Plan is scheduled for the winter of 2003. As a condition of approval for extraction by the Department of Fisheries and Oceans and upon reconfiguration of the Marsh, Blue Circle Cement will initiate an intensive monitoring program, examining various water quality parameters and changes in fish community structure.

Port Darlington Marsh (Bowmanville Marsh)
Description: Port Darlington Marsh (also known locally as Bowmanville Marsh) is a locally significant wetland composed of only one wetland type (100% marsh) (Little and Sutherland 1984b)
Site Type: 100% riverine (Little and Sutherland 1984b)
Area: 29.4 hectares
Principal Owner: Central Lake Ontario Conservation Authority, Municipality of Clarington, Port Darlington Harbour Company, Ontario Hydro
Status: The Central Lake Ontario Conservation Authority completed the "Bowmanville Creek Watershed Aquatic Resource Management Plan" for the Bowmanville Creek watershed in 1999. Monitoring activities performed for the Plan are listed in the following section. No monitoring activities were performed at this site in 2000.

Wilmot Rivermouth Wetland
Description: Wilmot Rivermouth Wetland is a provincially significant coastal wetland complex made up of three individual wetlands and is composed of two wetland types (29% swamp, 71% marsh) (Cunningham *et al.* 1994).
Site Type: 69% riverine and 31% lacustrine at rivermouth (Cunningham *et al.* 1994)
Area: 25.8 hectares
Principal Owner: Municipality of Clarington
Status: The wetland is included in the Samuel Wilmot Nature Area Environmental Management Plan, directed by the Municipality of Clarington,

Ganaraska Region Conservation Authority, Ontario Ministry of Natural Resources and other partners. Currently, a management advisory committee is being formed to implement the recommendations of the Plan. This committee will also be responsible for monitoring of open space activities and built features, reforestation, and protective plantings, and stormwater quality. No wetland monitoring activities have been identified at this site.

Port Newcastle Wetland Complex
Description: Port Newcastle Wetland Complex is a locally significant wetland complex made up of seven individual wetlands and is composed of two wetland types (42.5 % marsh and 57.5% swamp) (Kwik and Ray 1995).
Site Type: 100% riverine (Kwik and Ray 1995)
Area: 8.2 hectares
Principal Owner: Private ownership
Status: The Ganaraska Region Conservation Authority (GRCA) is currently in negotiations to acquire the property including the Wetland Complex. The Graham Creek watershed study, which includes the Complex, is scheduled for completion in 2002 by the GRCA. This study will include recommendations regarding the future management of the wetland. Environmental monitoring activities are currently being developed at this site.

Recent and Proposed Monitoring Studies

A comprehensive listing of past and proposed monitoring activities within coastal wetland sites in Durham Region is provided in Table 1. This list is divided into sections by wetland sites. For each wetland where monitoring was identified, the agency(ies) responsible and collection year(s) are indicated. Note that in some cases, many agencies were involved in implementing a particular monitoring activity and, for reasons of simplicity, all of these could not be listed here.

Table 1. Past and proposed monitoring activities within coastal wetland sites in Durham Region*. Agencies responsible for carrying out these activities as well as corresponding collection years are also denoted. Acronyms for agencies are as follows: CEW=Citizens Environmental Watch; CLOCA=Central Lake Ontario Conservation Authority; CWS=Canadian Wildlife Service; LSEMC=Lynde Shores Environmental Monitoring Committee; OMNR=Ontario Ministry of Natural Resources; OS=Ontario Streams; RRRC=Rouge River Restoration Committee; TAE=The Aquatic Environment; TRCA=Toronto and Region Conservation Authority.

Site	Responsible Agency/ Year(s)/ Monitoring Activity
Rouge River Marshes	• OMNR & OS/ 2000/ water turbidity using Secchi disk • OS/ 2000/ transect surveys on an annual basis • OS/ 2000/ first order topographic survey • OMNR/ 1994-1995/ wetland re-evaluation • OMNR & OS/ 1999/ browse monitoring by Canada geese
Site (con't)	**Responsible Agency/ Year(s)/ Monitoring Activity**

Rouge River Marshes (con't)	• OMNR & OS/ 1998,1999/ summer goose counts and incidental bird observations • OS/ 2000/ incidental bird observations • TRCA/ 1995/ Marsh Monitoring Program for marsh birds • TRCA/ 1995-1999/ Marsh Monitoring Program for amphibians • RRRC & TRCA/ 1999, 2000/ frog monitoring based on the Frogwatch - Ontario program developed by the Toronto Zoo; salamander monitoring - program designed by Toronto Zoo staff member • OMNR & OS/ 1999, 2000/ incidental reptile catches/ fish weirs • TRCA/ 1997-2000/ fish community inventory using seine nets • OMNR/ 1999/ extensive assessment of the littoral fisheries community • OMNR & OS/ 1999, 2000/ measure and weigh spawning fish species using wire link fences, live fish traps and hoopnets • OMNR & OS/ 1998-2000/ incidental mammal observations
Frenchman's Bay	• TRCA/ 1994-2001/ Marsh Monitoring Program for marsh birds • TRCA/ 1999/ point count surveys and breeding bird surveys • CWS/ 1998/ common tern nest counts as part of the survey of colonial waterbirds nesting on the Great Lakes • TRCA/ ongoing/ common tern nest counts conducted annually at three nesting raft sites • TRCA/ 1994-2001/ Marsh Monitoring Program for amphibians • TRCA/ 1990-2001/ fish community inventories using electrofishing techniques
Hydro Marsh	• TRCA/ 1999-2001/ water temperature measured using temperature recorders at two sites in the Marsh • TRCA/ 1999/ water samples analyzed for general physical and chemical parameters, bacteria and contaminants • TRCA/ 1999/ sediment samples collected using an Ekman grab sampler and analyzed for grain size, chemical parameters and contaminants • TRCA/ 1999, 2000, 2001/ freshwater clams, deployed in wire cages, were collected for contaminant and metal analyses • TRCA/ 1999/ vegetation communities were classified according to the Ecological Land Classification (ELC) system for southern Ontario; a forest resources inventory and a wetland evaluation were also conducted • TRCA/ 1994-2001/ Marsh Monitoring Program for marsh birds • TRCA/ 1999-2001/ point count surveys and breeding bird surveys • CWS/ 1999/ common tern nest counts as part of the survey of colonial waterbirds nesting on the Great Lakes • TRCA/ ongoing/ common tern nest counts conducted annually at three nesting raft sites • TRCA/ 1994-2001/ Marsh Monitoring Program for amphibians • TRCA/ 1999/ incidental data for reptiles • TRCA/ 1998, 2000, 2001/ fish community inventories using electrofishing techniques • TRCA/ 1999/ incidental monitoring of large and small terrestrial and aquatic mammals
Duffins Creek Marsh	• TAE & CEW/ 2000/ water temperature using probes • TAE & CEW/ 2000/ water samples analyzed for nitrates, phosphates, turbidity, pH and ammonia • TRCA/ 2000, 2001/ quantified winter vegetation emergence using a GPS unit • Consultant/ 1993/ autumn bird surveys • Consultant/ 1994/ spring-summer bird surveys CWS/ 1998/ common tern nest counts as part of the survey of colonial waterbirds nesting on the Great Lakes

Site (con't)	Responsible Agency/ Year(s)/ Monitoring Activity
Duffins Creek Marsh (con't)	• TRCA/ ongoing/ common tern nest counts conducted annually at three nesting raft sites • TRCA/ 1999, 2000/ Marsh Monitoring Program for marsh birds • TRCA/ 1999, 2000/ Marsh Monitoring Program for amphibians • TRCA/ 1997-1999/ fish community inventories using electrofishing techniques
Carruthers Creek Wetland Complex	• No monitoring activities were identified at this site
Cranberry Marsh	• CLOCA/ 1998, 1999/ full chemical analysis of water samples including bacteria, metals and contaminants • Consultant/ 1993/ autumn bird surveys • Consultant/ 1994/ spring-summer bird surveys • Consultant/ 1997/ spatial distribution of waterfowl nests and predation patterns • CWS/ 1988, 1989/ reptiles: snapping turtle egg collections for contaminant analysis • CLOCA/ 1999/ fish community inventories using minnow traps, seines and hoop nets • Trent University/ 1997, 1998/ distributions of small and medium-sized mammals within and outside 120 m "adjacent lands" surrounding wetlands
Lynde Creek Marsh	• LSEMC & consultant/ 1999-ongoing/ water samples collected from one marsh site were analyzed for 45 water quality parameters including metals, bacteria and grease • CLOCA/ 2001/ chemical analyses of water samples • CLOCA/ 2001/ an inventory of the benthic macroinvertebrate communtiy will be performed using the BIOMAP (bioassessment of water quality) sampling protocol • LSEMC & CLOCA/ 1997-ongoing/ monitor success of vegetation barrier, one to four times per year; annual photographic surveys along the length of the barrier • Consultant/ 1997/ spatial distribution of waterfowl nests and predation patterns • LSEMC & consultants/ 1998-ongoing/ breeding bird survey conducted using line transects on either side of Lynde Creek in spring and early summer • CWS/ 1984, 1988, 1989, 1991, 1995/ snapping turtle egg collections for contaminant analysis • CLOCA/ 2001/ fish community inventories using electrofishing techniques • LSEMC & consultants/ 1998-ongoing/ incidental mammal observations
Corbett Creek Marsh	• No monitoring activities were identified at this site
Pumphouse Marsh	• No monitoring activities were identified at this site
Oshawa Second Marsh	• Georgian Bay College student/ 1996/ basic physical and chemical analyses of water samples • Consultant/1993/ survey of aquatic invertebrates using an Ekman dredge and sweep net • Consultant/ 1997/ survey of aquatic invertebrates using BIOMAP protocol • Consultant/ 1993,1995,1997/ quantitative or qualitative analyses of marsh vegetation and/or assessment of survivorship of plants established during restoration activities after 1995 • Consultant/ 1996/ vegetation communities were classified according to the Ecological Land Classification system for southern Ontario; assessment of survivorship of plants established during restoration activities

Site (con't)	Responsible Agency/ Year(s)/ Monitoring Activity
Oshawa Second Marsh (con't)	• York University/ 1996/ herbivory study assessing plant survivorship using wire exclosures • Consultant/ 1999/ emergent vegetation were documented in response to low water levels; observations of herbivory; quantitative analysis of marsh vegetation at sites sampled in 1993 • Consultant/ 1993/ autumn bird surveys • Consultant/ 1994/ spring-summer bird surveys • Consultant/ 1995-2000/ breeding bird survey conducted using over 40 point counts and line transects • Consultant and volunteers/ 1993, 1994, 1999, 2000/ Marsh Monitoring Program for marsh birds • Consultant/ 1996, 1997/ spatial distribution of waterfowl nests and predation patterns • Consultant/ 1996/ status of two nuisance bird species • CWS/ 1999/ common tern nest counts as part of the survey of colonial waterbirds nesting on the Great Lakes • Consultant and volunteers/ 1993-2000/ Marsh Monitoring Program for amphibians as well as diurnal searches of adults and larvae at known breeding sites • Consultant and volunteers/ 1996, 1998/ incidental observations of reptiles • Consultants/ 1994, 1995/ fish community inventories using minnow traps, seine nets and hoop nets • Consultant/ 1996/ northern pike spawning survey • OMNR/ 1996-1999/ fish community inventories using minnow traps, seines, and hoop nets • Trent University/ 1997, 1998/ distributions of small and medium-sized mammals within and outside 120 m "adjacent lands" surrounding wetlands
McLaughlin Bay Marsh	• No monitoring activities were identified at this site
Raby Head Wetland #1	• CLOCA/ 1997/ vegetation communities were classified according to the Ecological Land Classification system for southern Ontario
West Side Beach Marsh	• Consultant/ 1992/ fisheries and fish habitat inventory • Consultant/ 1993/ bird and wildlife use • Consultant/ 1993/ autumn bird surveys • Consultant/ 1995/ vegetation inventory and analysis • Blue Circle Canada Inc./1998-ongoing/ water temperature using probes
Port Darlington Marsh	• CLOCA/ 1999/ vegetation communities were classified according to the Ecological Land Classification system for southern Ontario • CLOCA/ 1998, 1999/ fish community monitoring was performed using hoop nets, seines and minnow traps
Wilmot Rivermouth Wetland	• No monitoring activities were identified at this site
Port Newcastle Wetland Complex	• No monitoring activities were identified at this site

***** At all wetland sites, where access is permitted (CWS, 2001), black tern nest counts will be conducted as part of the survey of colonial waterbirds nesting on the Great Lakes

Table 2 summarizes the years in which monitoring activities were performed (or are scheduled for) at each site for each variable of interest. Note that at some sites, no monitoring activities have taken place in recent years.

Table 2: Years Monitoring Activities were Performed by Wetland Site. Coding is as follows: WT = Water Temperature; WQ = Water Quality; S = Sediments; I = Invertebrates; V = Vegetation; B = Birds; A = Amphibians; R = Reptiles; F = Fish; M = Mammals

Site	Parameters									
	WT	WQ	S	I	V	B	A	R	F	M
Rouge River Marshes		2000			1994-1995, 1999, 2000	1995, 1998-2000	1995-2000	1999, 2000	1999, 2000	1998-2000
Frenchman's Bay						1994-2001	1994-2001		1990-2001	
Hydro Marsh	1999 -2001	1999	1999	1999-2001	1999	1994-2001	1994-2001	1999	1998, 2000, 2001	1999
Duffins Creek Marsh	2000	2000			2000, 2001	1993, 1994, 1998 - 2000	1999, 2000		1997-1999	
Carruthers Creek Wetland Complex										
Cranberry Marsh		1998 1999				1993, 1994, 1997		1988, 1989	1999	1997, 1998
Lynde Creek Marsh		1999-2001		2001	1997-2001	1997-2001		1984, 1988, 1989, 1991 1995	2001	1999-2001
Corbett Creek Mouth Marsh										
Pumphouse Marsh										
Oshawa Second Marsh		1996		1993, 1997	1993, 1995-1997, 1999	1993-2000	1993-2000	1996, 1998	1994-1999	1997, 1998
McLaughlin Bay Marsh										
Raby Head Wetland #1					1997					
West Side Beach Marsh	1998-2001				1995	1993			1992	
Port Darlington Marsh (Bowmanville Marsh)					1999				1998, 1999	
Wilmot Rivermouth Wetland										
Port Newcastle Wetland Complex										

Next Steps

Monitoring, Project Goals, Objectives and Protocols

A concise definition of monitoring is provided by Morrison (1994): “Monitoring is basically the repeated inventory of an item in order to determine trend and status”. The next step, that is, the identification of the significance of observed changes over time is the real challenge. Assessing this step correctly lies squarely on the shoulders of well-defined objectives. Accordingly, in developing a monitoring project, there are several key steps which must be taken to ensure a successful monitoring project. The two most important tasks are to define the overall goals and objectives of the study.

It is important to discern the difference between the goals and objectives of a project. A project goal is a general statement of principle which states the overall purpose and provides direction for the project. The goal is generally broad in scope and does not include precise or measurable components. For example, goals for this particular Project might be to:

1. Determine ecosystem health over time at coastal wetlands in Durham Region, or;
2. Determine water quality changes over time at coastal wetlands in Durham Region.

The project’s objectives should be derived from the project goal. Objectives should define how exactly the project goal can be successfully achieved. Sound objectives are specific, clear, precise and should include measurable components. The suite of objectives that can be considered are determined by a range of factors including: funding availability, logistic consideratons, and political constraints. Many different objectives can be derived from a single project goal. For example, objectives for this particular Project might be to:

1. Determine percent change in emergent vegetation over a five year period using annual spring 1:10,000 photography at coastal wetland sites in Durham Region, and/or;
2. Determine amphibian species richness using spring surveys for each of five years at coastal wetland sites in Durham Region, and/or;
3. Examine changes in species richness and abundance for aquatic invertebrates to determine change in composition as an indicator of water quality over time at coastal wetland sites in Durham Region

Further discussion of project goals and objectives specific to this study are required. This task requires careful consideration, and requires agreement among all stakeholders. Finally, it is imperative to the success of a multi-partnered project that the mandates and interests of agencies participating are considered and incorporated into the needs assessment stage of the project's action plan.

Once goals and objectives have been identified, monitoring protocols will be recommended which address the specific objectives and goals of the project. Monitoring protocols selected for the study as well as subsequent data collected must relate directly back to the overall objectives (and, therefore, goals) of the project.

The number of variables (e.g. water quality, fish, birds) to be monitored should be dependent on the objectives which will have considered resource and funding availability. A core objective should be established which will represent the minimum effort that will be undertaken to reach the goal of the project. For example, a core monitoring program might consist of:

1. Examining percent change in emergent vegetation at coastal wetland sites on an annual basis in Durham Region using remote sensing, and;
2. Sampling the species richness and abundance of benthic invertebrate communities at coastal wetland sites in Durham Region

The development of a hierarchy of variables to be monitored as resources and funding permits should be considered.

Monitoring activities are often initiated as a means of monitoring the outcome of restoration efforts. Table 3 provides an example of one wetland site (i.e., Rouge River Marshes) where this has occurred. This format may be a useful tool for providing annual updates among partners of current and proposed restoration activities as well as monitoring activities that have been implemented.

Table 3. Restoration activities (in progress and proposed) and monitoring activities implemented at the Rouge River Marshes as of winter 2001.

Site	Restoration Activities (completed or in progress)	Monitoring Activity (in progress)	Restoration Activities (proposed)
Rouge River Marshes	• As part of a shoreline naturalization plan, a buffer zone has been created between the marsh and the parking lot by regrading and revegetating the area using indigenous species (appox. 25% complete) • Carp barriers were installed • Experimental exclosures containing native vegetation were installed • Habitat structures, including bird boxes, a snake hibernaculum and roosting and basking logs, were installed • Osprey nesting platforms	• Water turbidity using Secchi disk • First order topographic surveys • Vegetation transect surveys on an annual basis • Measure and weigh spawning fish species using wire link fences, live fish traps, hoopnets and seines; extensive assessment of the littoral fisheries community • Harvesting of vegetation from exclosures to estimate biomass and species diversity (in relation to browsing by Canada geese) • Incidental observations of birds • Amphibian monitoring based on Frogwatch program • Incidental observations of reptiles	• Experimental exclosures focusing on emergent vegetation • Shoreline rehabilitation

There are other important considerations to address when developing a coordinated monitoring project. Roles of the participating agencies need to be defined, including lead roles and support roles for monitoring activities, with regard to project funding and management. The role of volunteers in this initiative also needs to be explored further. There are many challenges associated with multi-partner projects, but through a well-planned and consultative process the goals and objectives of this Project can be achieved.

Proposed Organizational Structure

Once agencies have agreed to form partnerships to implement this Project, three committees will be formed. These are as follows:

The Durham Region Coastal Wetlands Monitoring Project Group:

- consists of representatives from a number of agencies involved in, or showing an interest in, coastal wetlands monitoring in Durham Region

- will be kept informed of recommendations made by the Implementation Committee and the Monitoring Committee (see below); and
- will meet to provide input on actions taken throughout the course of the Project.

Within this Group, there will be two sub-committees:

The Implementation Committee will:

- act as managing body and oversee implementation of the Project in its entirety;
- consist of key representatives from agencies involved in monitoring in Durham Region; and
- make decisions pertaining to the governance of the Project and allocation of resources including those from their agencies, as well as application for and management of funds.

The Monitoring Committee will:

- consist of monitoring experts who will develop monitoring protocols as dictated by the goals and objectives identified for the Project;
- provide recommendations relating to monitoring protocols and data collection to the Implementation Committee;
- monitor the effectiveness of these protocols in meeting the defined goals and objectives throughout the course of the Project and recommend/make modifications as needed; and
- manage the monitoring database**.**

It is essential to the success of the project that an effective communication network is established to gather and disseminate information among all committees and partners in a timely manner.

Proposed Action Plan

An action plan detailing the development of the Durham Region Coastal Wetlands Monitoring Project is given in Table 4. As a pilot study to the Project, Oshawa Second Marsh has been recommended as a site for monitoring in the first year of study (spring 2001). Following an assessment of monitoring activities at these sites, all other wetlands will be monitored in the following year (2002).

Table 4. Durham Region Coastal Wetlands Monitoring Project action plan. Phase codes are as follows : 1 = preliminary step; 2 = needs assessment; 3 = gap assessment; 4 = implementation step

Phase	Deliverable	Timeframe	Responsible Party
1	Identify players	Jan 2001	CWS/CLOCA
1	Meeting of all players to discuss initiation of the Durham Region Coastal Wetlands Monitoring Project	early Feb 2001	CWS/CLOCA
1	Determine the level of support among players for the concept of a long term monitoring project in Durham Region	Feb 2001	CWS/CLOCA
1	Assess players' resources and capabilities to project	late Feb/ early March 2001	Players led by CWS/CLOCA
2	Establish Project goal(s) and objective(s)	early Feb 2001	Players led by CWS/CLOCA
2	Establish implementation committee	Feb 2001	CWS/CLOCA
2	Establish monitoring committee	Feb 2001	CWS/CLOCA
2	Design monitoring program based on background assessment of sites (e.g. hydrology, bathymetry, etc.) • Variables to be monitored • Protocols to be adopted • Resources required	late Feb/ early March 2001	Players led by CWS/CLOCA
2	Identify partners and their respective roles in implementation of Project (i.e., coordination of data collection, analyses and distribution of results among agencies)	mid March 2001	" "
2	Establish reporting schedule for activities	mid March 2001	Partners led by CWS/CLOCA
3	Perform gap analysis between program requirements and available resources and capabilities	mid March 2001	CWS/CLOCA
4*	Fill resource and capability gaps through program redesign	late March 2001	Partners led by CWS/CLOCA
4*	Completion and distribution of final monitoring report outlining implementation of Project	early April	CWS/CLOCA
4*	Data collection and analyses at pilot study sites	April-Sept. 2001	Partners

4*	Meeting of all partners to discuss results of pilot study and make recommendations for continued monitoring	Oct 2001	CWS/CLOCA

* at Oshawa Second Marsh in 2001

GLOSSARY OF TERMS

Wetland: lands that are saturated with water sufficiently long enough to promote hydric soils, and where present, the vegetation is dominated by hydrophitic or water-tolerant plants.

Marsh: wetland areas periodically inundated with standing or slow moving water and/or permanently inundated areas characterized by emergent, floating and free-floating vegetation often with areas of open water; woody shrubs (over one metre tall) or trees attain less than 25% by cover.

Swamp: wooded wetlands with 25% or more cover by shrubs (over one metre tall) or trees. Areas with 50% or more cover of low shrubs (less than one metre tall) are also considered to be swamps in Ontario. Swamps may not contain standing water (seasonally or permanently) and are therefore defined by hydric soils and by the species of woody vegetation and other wetland plant species that occur in them.

Lacustrine: a wetland associated with, and therefore influenced by, a lake (In the Ontario Wetland System, a lake is defined as a body of water more than eight hectares in area and two metres deep at some point).

Lacustrine on an enclosed bay: wetland separated from the lake by barrier beach which may intermittently seal-off surface water flows.

Lacustrine at rivermouth: wetland that forms where a river enters a lake forming a rivermouth wetland (e.g., forming out into the lake as in a deltaic formation)

Palustrine: wetland with absent or intermittent inflow and either permanent or intermittent outflow.

Riverine: wetland with a permanent inflow and permanent outflow, includes floodplains and main river channels to the 2 metre depth.

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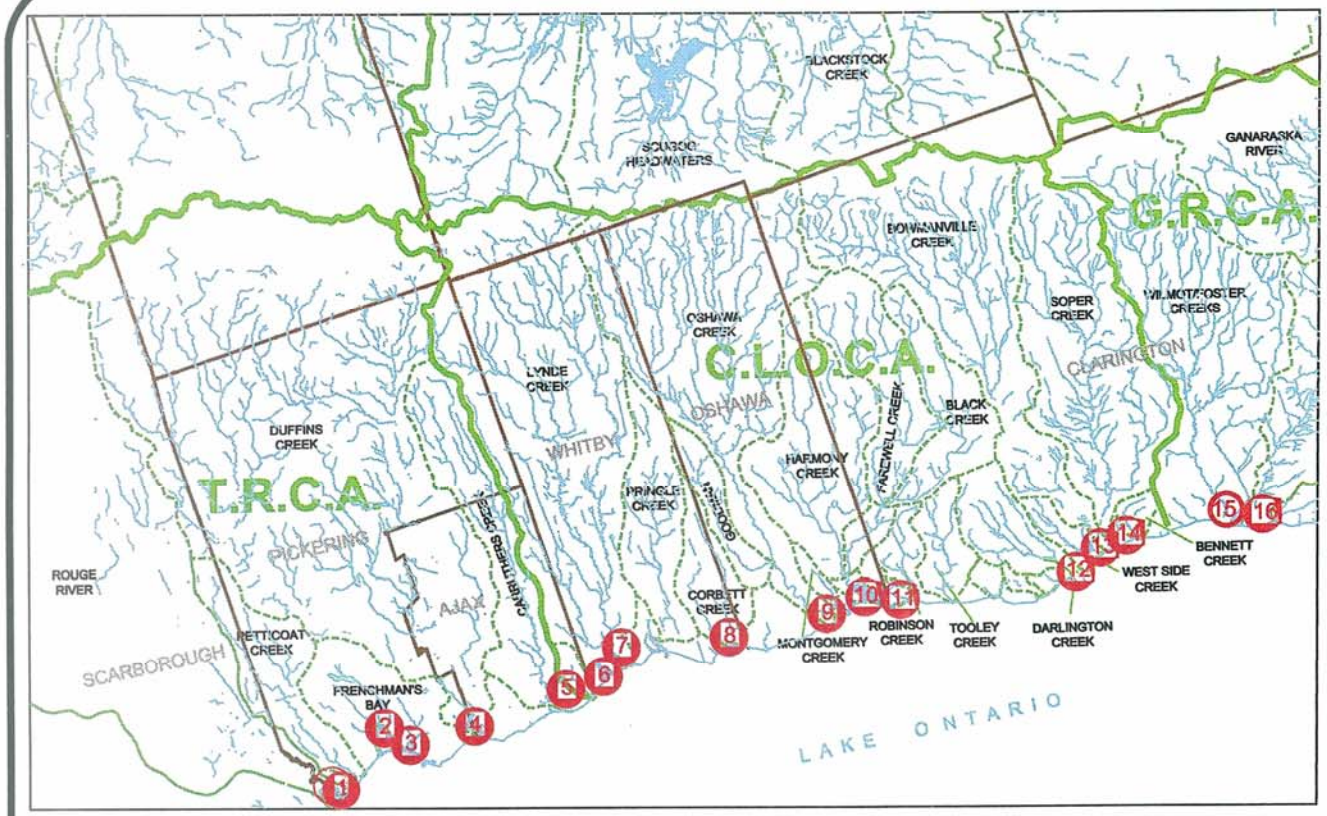

KEY TO COASTAL WETLANDS

1. Rouge River Marsh
2. Frenchmen's Bay
3. Pickering Nuclear Marsh (Hydro Marsh)
4. Duffins Creek Marsh
5. Carruthers Creek Marsh
6. Cranberry Marsh
7. Lynde Creek Marsh
8. Corbett Creek Mouth Marsh
9. Pumphouse Marsh
10. Oshawa Second Marsh
11. McLaughlin Bay Marsh
12. Raby Head Wetland #1
13. Westside Beach Marsh
14. Port Darlington Marsh (Bowmanville Marsh)
15. Wilmot Rivermouth Wetland
16. Port Newcastle Wetland

Central Lake Ontario Conservation

LEGEND

- Municipal Boundary
- Conservation Authority Boundary
- Watershed Boundary
- 5 — Coastal Wetland Location and Keymap Number

NOT TO SCALE

Print Date: October, 2000

Durham Region Waterfront Wetlands Monitoring Project

DURHAM REGION COASTAL WETLANDS

Conservation TORONTO AND REGION

WETLAND INFORMATION

Evaluated Boundary (Ontario Ministry of Natural Resources)

Status: Provincially Significant Wetland

Size: 59.6 Hectares

Location: City of Toronto
Regional Municipality of Toronto,
City of Pickering
Regional Municipality of Durham

Owner: Toronto and Region Conservation Authority

Scale: 1:10000

Aerial Photography: 1999
Produced by Toronto and Region Conservation Authority under Licence with the Ontario Ministry of Natural Resources © Queen's Printer for Ontario, March 1, 2001

Waterfront Wetlands Monitioring Project

ROUGE RIVER MARSHES

Conservation TORONTO AND REGION

WETLAND INFORMATION

Evaluated Boundary (Ontario Ministry of Natural Resources)	
Status:	Provincially Significant Wetland
Size:	47 Hectares
Location:	City of Pickering, Regional Municipality of Durham
Owner:	Toronto and Region Conservation Authority; Ontario Power Generation; City of Pickering; private

Scale: 1:15000

Aerial Photography: 1999
Produced by Toronto and Region Conservation Authority under Licence with the Ontario Ministry of Natural Resources © Queen's Printer for Ontario. March 1, 2001

Durham Region
Waterfront Wetlands
Monitioring Project

FRENCHMAN'S BAY MARSHES

Conservation TORONTO AND REGION

WETLAND INFORMATION

Evaluated Boundary (Ontario Ministry of Natural Resources)	
Status:	Provincially Significant Wetland
Size:	69 Hectares
Location:	Town of Ajax, City of Pickering Regional Municipality of Durham
Owner:	Toronto and Region Conservation Authority

Scale: 1:15000

Aerial Photography: 1999
Produced by Toronto and Region Conservation Authority under Licence with the Ontario Ministry of Natural Resources © Queen's Printer for Ontario, March 1, 2001

Durham Region
Waterfront Wetlands
Monitioring Project

DUFFINS CREEK WETLAND

Conservation
TORONTO AND REGION

WETLAND INFORMATION

Evaluated Boundary (Ontario Ministry of Natural Resources)

Status: Provincially Significant Wetland

Size: 141 Hectares

Location: Town of Ajax, Regional Municipality of Durham

Owner: partially by Toronto and Region Conservation Authority

Scale: 1:15000

Aerial Photography: 1999
Produced by Toronto and Region Conservation Authority under Licence with the Ontario Ministry of Natural Resources © Queen's Printer for Ontario, March 1, 2001

Durham Region
Waterfront Wetlands
Monitioring Project

CARRUTHERS CREEK WETLAND COMPLEX

Central Lake Ontario Conservation

WETLAND INFORMATION

EVALUATED BOUNDARY
(ONTARIO MINISTRY OF NATURAL RESOURCES)
1983 - UPDATED 2001

STATUS: PROVINCIALLY SIGNIFICANT WETLAND

SIZE: 47.2 HECTARES

LOCATION: TOWN OF WHITBY,
THE REGIONAL MUNICIPALITY
OF DURHAM

OWNER: CENTRAL LAKE ONTARIO
CONSERVATION AUTHORITY

SCALE: 1:10,500

AERIAL PHOTOGRAPHY: 1995
PRODUCED BY CENTRAL LAKE ONTARIO CONSERVATION AUTHORITY UNDER LICENCE WITH THE ONTARIO MINISTRY OF NATURAL RESOURCES QUEEN'S PRINTER FOR ONTARIO, MARCH, 2001

Durham Region
Waterfront Wetlands Monitoring
Project

CRANBERRY MARSH

Central Lake Ontario Conservation

WETLAND INFORMATION

EVALUATED BOUNDARY
(ONTARIO MINISTRY OF NATURAL RESOURCES)
1983 - UPDATED 2001

STATUS: PROVINCIALLY SIGNIFICANT WETLAND

SIZE: 129.77 HECTARES

LOCATION: TOWN OF WHITBY,
THE REGIONAL MUNICIPALITY
OF DURHAM

OWNER: CENTRAL LAKE ONTARIO
CONSERVATION AUTHORITY

SCALE: 1:10,500

AERIAL PHOTOGRAPHY 1995
PRODUCED BY CENTRAL LAKE ONTARIO CONSERVATION AUTHORITY UNDER LICENCE WITH THE ONTARIO MINISTRY OF NATURAL RESOURCES QUEEN'S PRINTER FOR ONTARIO, MARCH, 2001

Durham Region
Waterfront Wetlands Monitoring
Project

LYNDE CREEK MARSH

Central Lake Ontario Conservation

WETLAND INFORMATION

	EVALUATED BOUNDARY (ONTARIO MINISTRY OF NATURAL RESOURCES) 1987
STATUS:	PROVINCIALLY SIGNIFICANT WETLAND
SIZE:	21.23 HECTARES
LOCATION:	TOWN OF WHITBY, THE REGIONAL MUNICIPALITY OF DURHAM
OWNER:	THE REGIONAL MUNICIPALITY OF DURHAM; TOWN OF WHITBY; THICKSON WOODS HERITAGE FOUNDATION

SCALE: 1:10,500

AERIAL PHOTOGRAPHY: 1998
PRODUCED BY CENTRAL LAKE ONTARIO CONSERVATION AUTHORITY UNDER LICENCE WITH THE ONTARIO MINISTRY OF NATURAL RESOURCES QUEEN'S PRINTER FOR ONTARIO, MARCH, 2001

Durham Region Waterfront Wetlands Monitoring Project

CORBETT CREEK MOUTH MARSH

Central Lake Ontario Conservation

WETLAND INFORMATION

EVALUATED BOUNDARY (ONTARIO MINISTRY OF NATURAL RESOURCES) 1983

STATUS: PROVINCIALLY SIGNIFICANT WETLAND

SIZE: 7.24 HECTARES

LOCATION: CITY OF OSHAWA
THE REGIONAL MUNICIPALITY OF DURHAM

OWNER: CITY OF OSHAWA

SCALE: 1:8,500

AERIAL PHOTOGRAPHY: 1995

PRODUCED BY CENTRAL LAKE ONTARIO CONSERVATION AUTHORITY UNDER LICENCE WITH THE ONTARIO MINISTRY OF NATURAL RESOURCES QUEEN'S PRINTER FOR ONTARIO, MARCH, 2001

Durham Region
Waterfront Wetlands Monitoring Project

PUMPHOUSE MARSH

Central Lake Ontario Conservation

WETLAND INFORMATION

EVALUATED BOUNDARY
(ONTARIO MINISTRY OF NATURAL RESOURCES)
1983

STATUS: PROVINCIALLY SIGNIFICANT WETLAND

SIZE: 132.47 HECTARES

LOCATION: CITY OF OSHAWA
THE REGIONAL MUNICIPALITY
OF DURHAM

OWNER: CITY OF OSHAWA

SCALE: 1:12,000

AERIAL PHOTOGRAPHY: 1995

PRODUCED BY CENTRAL LAKE ONTARIO CONSERVATION AUTHORITY UNDER LICENCE WITH THE ONTARIO MINISTRY OF NATURAL RESOURCES. QUEEN'S PRINTER, MARCH, 2001

Durham Region Waterfront Wetlands Monitoring Project

OSHAWA SECOND MARSH

Central Lake Ontario Conservation

WETLAND INFORMATION

WETLAND BOUNDARY (APPROXIMATE)

STATUS: PROVINCIALLY SIGNIFICANT WETLAND

SIZE: 41.67 HECTARES

LOCATION: MUNICIPALITY OF CLARINGTON
THE REGIONAL MUNICIPALITY OF DURHAM
GENERAL MOTORS OF CANADA LTD.
CITY OF OSHAWA;
ONTARIO MINISTRY OF NATURAL RESOURCES

SCALE: 1:12,000

AERIAL PHOTOGRAPHY: 1995
PRODUCED BY CENTRAL LAKE ONTARIO CONSERVATION AUTHORITY UNDER LICENCE WITH THE ONTARIO MINISTRY OF NATURAL RESOURCES. QUEEN'S PRINTER FOR ONTARIO, MARCH, 2002

Durham Region Waterfront Wetlands Monitoring Project

McLAUGHLIN BAY MARSH

Central
Lake Ontario
Conservation

WETLAND INFORMATION

Evaluated Boundary
(Ontario Ministry of Natural Resources)
1984

Status: Locally Significant Wetland

Size: 5.25 hectares

Location: Municipality of Clarington
The Regional Municipality
of Durham

Owner: Blue Circle Cement

Scale: 1:9,500

Aerial Photography: 1998

Produced by Central Lake Ontario Conservation Authority under licence with the Ontario Ministry of Natural Resources Queen's Printer for Ontario, March, 2001

Durham Region
Waterfront Wetlands Monitoring
Project

Raby Head Wetland

Central Lake Ontario Conservation

WETLAND INFORMATION

EVALUATED BOUNDARY
(ONTARIO MINISTRY OF NATURAL RESOURCES) 1983

STATUS: PROVINCIALLY SIGNIFICANT WETLAND

SIZE: 45.06 HECTARES

LOCATION: MUNICIPALITY OF CLARINGTON
THE REGIONAL MUNICIPALITY OF DURHAM

OWNER: BLUE CIRCLE CEMENT
CENTRAL LAKE ONTARIO CONSERVATION AUTHORITY

SCALE: 1:8,500

AERIAL PHOTOGRAPHY: 1995
PRODUCED BY CENTRAL LAKE ONTARIO CONSERVATION AUTHORITY UNDER LICENCE WITH THE ONTARIO MINISTRY OF NATURAL RESOURCES QUEEN'S PRINTER FOR ONTARIO, MARCH 2001

Durham Region
Waterfront Wetlands Monitoring Project

WESTSIDE BEACH MARSH

Central Lake Ontario Conservation

WETLAND INFORMATION

Evaluated Boundary (Ontario Ministry of Natural Resources) 1984

Status:	Locally Significant Wetland
Size:	29.40 hectares
Location:	Municipality of Clarington The Regional Municipality of Durham
Owner:	Central Lake Ontario Conservation Authority Municipality of Clarington Port Darlington Harbour Company Ontario Hydro

Scale: 1:7,200

Aerial Photography: 1995

Produced by Central Lake Ontario Conservation Authority Under Licence With The Ontario Ministry of Natural Resources Queen's Printer For Ontario, March, 2001

Durham Region Waterfront Wetlands Monitoring Project

PORT DARLINGTON

GANARASKA REGION CONSERVATION AUTHORITY
P.O. BOX 328, Port Hope, Ontario L1A 3W4
(905) 885-8173, fax (905) 885-9824

WETLAND INFORMATION

Wetland Boundary (Approximate Boundary)

Status:	Provincially Significant Wetland
Size:	25.84 hectares
Location:	Village of Newcastle The Regional Municipality of Durham
Owner:	Municipality of Clarington

Scale: 1:7,800

Aerial Photography: 1995
Produced by Central Lake Ontario Conservation Authority under licence with The Ontario Ministry of Natural Resources Queen's Printer for Ontario, March, 2001

Durham Region Waterfront Wetlands Monitoring Project

WILMOT RIVERMOUTH WETLAND

GANARASKA REGION CONSERVATION AUTHORITY
P.O. BOX 328, Port Hope, Ontario L1A 3W4
(905) 885-8173, fax (905) 885-9824

WETLAND INFORMATION

Wetland Boundary (Approximate Boundary)

Status:	Locally Significant Wetland
Size:	8.18 hectares
Location:	Village of Newcastle, The Regional Municipality of Durham
Owner:	Private Ownership

Scale: 1:10,500

Aerial Photography: 1995
Produced by Central Lake Ontario Conservation Authority Under Licence With The Ontario Ministry of Natural Resources Queen's Printer For Ontario, March, 2001

Durham Region
Waterfront Wetlands Monitoring Project

PORT NEWCASTLE WETLAND COMPLEX

APPENDIX B - EQUIPMENT LIST

Equipment List

The following list does not include personal provisions (e.g. insect repellent, sun hat, water, etc.). However, these items are important and they may be required to fulfill safety requirements. A cell phone and first aid kit are standard equipment for all field work. In addition, cameras and binoculars could be useful during all field work.

Also note that "boat" means a boat (or canoe) and all supporting operational and safety equipment.

Objective/Indicator	Item/Capability
BIOLOGICAL CONDITION	
2.1 Plant Community Condition	
2.1.1 Wetland and Adjacent Upland Ecological Land Classification	
a. Field Work	Current ELC field guide
	Soil auger or Oakfield Tube
	Wedge prism
	Compass
	Measuring Tape for soil core
	Data Sheets and clipboard
	Pens, pencils
	Identification guides (herbs, trees/shrubs, soil, wildlife)
	Sealable plastic bags for unidentified plant specimens and/or plant press
	Current 1:10 000 air photos or printed orthophotos at 1:3000 scale
	Ontario Base Maps*
	GPS unit
	Munsell charts*
	Diameter at breast height (DBH) tape measure*
	Binoculars*
	100-mL bottle of HCl (10%)*
	Clinometer*
	Chestwaders/canoe/boat*
b. Office Work	Current 1:10 000 air photos or digital orthophotos
	Stereoscope
	ArcGIS (or other GIS software) and Access capabilities
	Soil mapping*
	MNR wetland evaluation*
	Ontario Base Maps*
	Digital Elevation Model*
	Other studies containing ELC data* (e.g. Environmental Impact Studies)

* optional equipment ** or equivalent

Objective/Indicator	Item/Capability
2.1.2 Submerged Plant Community	Boat or canoe with **anchor**
	1 x 1 metre floating quadrat frame
	Fan rake
	Metre stick and weighted string to measure deeper water
	Data sheets and clipboard
	Pens and pencils
	Aquatic plant ID capabilities
	Wetland plant ID guides, e.g.: ➢ Wetland Plants of Ontario – Newmaster et al. 1997 ➢ Aquatic and Wetland Plants of Northeastern North America (Vol. 1 & 2) – Crow and Hellquist 2000
	GPS unit
	GPS holder*
	Turbidimeter
	Meter for measuring conductivity, pH and water temperature (if collecting additional water quality data)*
	Field map of wetland with labeled random points overlaid on orthophoto
	Large "Zip-loc" bags for specimens**
2.2 Fish and Wildlife Community Condition	
2.2.1 Fish Community **NOTE**: Equipment used and electrofishing operation must be conducted according to *Electrofishing Guidelines and Procedures (OMNR Policy No. FI.3.01.01), 1986* (or most current policy) administered by the Ontario Ministry of Natural Resources (OMNR)	Electrofishing Boat: 16-foot, flat bottom aluminum boat with safety railing, single-axle boat trailer
	Processing Boat: 14-foot, flat bottom aluminum boat
	Canoe*
	Non-conductive paddles, i.e. wood
	Boats propelled by 12-volt, battery operated electric motor (36 and 50 lbs thrust). Electric motors are also available in 24-volt and 36-volt models that may be more suitable.
	Batteries used for electric motors are deep cycle and completely sealed (therefore, no acid spills, no off-gassing, and are maintenance free)
	Smith-Root, 2.5 GPP Electrofisher powered by gas operated generator (other electrofisher models that satisfy the requirements of OMNR Policy No. FI.3.01.01 (or most current policy) can be used)
	Smith-Root, single boat boom
	Ohmmeter to measure resistance to ensure electrofishing boat is electrically bonded
	Fire extinguisher for electrofishing boat
	Non-conductive electrofishing net
	Waterproof insulated electrofishing gloves of at least 43 cm in length
	Knee-high rubber boots for electrofishing boat crew
	Polarized sun glasses for netter

* optional equipment ** or equivalent

Objective/Indicator	Item/Capability
Fish Community (cont'd)	Floating rope with anchor tied to one end; used to delineate sample points along each transect (44 m in length; knotted at 8-m intervals)
	Plastic bins/buckets for sorting
	Data sheets (waterproof paper)
	Clipboard(s)
	Pens and pencils
	Fish measuring board
	Fish and submerged aquatic vegetation identification material
	Items required for obtaining a voucher specimen (e.g. preservative or photo)*
	Cell Phone(s)
	First Aid Kit
	Field Binder with: ➢ Map of local hospital locations and contact information ➢ Staff Phone List ➢ Material Safety Data Sheets ➢ OMNR daily check list ➢ Applicable field notes ➢ Applicable protocol if feasible ➢ Equipment manuals
	Personal Flotation Device (PFD) for each crew member
	Safety kit in each boat includes: ➢ Sound signaling device - whistle ➢ Flashlight ➢ Bailing bucket ➢ Throw line
	Metre stick and weighted string to measure deeper water
	600 g ±0.1 g portable scale**
	6000 g ±1 g portable scale**
	50 kg ±20 g) portable scale**
	YSI multimeter (DO and Temp)**
	Thermometer (for air temp.)
	Turbidimeter (measures in NTUs)**
	Conductivity meter**
	GPS unit
	Digital camera (waterproof or resistant)
2.2.2 Breeding Bird Community	Canoe or boat or chestwaders/boots*
	10' Aluminum electrical conduit for staking survey stations (when first setting up route only)
	MMP training and instruction package
	Laminated field map showing MMP stations*
	Clipboard/data sheets/pencils

* optional equipment ** or equivalent

Objective/Indicator		Item/Capability
	Breeding Bird Community (cont'd)	Binoculars
		GPS unit with MMP station locations preloaded
		Portable CD player with external speakers
		Playback CD
		Cell phone
		Flashlight/headlamp*
		Bird identification guide
2.2.3	Amphibian Community	Canoe or boat or chestwaders/boots*
		10' Aluminum electrical conduit for staking count stations (when first setting up route only) with highly reflective tape at top
		MMP training and instruction package
		Laminated field map with MMP stations*
		Clipboard/data sheets/pencils
		GPS unit with MMP station locations preloaded
		Cell phone
		Flashlight/headlamp
2.2.4	Macroinvertebrate Community (see 3.1.1 Water Quality - Annual Sampling for additional equipment)	Canoe or boat (or chestwaders*)
		Hand counters
		GPS unit with station UTMs preloaded
		Data sheets/Clipboard/Pens & pencils
		Forceps (flexible)
		Plastic bins (6 uniquely numbered)
		70% ethanol
		Numbered glass vials ~ 40 mL (2/3 full of 70% ethanol)
		Paper labels for inside vials
		D-frame nets with 500-µm mesh
GEOPHYSICAL CONDITION		
3.1	**Wetland**	
3.1.1	Water Quality - Monthly	Boat/Canoe (or chestwaders*)
		Turbidimeter (in NTU)**
		Multimeter for conductivity, pH, water temperature
		Tape measure/metre stick/weighted string for deeper water
		Thermometer (for air temperature)
		Data sheets/Clipboard/Pencils
		GPS unit
	Water Quality - Annual	Hydrolab or other multimeter with appropriate sensors and hand-held unit**
		Turbidimeter**
		GPS unit with station locations preloaded
		18 (or more) clean, deionized water-rinsed, plastic centrifuge tubes
		H_2SO_4-washed125-mL flint-glass bottles (3 per wetland to be surveyed)

* optional equipment ** or equivalent

Objective/Indicator	Item/Capability
Water Quality – Annual (cont'd)	Chlorophyll *a* sampling equipment, if necessary: ➢ 500-mL or 1-Litre polypropylene bottle ➢ Reusable filter holder ➢ Hand pump ➢ Filter slide (1 per sample station) ➢ Filter paper (1 per sample station) ➢ Forceps/tweezers ➢ 50-mm plastic filter slides (1 per sample station) ➢ Tape*
	Data sheets (waterproof paper)/Clipboard/Pencils
	Metre stick**
	Alkalinity test strips
	Hach DR/890 colorimeter**
	Hach reagents required for analysis of ammonium and nitrate**
	Self-adhesive, durable, waterproof labels
	Permanent markers
	Cooler and ice packs
3.1.2 Water Levels	Water level data logger and holder
	Barometric pressure logger (at least one along Durham shoreline)
	Metre stick or tape measure
	Notebook/pencils
	Laptop (for downloading from loggers)*
	GPS unit with sub-metre accuracy
	Chestwaders or boat/canoe
	Laser level**/tripod/grade rod
	Cell phone (to call gauging stations)
3.1.3 Sediment Quality	Boat/Canoe and/or Chestwaders
	Ponar/Petite Ponar sampler or Ekman dredge
	2 Large glass bowls (3-L capacity)
	Large rectangular glass baking dish (e.g. 26 x 37 cm, 4-L capacity)
	Stainless steel spoon (serving spoon)
	Stainless steel 2-mm sieve
	Masking tape
	Data sheets/Clipboard/Pencils
	Permanent marker
	Polyethylene sample jars (125 mL)**
	Glass sample jars (250 mL) with Teflon-lined screw cap**
	Cooler with ice packs
	GPS unit
3.1.4 Wetland Bathymetry	Dependent on Methodology

* optional equipment ** or equivalent

Objective/Indicator		Item/Capability
3.2	**Watershed**	
3.2.1	Watershed Natural and Cultural Land Cover	Recent air photos, can be either hard copy stereo pairs or orthophotos (stereo pairs require a scale of 1:10 000 or better)
		Stereoscope (for use with stereo pairs)*
		Digital elevation model (DEM)*
		Soils mapping*
		GIS station equipped with ArcGIS
		Aerial photography interpretation skills
3.2.2	Land Cover Change in Adjacent Uplands	Recent air photos, can be either hard copy stereo pairs or orthophotos (stereo pairs require a scale of 1:10 000 or better)
		Stereoscope (for use with stereo pairs)*
		Digital elevation model (DEM)*
		Soils mapping*
		GIS station equipped with ArcGIS
		Aerial photography interpretation skills
3.2.3	Public Ownership of Watershed Lands	Access to Teranet (or Tax Roll Data – not recommended)
		GIS station equipped with ArcGIS
3.2.4	Sediment/Nutrient Loading	Dependent on Methodology

* optional equipment ** or equivalent

APPENDIX C - DATA SHEETS WITH EXAMPLES

Durham Region Coastal Wetland Monitoring Project – Submerged Aquatic Vegetation

Wetland: _____ Date: _____ Surveyors: _____

Start Time: _____ End Time: _____ Wind: _____(0-12) Cloud Cover: _____/10^{ths} Air Temp.: _____°C

Quadrat #											
Water Depth (cm)											
Sediment Type – Clay (Cl), Silt (Si), Fine sand (FS), Coarse sand (CS), Gravel (G), Cobble (Co), Organic (O)											
Turbidity (NTU)											
Total Areal Coverage (%)*											
Common Name	**Latin Name**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**
Coontail	*Ceratophyllum demersum*										
Chara	*Chara* sp.										
Canada waterweed	*Elodea canadensis*										
Slender waterweed	*Elodea nuttallii*										
Water stargrass	*Heteranthera dubia*										
European frogbit	*Hydrocharis morsus-ranae*										
Lesser duckweed	*Lemna minor*										
Star duckweed	*Lemna trisulca*										
Northern water milfoil	*Myriophyllum sibiricum*										
Eurasian water milfoil	*Myriophyllum spicatum*										
Slender naiad	*Najas flexilis*										
Yellow pond lily	*Nuphar variegata*										
White water-lily	*Nymphaea odorata*										
Water smartweed	*Polygonum amphibium*										
Curly pondweed	*Potamogeton crispus*										
Leafy pondweed	*Potamogeton foliosus*										
Slender pondweed	*Potamogeton pusillus*										
Richardson's pondweed	*Potamogeton richardsonii*										
Flat-stemmed pondweed	*Potamogeton zosteriformis*										
Greater duckweed	*Spirodela polyrhiza*										
Sago pondweed	*Stuckenia pectinata*										
Common bladderwort	*Utricularia vulgaris*										
Wild celery	*Vallisneria americana*										
Wild rice	*Zizania palustris*										
Algae:**											
Filamentous algae (surface)											
Fila. algae (underwater)											

NOTES:

* Total areal coverage ≤ 100%, but sum of individual species covers can be > 100%

** Do not include algae in total areal coverage estimate (except *Chara* spp.)

UTM Coordinates (NAD83) Zone 17										
Northing	N	N	N	N	N	N	N	N	N	N
Easting	E	E	E	E	E	E	E	E	E	E

Durham Region Coastal Wetland Monitoring Project – Submerged Aquatic Vegetation

Wetland: Bowmanville Marsh Date: Aug. 10/06 Surveyors: S. Pernanen, J. Scott

Start Time: 1000 End Time: 1215 Wind: 2 (0-12) Cloud Cover: 3 /10ths Air Temp.: 26 °C

Quadrat #		7	18	2	5	20	13	9	1	15	4
Water Depth (cm)		67	52	41	38	55	47	53	45	69	35
Sediment Type – Clay (Cl), Silt (Si), Fine sand (FS), Coarse sand (CS), Gravel (G), Cobble (Co), Organic (O)		G	Si	CS	Si	O	O	O Si	Si	Si	Si
Turbidity (NTU)		35.7	32.1	27.8	18.3	15.2	11.3	17.4	12.8	21.2	9.9
Total Areal Coverage (%)*		1	45	10	30	41	1	70	65	0	0
Common Name	**Latin Name**	%	%	%	%	%	%	%	%	%	%
Coontail	*Ceratophyllum demersum*							5	1		
Chara	*Chara* sp.										
Canada waterweed	*Elodea canadensis*										
Slender waterweed	*Elodea nuttallii*										
Water stargrass	*Heteranthera dubia*										
European frogbit	*Hydrocharis morsus-ranae*										
Lesser duckweed	*Lemna minor*	1	1	1	2	21	1	2	1		
Star duckweed	*Lemna trisulca*										
Northern water milfoil	*Myriophyllum sibiricum*										
Eurasian water milfoil	*Myriophyllum spicatum*										
Slender naiad	*Najas flexilis*										
Yellow pond lily	*Nuphar variegata*										
White water-lily	*Nymphaea odorata*		45	10	30			70	65		
Water smartweed	*Polygonum amphibium*										
Curly pondweed	*Potamogeton crispus*										
Leafy pondweed	*Potamogeton foliosus*										
Slender pondweed	*Potamogeton pusillus*										
Richardson's pondweed	*Potamogeton richardsonii*										
Flat-stemmed pondweed	*Potamogeton zosteriformis*										
Greater duckweed	*Spirodela polyrhiza*										
Sago pondweed	*Stuckenia pectinata*										
Common bladderwort	*Utricularia vulgaris*										
Wild celery	*Vallisneria americana*										
Wild rice	*Zizania palustris*										
Floating Arrowhead	*Sagittaria cuneata*				2						
Algae:**											
Filamentous algae (surface)											
Fila. algae (underwater)		10		60			30	30	10	50	75
UTM Coordinates (NAD83) Zone 17											
Northing		N 4862359	N 4862292	N 4862283	N 4862290	N 4862261	N 4862246	N 4862230	N 4862239	N 4862259	N 4862320
Easting		E 687432	E 687451	E 687444	E 687397	E 687365	E 687372	E 687333	E 687276	E 687207	E 687148

NOTES:

- At quadrats 18, 7, 2 it was difficult to see plants due to turbid water.
- 5 Caspian Terns foraging in marsh.
- Turbidity measured with Hach 2100P.

* Total areal coverage ≤ 100%, but sum of individual species covers can be > 100%

** Do not include algae in total areal coverage estimate (except *Chara* spp.)

SAMPLE

DRCWMP Fish Collection Field Data Sheet

Wetland _____ Transect _____ Date (dd/mm/yy) ___/___/_____ Time Start _____

Field Crew _____ Time Finish _____

Barrier Beach: ☐ Open ☐ Closed ☐ N/A *Habitat Type:* ☐ Inlet ☐ Outlet ☐ Shoreline ☐ Beach ☐ Open Water

Air Temp. _____ °C Wind Direction _____ Wind Strength* _____ Cloud Cover _____/10ths

Water Temp. _____ °C Conductivity _____ µS/cm pH _____ Turbidity _____ NTU

Dissolved O_2 _____ mg/L Water Depth _____ cm Other Data _____

Voltage _____ Volts Current _____ Amps Frequency _____ Hz Shocking Time _____ Sec

UTM Coordinates (NAD83): Start of Transect Zone _____ _____ E _____ N

End of Transect Zone _____ _____ E _____ N

#	Species	Fish** Code	Fork Length (mm)	Weight (g)	Condition (dead, lesion, voucher, etc.)	#	Species	Fish Code	Fork Length (mm)	Weight (g)	Condition (dead, lesion, voucher, etc.)
1						21					
2						22					
3						23					
4						24					
5						25					
6						26					
7						27					
8						28					
9						29					
10						30					
11						31					
12						32					
13						33					
14						34					
15						35					
16						36					
17						37					
18						38					
19						39					
20						40					

** Use Beaufort Scale ** on back*

Batches (only batch additional fish after 10 individuals of each species have been measured and recorded above)

	Species	Fish Code	Quantity	Weight (g)		Species	Fish Code	Quantity	Weight (g)
1					3				
2					4				

Aquatic Plant Cover (primarily submerged and floating aquatic plants, two metres either side of transect)

Total Plant Cover: _____% Emergent: _____% Submerged: _____% Floating: _____%

Type	Species	% Cover	Height (cm)
Dominant			
Subdominant			
Other			
Other			

Dominant Substrate: ☐ Clay ☐ Silt ☐ Fine Sand ☐ Coarse Sand ☐ Gravel ☐ Cobble ☐ Organic

Notes

Lamprey Family - 010 — **Petromyzontidae**

011 American brook lamprey ..... *Lampetra appendix*
016 chestnut lamprey ..... *Ichthyomyzon castaneus*
012 northern brook lamprey ..... *Ichthyomyzon fossor*
013 silver lamprey ..... *Ichthyomyzon unicuspis*
014 sea lamprey ..... *Petromyzon marinus*
015 ..... *Ichthyomyzon* sp.

Paddlefish Family - 020 — **Polyodontidae**

021 paddlefish ..... *Polyodon spathula*

Sturgeon Family - 030 — **Acipenseridae**

031 lake sturgeon ..... *Acipenser fulvescens*

Gar Family - 040 — **Lepisosteidae**

041 longnose gar ..... *Lepisosteus osseus*
042 spotted gar ..... *Lepisosteus oculatus*
Florida gar ..... *Lepisosteus platyrhinchus*
043 ..... *Lepisosteus* sp.

Bowfin Family - 050 — **Amiidae**

051 bowfin ..... *Amia calva*

Herring Family - 060 — **Clupeidae**

061 alewife ..... *Alosa pseudoharengus*
062 American Shad ..... *Alosa sapidissima*
063 gizzard shad ..... *Dorosoma cepedianum*
064 ..... *Alosa* sp.

Salmon/Trout Subfamily - 070 — **Salmonidae, Salmoninae**

071 pink salmon ..... *Oncorhynchus gorbuscha*
072 chum salmon ..... *Oncorhynchus keta*
073 coho salmon ..... *Oncorhynchus kisutch*
074 sockeye salmon ..... *Oncorhynchus nerka*
075 Chinook salmon ..... *Oncorhynchus tshawytscha*
076 rainbow trout ..... *Oncorhynchus mykiss*
077 Atlantic salmon ..... *Salmo salar*
078 brown trout ..... *Salmo trutta*
079 Arctic char ..... *Salvelinus alpinus*
080 brook trout ..... *Salvelinus fontinalis*
081 lake trout ..... *Salvelinus namaycush*
082 splake ..... *Salvelinus fontinalis x S. namaycush*
083 Aurora trout ..... *Salvelinus fontinalis timagamiensis*
084 ..... *Oncorhynchus* sp.
085 ..... *Salmo* sp.
086 ..... *Salvelinus* sp.
400 Salmonidae hybrids
420 Salmoninae hybrids

Whitefish Subfamily - 090 — **Salmonidae, Coregoninae**

091 lake whitefish ..... *Coregonus clupeaformis*
092 longjaw cisco ..... *Coregonus alpenae*
093 cisco (lake herring) ..... *Coregonus artedi*
094 bloater ..... *Coregonus hoyi*
095 deepwater cisco (chub) ..... *Coregonus johannae*
096 kiyi ..... *Coregonus kiyi*
097 blackfin cisco ..... *Coregonus nigripinnis*
098 Nipigon cisco ..... *Coregonus nipigon*
099 shortnose cisco ..... *Coregonus reighardi*
100 shortjaw cisco ..... *Coregonus zenithicus*
101 pygmy whitefish ..... *Prosopium coulterii*
102 round whitefish ..... *Prosopium cylindraceum*
103 chub ..... *Coregonus sp.*
106 ..... *Coregonus* sp.
107 ..... *Prosopium* sp.
450 hybrids

Grayling Subfamily - 110 — **Salmonidae, Thymallinae**

111 Arctic grayling ..... *Thymallus arcticus*

Smelt Family - 120 — **Osmeridae**

121 rainbow smelt ..... *Osmerus mordax*

Pike Family - 130 — **Esocidae**

131 northern pike ..... *Esox lucius*
132 muskellunge ..... *Esox masquinongy*
133 grass pickerel ..... *Esox americanus vermiculatus*
135 chain pickerel ..... *Esox niger*
134 ..... *Esox* sp.
500 hybrids
501 *Esox lucius x E. americanus vermiculatus*
502 *Esox lucius x E. masquinongy*

Mudminnow Family - 140 — **Umbridae**

141 central mudminnow ..... *Umbra limi*

Mooneye Family - 150 — **Hiodontidae**

151 goldeye ..... *Hiodon alosoides*
152 mooneye ..... *Hiodon tergisus*

Sucker Family - 160 — **Catostomidae**

161 quillback ..... *Carpiodes cyprinus*
162 longnose sucker ..... *Catostomus catostomus*
163 white sucker ..... *Catostomus commersonii*
164 lake chubsucker ..... *Erimyzon sucetta*
165 northern hog sucker ..... *Hypentelium nigricans*
166 bigmouth buffalo ..... *Ictiobus cyprinellus*
167 spotted sucker ..... *Minytrema melanops*
168 silver redhorse ..... *Moxostoma anisurum*
169 black redhorse ..... *Moxostoma duquesnei*
170 golden redhorse ..... *Moxostoma erythrurum*
171 shorthead redhorse ..... *Moxostoma macrolepidotum*
172 greater redhorse ..... *Moxostoma valenciennesi*
173 river redhorse ..... *Moxostoma carinatum*
174 black buffalo ..... *Ictiobus niger*
176 ..... *Catostomus* sp.
177 ..... *Moxostoma* sp.
178 ..... *Ictiobus* sp.
550 hybrids
551 *Ictiobus* hybrids

Minnow Family - 180 — **Cyprinidae**

181 goldfish ..... *Carassius auratus*
182 northern redbelly dace ..... *Phoxinus eos*
183 finescale dace ..... *Phoxinus neogaeus*
184 redside dace ..... *Clinostomus elongatus*
185 lake chub ..... *Couesius plumbeus*
186 common carp ..... *Cyprinus carpio*
187 gravel chub ..... *Erimystax x-punctatus*
188 cutlip minnow ..... *Exoglossum maxillingua*
189 brassy minnow ..... *Hybognathus hankinsoni*
190 eastern silvery minnow ..... *Hybognathus regius*
191 silver chub ..... *Macrhybopsis storeriana*
192 hornyhead chub ..... *Nocomis biguttatus*
193 river chub ..... *Nocomis micropogon*
194 golden shiner ..... *Notemigonus crysoleucas*
195 pugnose shiner ..... *Notropis anogenus*
196 emerald shiner ..... *Notropis atherinoides*
197 bridle shiner ..... *Notropis bifrenatus*
198 common shiner ..... *Luxilus cornutus*
199 blackchin shiner ..... *Notropis heterodon*
200 blacknose shiner ..... *Notropis heterolepis*
201 spottail shiner ..... *Notropis hudsonius*
202 rosyface shiner ..... *Notropis rubellus*
203 spotfin shiner ..... *Cyprinella spiloptera*
204 sand shiner ..... *Notropis stramineus*
205 redfin shiner ..... *Lythrurus umbratilis*
206 mimic shiner ..... *Notropis volucellus*
207 pugnose minnow ..... *Opsopoeodus emiliae*
208 bluntnose minnow ..... *Pimephales notatus*
209 fathead minnow ..... *Pimephales promelas*
210 western blacknose dace ..... *Rhinichthys obtusus*
211 longnose dace ..... *Rhinichthys cataractae*
212 creek chub ..... *Semotilus atromaculatus*
213 fallfish ..... *Semotilus corporalis*
214 pearl dace ..... *Margariscus margarita*
215 silver shiner ..... *Notropis photogenis*
216 central stoneroller ..... *Campostoma anomalum*
217 striped shiner ..... *Luxilus chrysocephalus*
218 ghost shiner ..... *Notropis buchanani*
219 grass carp ..... *Ctenopharyngodon idella*
220 rudd ..... *Scardinius erythrophthalmus*
221 ..... *Phoxinus* sp.
222 ..... *Hybognathus* sp.
223 ..... *Nocomis* sp.
224 ..... *Notropis* sp.
225 ..... *Pimephales* sp.
226 ..... *Rhinichthys* sp.
227 ..... *Semotilus* sp.
228 ..... *Hybopsis* sp.
600 hybrids
601 *Carassius auratus x Cyprinus carpio*
602 *Phoxinus* hybrids
603 *Phoxinus eos x P. neogaeus*
604 *Phoxinus eos x Margariscus margarita*
605 *Phoxinus neogaeus x Margariscus margarita*
610 *Notropis* hybrids
611 *Luxilis cornutus x L. rubellus*
612 *Luxilis cornutus x Semotilus atromaculatus*
620 *Pimephales promelas x P. notatus*

Catfish Family - 230 — **Ictaluridae**

231 black bullhead ..... *Ameiurus melas*
232 yellow bullhead ..... *Ameiurus natalis*
233 brown bullhead ..... *Ameiurus nebulosus*
234 channel catfish ..... *Ictalurus punctatus*
235 stonecat ..... *Noturus flavus*
236 tadpole madtom ..... *Noturus gyrinus*
237 brindled madtom ..... *Noturus miurus*
238 margined madtom ..... *Noturus insignis*
244 northern madtom ..... *Noturus stigmosus*
239 flathead catfish ..... *Pylodictis olivaris*
241 ..... *Ictalurus* sp.
242 ..... *Noturus* sp.
243 ..... *Ameiurus sp.*
650 hybrids
651 *Ameiurus melas x A. nebulosus*

Eel Family - 250 — **Anguillidae**

251 American eel ..... *Anguilla rostrata*

Killifish Family - 260 — **Cyprinodontidae**

261 banded killifish ..... *Fundulus diaphanus*
262 blackstripe topminnow ..... *Fundulus notatus*

Cod Family - 270 — **Gadidae**

271 burbot ..... *Lota lota*

Stickleback Family - 280 — **Gasterosteidae**

281 brook stickleback ..... *Culaea inconstans*
282 threespine stickleback ..... *Gasterosteus aculeatus*
283 ninespine stickleback ..... *Pungitius pungitius*

Trout-perch Family - 290 — **Moronidae**

291 trout-perch ..... *Percopsis omiscomaycus*

Temperate Bass Family - 300 — **Percichthyidae**

301 white perch ..... *Morone americana*
302 white bass ..... *Morone chrysops*
303 ..... *Morone* sp.

Sunfish Family - 310 — **Centrarchidae**

311 rock bass ..... *Ambloplites rupestris*
312 green sunfish ..... *Lepomis cyanellus*
313 pumpkinseed ..... *Lepomis gibbosus*
323 warmouth ..... *Lepomis gulosus*
324 orangespotted sunfish ..... *Lepomis humilis*
314 bluegill ..... *Lepomis macrochirus*
315 longear sunfish ..... *Lepomis megalotis*
316 smallmouth bass ..... *Micropterus dolomieu*
317 largemouth bass ..... *Micropterus salmoides*
318 white crappie ..... *Pomoxis annularis*
319 black crappie ..... *Pomoxis nigromaculatus*
320 ..... *Lepomis* sp.
321 ..... *Micropterus* sp.
322 ..... *Pomoxis* sp.
700 hybrids
701 *Lepomis* hybrids
702 *Lepomis gibbosus x L. macrochirus*
703 *Lepomis cyanellus x L. gibbosus*
704 *Lepomis cyanellus x L. megalotis*
705 *Lepomis cyanellus x L. macrochirus*
706 *Pomoxis annularis x P. nigromacula*

Perch Family - 330 — **Percidae**

331 yellow perch ..... *Perca flavescens*
332 sauger ..... *Sander canadensis*
333 blue pike (blue pickerel) ..... *Sander vitreus glaucus*
334 walleye (yellow pickerel) ..... *Sander vitreus*
335 eastern sand darter ..... *Ammocrypta pellucida*
336 greenside darter ..... *Etheostoma blennioides*
337 rainbow darter ..... *Etheostoma caeruleum*
338 Iowa darter ..... *Etheostoma exile*
339 fantail darter ..... *Etheostoma flabellare*
340 least darter ..... *Etheostoma microperca*
341 johnny darter ..... *Etheostoma nigrum*
342 logperch ..... *Percina caprodes*
343 channel darter ..... *Percina copelandi*
344 blackside darter ..... *Percina maculata*
345 river darter ..... *Percina shumardi*
346 tessellated darter ..... *Etheostoma olmstedi*
350 ruffe ..... *Gymnocephalus cernuus*
347 ..... *Stizostedion* sp.
348 ..... *Etheostoma* sp.
349 ..... *Percina* sp.
750 hybrids
751 *Sander canadensis x S. vitreus*

Silverside Family - 360 — **Atherinidae**

361 brook silverside ..... *Labidesthes sicculus*

Goby Family — **Gobiidae**

366 round goby ..... *Neogobius melanostomus*
367 tubenose goby ..... *Proterorhinus marmoratus*

Drum Family - 370 — **Sciaenidae**

371 freshwater drum ..... *Aplodinotus grunniens*

Sculpin Family - 380 — **Cottidae**

381 mottled sculpin ..... *Cottus bairdii*
382 slimy sculpin ..... *Cottus cognatus*
383 spoonhead sculpin ..... *Cottus ricei*
384 deepwater sculpin ..... *Myoxocephalus thompsonii*
387 fourhorn sculpin ..... *Myoxocephalus quadricornis*
385 ..... *Cottus* sp.
386 ..... *Myoxocephalus* sp.
800 hybirds
801 *Cottus bairdii x Cottus cognatus*

Lumpfish/Snailfish Family – 390 — **Cyclopteridae**

391 lumpfish ..... *Cyclopterus lumpus*

Flounder Family — **Pleuronectidae**

396 European flounder ..... *Platichthys flesus*

Misc. Categories

1 unknown small fish
997 baitfish
998 roe
999 any species

Updated July 2005 to reflect changes in *Common and Scientific Names of Fishes from the United States, Canada, and Mexico, 6th ed.* (Nelson et al. 2004)

DRCWMP Fish Collection Field Data Sheet

Wetland Corbett Creek Transect 1 Date (dd/mm/yy) 16/08/06 Time Start 1135
Field Crew I. Kelsey, S. Pernanen, G. Grabas, I. Net, U. Wei Time Finish 1140
Barrier Beach: ☒ Open ☐ Closed ☐ N/A *Habitat Type:* ☐ Inlet ☐ Outlet ☒ Shoreline ☐ Beach ☐ Open Water
Air Temp. 26 °C Wind Direction NW Wind Strength* 3 Cloud Cover 7 /10ths
Water Temp. 24.3 °C Conductivity 952 µS/cm pH 7.8 Turbidity 15.3 NTU
Dissolved O_2 8.3 mg/L Water Depth 85 cm Other Data TDS - 0.754 g/L
Voltage 550 Volts Current 4 Amps Frequency 60 Hz Shocking Time 120 Sec
UTM Coordinates (NAD83): Start of Transect Zone 17 669930 E 4857802 N
End of Transect Zone 17 669921 E 4857837 N

#	Species	Fish** Code	Fork Length (mm)	Weight (g)	Condition (dead, lesion, voucher, etc.)	#	Species	Fish Code	Fork Length (mm)	Weight (g)	Condition (dead, lesion, voucher, etc.)
1	common carp	186	44	1.8	voucher	21					
2	fathead minnow	209	41	0.9	dead/voucher	22					
3	↓	↓	38	0.5		23					
4			41	0.9		24					
5			40	0.9		25					
6			34	0.7	lesion	26					
7			31	0.4		27					
8			34	0.4		28					
9			36	0.3		29					
10			29	0.1		30					
11			33	0.5		31					
12	brown bullhead	233	45	1.5		32					
13						33					
14						34					
15						35					
16						36					
17						37					
18						38					
19						39					
20						40					

SAMPLE

* Use Beaufort Scale ** on back

Batches (only batch additional fish after 10 individuals of each species have been measured and recorded above)

	Species	Fish Code	Quantity	Weight (g)		Species	Fish Code	Quantity	Weight (g)
1	fathead minnow	209	8	4.8	3				
2					4				

Aquatic Plant Cover (primarily submerged and floating aquatic plants, two metres either side of transect)
Total Plant Cover: 35 % Emergent: 0 % Submerged: 25 % Floating: 10 %

Type	Species	% Cover	Height (cm)
Dominant	Myriophyllum spicatum OR Eurasian watermilfoil	15	75
Subdominant	Nuphar variegata OR Yellow Pond Lily	5	85
Other	Elodea canadensis OR Canada waterweed	5	60
Other	Nymphaea odorata OR White water-lily	2	85

Dominant Substrate: ☐ Clay ☒ Silt ☐ Fine Sand ☐ Coarse Sand ☐ Gravel ☐ Cobble ☐ Organic

Notes Transect was adjacent to cattail (Typha sp.) shoreline; barrier beach not wide open, i.e. water flowing out only

Durham Region Coastal Wetland Monitoring Project
Fish Sampling – Habitat Conditions Data Sheet

Wetland				Field Crew			
Transect #				Date (dd/mm/yy)		Time	
Air Temp	°C	Wind Direction		Wind Strength		Cloud Cover	/10ths
Water Temp	°C	Conductivity	µS/cm	pH		Turbidity	NTU
Dissolved O_2	mg/L	Water Depth	cm	Other Data			
UTM Coordinates (NAD83)				START: Zone /	E /		N
				END: Zone /	E /		N

Submerged Aquatic Vegetation	Total SAV Cover %	Emergent %
	Submerged %	Floating-leaved %

Species	% Cover	Height (cm)

Dominant Substrate ☐ Clay ☐ Silt ☐ Fine Sand ☐ Coarse Sand ☐ Gravel ☐ Cobble ☐ Organic

Notes

Transect #				Date (dd/mm/yy)		Time	
Air Temp	°C	Wind Direction		Wind Strength		Cloud Cover	/10ths
Water Temp	°C	Conductivity	µS/cm	pH		Turbidity	NTU
Dissolved O_2	mg/L	Water Depth	cm	Other Data			
UTM Coordinates (NAD83)				START: Zone /	E /		N
				END: Zone /	E /		N

Submerged Aquatic Vegetation	Total SAV Cover %	Emergent %
	Submerged %	Floating-leaved %

Species	% Cover	Height (cm)

Dominant Substrate ☐ Clay ☐ Silt ☐ Fine Sand ☐ Coarse Sand ☐ Gravel ☐ Cobble ☐ Organic

Notes

Durham Region Coastal Wetland Monitoring Project

Fish Sampling – Habitat Conditions Data Sheet

Wetland Corbett Creek Marsh			Field Crew S. Pernanen, S. Kranzl		
Transect # 1			Date 16/08/06 (dd/mm/yy)	Time 1142	
Air Temp 26 °C	Wind Direction NW		Wind Strength 3	Cloud Cover 7	/10ths
Water Temp 24.3 °C	Conductivity 952 µs/cm		pH 7.8	Turbidity 15.3	NTU
Dissolved O_2 8.3 mg/L	Water Depth 85 cm		Other Data TDS - 0.754 g/L		
UTM Coordinates (NAD83)			START: Zone 17 / 669930 E/ 4857802 N		
			END: Zone 17 / 669921 E/ 4857837 N		

Submerged Aquatic Vegetation	Total SAV Cover 35 %	Emergent 0 %
	Submerged 25 %	Floating-leaved 10 %
Species	% Cover	Height (cm)
Myriophyllum spicatum	15	75
Nuphar variegata	5	85
Elodea canadensis	5	60
Nymphaea odorata	2	85
Lemna minor	1	—

Dominant Substrate ☐ Clay ☒ Silt ☐ Fine Sand ☐ Coarse Sand ☐ Gravel ☐ Cobble ☐ Organic

Notes
Equipment - Turbidity - Hach 2100P Turbidimeter
- others - YSI 650 MDS with 600 QS sonde

SAMPLE

Transect # 2			Date 16/08/06 (dd/mm/yy)	Time 1156	
Air Temp 26 °C	Wind Direction NW		Wind Strength 3	Cloud Cover 7	/10ths
Water Temp 24.9 °C	Conductivity 1081 µs/cm		pH 7.6	Turbidity 12.3	NTU
Dissolved O_2 7.9 mg/L	Water Depth 67 cm		Other Data TDS 0.761 g/L		
UTM Coordinates (NAD83)			START: Zone 17 / 669975 E/ 4857830 N		
			END: Zone 17 / 669999 E/ 4857795 N		

Submerged Aquatic Vegetation	Total SAV Cover %	Emergent %
	Submerged %	Floating-leaved %
Species	% Cover	Height (cm)
Elodea canadensis	30	20
Nymphaea odorata	20	65
Nuphar variegata	15	65
Hydrocharis morsus-ranae	7	—
Ceratophyllum demersum	5	45

Dominant Substrate ☐ Clay ☐ Silt ☐ Fine Sand ☐ Coarse Sand ☐ Gravel ☐ Cobble ☒ Organic

Notes
Mute swan pair with 3 young

Durham Region Coastal Wetland Monitoring Project
Monthly Water Quality Sampling Data Sheet

Wetland: _____ Date: _____/_____/_____(dd/mm/yy) Start Time: _____ End Time: _____

Field Crew: _____

Air Temp: _____°C Wind Direction: _____ Wind Strength*: _____(0-12) Cloud Cover: _____/10^{ths}

Rainfall during previous 48 hours: ☐ No ☐ Yes _____ Equipment Used: _____

Notes: _____

_____

Barrier Beach: ☐ Open ☐ Closed ☐ N/A

Sample ID	Location (e.g. outlet)	GPS ID	UTM Coordinates (NAD83)			Water Depth (cm)	Turbidity 1 (NTU)	Turbidity 2 (NTU)	Water Temp. (°C)	Conductivity (µS/cm)	pH	Comments (e.g. many carp, lots of waterfowl)
			Zone	Easting	Northing							

* Use Beaufort Scale: **0** = 0-1 km/h smoke rises vertically; **1** = 2-5 km/h smoke drifts slowly; **2** = 6-11km/h leaves rustle; **3** = 12-19 km/h leaves/twigs in constant motion; **4** = 20-29 km/h small branches move; **5** = 30-38 km/h small trees sway; **6** = 39-50 km/h large branches in constant motion

Page ____ of ____

Durham Region Coastal Wetland Monitoring Project

Monthly Water Quality Sampling Data Sheet

Wetland: Corbett Creek Marsh Date: 15 / 06 / 06 (dd/mm/yy) Start Time: 0930 End Time: 1100

Field Crew: S. Pernanen, I. Kelsey

Air Temp: 18.2 °C Wind Direction: W Wind Strength*: 2 (0-12) Cloud Cover: 6 /10ths

Rainfall during previous 48 hours: ☐ No ☒ Yes light showers yesterday. Equipment Used: Turb - Hach 2100P, others - YSI 600 QS sonde

Notes: Barrier beach was wide open (3 m wide)

Barrier Beach: ☒ Open ☐ Closed ☐ N/A

Sample ID	Location (e.g. outlet)	GPS ID	UTM Coordinates (NAD83)			Water Depth (cm)	Turbidity 1 (NTU)	Turbidity 2 (NTU)	Water Temp. (°C)	Conductivity (µS/cm)	pH	Comments (e.g. many carp, lots of waterfowl)
			Zone	Easting	Northing							
	inlet - west		17	669189	4857885	68	17.5	16.8	22.0	2200	7.95	
	middle		17	669430	4857824	47	6.8	5.3	20.1	2030	7.97	
	inlet - east		17	669540	4858620	103	35.1	37.3	21.3	1970	7.85	many carp thrashing around in this area
	outlet		17	669953	4857767	63	14.8	14.2	20.0	975	7.34	

* Use Beaufort Scale: **0** = 0-1 km/h smoke rises vertically; **1** = 2-5 km/h smoke drifts slowly; **2** = 6-11km/h leaves rustle; **3** = 12-19 km/h leaves/twigs in constant motion; **4** = 20-29 km/h small branches move; **5** = 30-38 km/h small trees sway; **6** = 39-50 km/h large branches in constant motion

Durham Region Coastal Wetland Monitoring Project
Water Quality and Macroinvertebrate Collection Data Sheet

Wetland: _____ Date: _____(dd/mm/yy) Surveyors: _____

Start Time: _____ End Time: _____ Wind: _____(0-12) Cloud Cover: _____/10^{ths} Air Temp.: _____°C

	Replicate		
	1	**2**	**3**
UTM Coordinates (NAD83)			
Zone	17	17	17
Easting			
Northing			
Vegetation			
Dominant Emergent (> 75%)			
Subdominant (5-75%)			
Subdominant (5-75%)			
Subdominant (5-75%)			
Other (< 5%)			
Other (< 5%)			
Other (< 5%)			
Measurements			
Water Temperature (°C)			
Conductivity (µS/cm)			
Dissolved Oxygen (mg/L)			
pH			
Turbidity (NTU)			
Redox (mV)			
Alkalinity (mg/L)			
Water Depth (cm)			
Equipment Used			
Chlorophyll a			
Volume of water filtered (mL)			
Sample ID*			
$MgCO_3$ added (0.8 mL)			
Nutrient Samples			
NH_4 Vial Number			
NH_4 Concentration (mg/L)			
NO_3 Vial Number			
NO_3 Concentration (mg/L)			
TP Sample ID**			
TP - H_2SO_4 added (0.8 mL)			
Equipment Used			
Macroinvertebrates			
Bucket Number			
Vial Number			
Notes			

* Chlorophyll *a* sample ID format: 3-letter wetland code – YYMMDD – CH Replicate # (e.g. OSM-060717-CH1)

** TP sample ID format: 3-letter wetland code – YYMMDD – TP Replicate # (e.g. OSM-060717-TP1)

Durham Region Coastal Wetland Monitoring Project
Water Quality and Macroinvertebrate Collection Data Sheet

Wetland: Carruthers Creek Date: 01/08/06 (dd/mm/yy) Surveyors: G. Grabas, K. Holmes

Start Time: 0950 End Time: 1210 Wind: 2 (0-12) Cloud Cover: 0 /10ths Air Temp.: 27 °C

	Replicate		
	1	2	3
UTM Coordinates (NAD83)			
Zone	17	17	17
Easting	661661	661959	662117
Northing	4855018	4854917	485.4707
Vegetation			
Dominant Emergent (> 75%)	Typha x glauca	T. x glauca	T. x glauca
Subdominant (5-75%)	Lemna minor	Nymphaea odorata	Impatiens capensis
Subdominant (5-75%)	Hydrocharis morsus		
Subdominant (5-75%)			
Other (< 5%)	Lythrum salicaria	Stuckenia pectinata	
Other (< 5%)			
Other (< 5%)			
Measurements			
Water Temperature (°C)	24.0	23.7	26.3
Conductivity (µS/cm)	693	713	1051
Dissolved Oxygen (mg/L)	6.88	11.21	12.06
pH	9.48	9.83	8.86
Turbidity (NTU)	45.0	30.6	31.0
Redox (mV)	426	395	401
Alkalinity (mg/L)	240	240	260
Water Depth (cm)	30	25	31
Equipment Used	Turb. - Hach 2100P; others - YSI 650 MDS + 600 QS sonde		
Chlorophyll a			
Volume of water filtered (mL)	450	500	500
Sample ID*	CCW-060801-CH1	CCW-060801-CH2	CCW-060801-CH3
$MgCO_3$ added (0.8 mL)	✓	✓	✓
Nutrient Samples			
NH_4 Vial Number	N2	N6	N3
NH_4 Concentration (mg/L)	0.18	0.36	0.16
NO_3 Vial Number	N1	N5	N4
NO_3 Concentration (mg/L)	1.9	1.3	1.9
TP Sample ID**	CCW-060801-TP1	CCW-060801-TP2	CCW-060801-TP3
TP - H_2SO_4 added (0.8 mL)	✓	✓	✓
Equipment Used	NH_4 & NO_3 - Hach DR/890 Colorimeter		
Macroinvertebrates			
Bucket Number	1	2	3
Vial Number	18	6	39
Notes		Nitrate tested twice - same result	

SAMPLE

* Chlorophyll *a* sample ID format: 3-letter wetland code – YYMMDD – CH Replicate # (e.g. OSM-060717-CH1)

** TP sample ID format: 3-letter wetland code – YYMMDD – TP Replicate # (e.g. OSM-060717-TP1)

Durham Region Coastal Wetland Monitoring Project
Sediment Sample Collection Data Sheet

Wetland Name: _____ Date: _____(dd/mm/yy)

Start Time: _____ End Time: _____

Field Crew: _____

Conditions: _____(e.g. clouds, precipitation, etc.)

Sample ID*	Analyze for	UTM Coordinates (NAD83)			Location in Wetland	Sampling Equipment	Comments
		Zone	Easting	Northing			
_____-1-A							
_____-1-B							
_____-1-C							
_____-2-A							
_____-2-B							
_____-2-C							
_____-3-A							
_____-3-B							
_____-3-C							
_____-4-A†							
_____-4-B							
_____-4-C							
_____-5-A							
_____-5-B							
_____-5-C							
_____-6-A							
_____-6-B							
_____-6-C							

* Sample ID = 3-letter abbreviation of wetland name – Sample # – Subsample letter (e.g. OSM-1-A)

† If needed – minimum of 3 samples required per wetland

Durham Region Coastal Wetland Monitoring Project
Sediment Sample Collection Data Sheet

Wetland Name: Lynde Creek Marsh Date: 19/09/06 (dd/mm/yy)

Start Time: 0930 End Time: 1210

Field Crew: I. Kelsey, J. Scott

Conditions: Light rain; heavy rain during previous 48 hrs (e.g. clouds, precipitation, etc.)

Sample ID*	Analyze for	UTM Coordinates (NAD83)			Location in Wetland	Sampling Equipment	Comments
		Zone	Easting	Northing			
LCM-1-A	PAH, PCB, OC pest.	17	663886	4857967	Inlet - east	Ekman dredge	At SW & NE corners of Victoria St. bridge
LCM-1-B	metals+Hg						
LCM-1-C	TOC grain size						
LCM-2-A	PAH, PCB, OC pest.	17	663437	4857699	Inlet - west	Spoon	upstream of Eastborne Rd. bridge
LCM-2-B	metals+Hg						
LCM-2-C	TOC grain size						
LCM-3-A	PAH, PCB OC pest.	17	663891	4857449	Middle	Spoon	
LCM-3-B	metals+Hg						
LCM-3-C	TOC grainsize						
LCM-4-A†	PAH, PCB OC pest.	17	664524	4856750	Outlet	Ekman dredge	Difficult to find organic deposition – mostly sand
LCM-4-B	metals+Hg						
LCM-4-C	TOC grain size						
_____-5-A							
_____-5-B							
_____-5-C							
_____-6-A							
_____-6-B							
_____-6-C							

SAMPLE

* Sample ID = 3-letter abbreviation of wetland name – Sample # – Subsample letter (e.g. OSM-1-A)

† If needed – minimum of 3 samples required per wetland

APPENDIX D - BEAUFORT WIND SCALE

Beaufort Wind Scale

Rear-Admiral Sir Francis Beaufort of the British Royal Navy invented the Beaufort Wind Scale in 1805. It originally referred to the amount of sail a ship could carry in specific conditions. During a light breeze, only one sail would be taken in; in a moderate gale, seven would come down; and so on. Although the scale has been updated and modified several times, it is still widely used today to describe wind strength and speed.

Wind Force	Speed (km/h)	Wind Type	Effects
0	0-1	calm	smoke rises vertically
1	2-5	light air	smoke drifts slowly
2	6-11	light breeze	leaves rustle; wind vanes move
3	12-19	gentle breeze	leaves and twigs in constant motion
4	20-29	moderate breeze	small branches move; raises dust and loose papers
5	30-38	fresh breeze	small trees sway
6	39-50	strong breeze	large branches in continuous motion; telephone wires whistle
7	51-61	near gale	whole trees in motion; wind affects walking
8	62-74	gale	twigs and small branches break off trees
9	75-87	strong gale	branches break; shingles blown from roofs
10	88-101	storm	trees snap and uproot; some damage to buildings
11	102-117	violent storm	property damage widespread
12	118 +	hurricane	severe and extensive damage

APPENDIX E - SEDIMENT ANALYSIS PARAMETERS

Parameters Analyzed from Durham Region Coastal Wetland Sediments

Parameter	Units
PCBs:	
Aroclor 1016	ug/g
Aroclor 1221	ug/g
Aroclor 1232	ug/g
Aroclor 1242	ug/g
Aroclor 1248	ug/g
Aroclor 1254	ug/g
Aroclor 1260	ug/g
Aroclor 1262	ug/g
Aroclor 1268	ug/g
Total PCB	ug/g
OC Pesticides:	
a-BHC	ug/g
a-Chlordane	ug/g
Aldrin	ug/g
b-BHC	ug/g
d-BHC	ug/g
Dieldrin	ug/g
Endosulfan I	ug/g
Endosulfan II	ug/g
Endosulfan sulfate	ug/g
Endrin	ug/g
Endrin aldehyde	ug/g
g-Chlordane	ug/g
Heptachlor	ug/g
Heptachlor epoxide	ug/g
Lindane	ug/g
Methoxychlor	ug/g
Mirex	ug/g
o,p'-DDD	ug/g
o,p'-DDE	ug/g
o,p'-DDT	ug/g
Octachlorostyrene	ug/g
p,p'-DDD	ug/g
p,p'-DDE	ug/g
p,p'-DDT	ug/g
Toxaphene	ug/g
PAHs:	
Acenaphthene	ug/kg
Acenaphthylene	ug/kg
Anthracene	ug/kg
Benzo(a)anthracene	ug/kg
Benzo(a)pyrene	ug/kg

Parameter	Units
Benzo(b)fluoranthene	ug/kg
Benzo(ghi)perylene	ug/kg
Benzo(k)fluoranthene	ug/kg
Chrysene	ug/kg
Dibenzo(a,h)anthracene	ug/kg
Fluoranthene	ug/kg
Fluorene	ug/kg
Indeno(1,2,3-cd)pyrene	ug/kg
Naphthalene	ug/kg
Phenanthrene	ug/kg
Pyrene	ug/kg
Metals:	
Aluminum	%
Arsenic	ug/g
Barium	ug/g
Beryllium	ug/g
Bismuth	ug/g
Cadmium	ug/g
Calcium	%
Chromium	ug/g
Cobalt	ug/g
Copper	ug/g
Iron	%
Lead	ug/g
Lithium	ug/g
Magnesium	%
Manganese	ug/g
Mercury	ug/g
Molybdenum	ug/g
Nickel	ug/g
Potassium	%
Silver	ug/g
Sodium	%
Strontium	ug/g
Tin	ug/g
Titanium	ug/g
Vanadium	ug/g
Yttrium	ug/g
Zinc	ug/g
Others:	
Total Organic Carbon (TOC)	%
Grain size - sand	%
Grain size - silt	%
Grain size - clay	%

APPENDIX F - MATERIAL SAFETY DATA SHEETS

Reagent for Ammonia Test – Ammonia Cyanurate

NOTE: Check for updated MSDS annually

World Headquarters
Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

MSDS No: M00128

MATERIAL SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: Ammonia Cyanurate
Catalog Number: 2653199

Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

Emergency Telephone Numbers:
(Medical and Transportation)
(303) 623-5716 24 Hour Service
(515)232-2533 8am - 4pm CST

MSDS Number: M00128
Chemical Name: Not Applicable
CAS No.: Not Applicable
Chemical Formula: Not Applicable
Chemical Family: Not applicable
PIN: 1759
Intended Use: Reagent for ammonia test
Date of MSDS Preparation:
Day: 22
Month: 09
Year: 2005
MSDS Prepared: MSDS prepared by Product Compliance Department extension 3350

2. COMPOSITION / INFORMATION ON INGREDIENTS

Sodium Dichloroisocyanurate
Percent Range: 1.0 - 5.0
Percent Range Units: weight / weight
CAS No.: 2893789
LD50: Oral rat LD50 = 1400 mg/kg; Oral human LDLo = 3570 mg/kg
LC50: None reported
TLV: Not established
PEL: Not established
Ingredient WHMIS Symbol: Not applicable

Lithium Hydroxide, Anhydrous
Percent Range: 1.0 - 5.0
Percent Range Units: weight / weight
CAS No.: 1310652
LD50: Oral rat LD50 = 225 mg/kg
LC50: Inhalation rat LC50 = 980 mg/m^3/4H
TLV: STEL 2 mg/m^3 (ceiling)
PEL: 2 mg/m^3
Ingredient WHMIS Symbol: Corrosive

Sodium Citrate
Percent Range: 80.0 - 90.0
Percent Range Units: weight / weight
CAS No.: 68042
LD50: Oral rat LD50 >8 g/Kg

LC50: None Reported
TLV: Not established
PEL: Not established
Ingredient WHMIS Symbol: Not applicable

Sodium Tartrate
Percent Range: 5.0 - 15.0
Percent Range Units: weight / weight
CAS No.: 6106247
LD50: Oral rabbit LD50 = 5290 mg/kg
LC50: None Reported
TLV: Not established
PEL: Not established
Ingredient WHMIS Symbol: Not applicable

3. HAZARDS IDENTIFICATION

Emergency Overview:
Appearance: White powder
Physical State: Solid
Odor: Chlorine
CAUSES BURNS HARMFUL IF SWALLOWED
MAY CAUSE KIDNEY OR LIVER DAMAGE BASED ON ANIMAL DATA

HMIS:
Health: 3
Flammability: 1
Reactivity: 1
Protective Equipment: X - See protective equipment, Section 8.
Potential Health Effects:
Eye Contact: Causes eye burns.
Skin Contact: Causes burns.
Skin Absorption: None Reported
Target Organs: None Reported
Ingestion: Causes: burns May cause: dizziness nausea kidney damage liver damage
Target Organs: Liver Kidneys Central nervous system Bone marrow
Inhalation: Causes: burns May cause: shortness of breath coughing
Target Organs: None reported
Medical Conditions Aggravated: Pre-existing: Eye conditions Skin conditions Respiratory conditions
Chronic Effects: Lithium compounds have been implicated in development of aplastic anemia. Signs of lithium poisoning include dehydration, extreme weight loss, fine tremor of hands, nausea, vomiting and diarrhea, Chronic overexposure may cause central nervous system effects kidney damage liver damage
Cancer / Reproductive Toxicity Information:
This product does NOT contain any IARC listed chemicals.

This product does NOT contain any NTP listed chemicals.

Additional Cancer / Reproductive Toxicity Information: None reported
Toxicologically Synergistic Products: None reported
WHMIS Hazard Classification: Class E - Corrosive material Class D, Division 2, Subdivision B - Toxic material (other toxic effects)
WHMIS Symbols: Corrosive Other Toxic Effects

4. FIRST AID

Eye Contact: Immediately flush eyes with water for 15 minutes. Call physician.

Skin Contact (First Aid): Wash skin with soap and plenty of water for 15 minutes. Remove contaminated clothing. Call physician immediately.
Ingestion (First Aid): Do not induce vomiting. Give 1-2 glasses of water. Call physician immediately. Never give anything by mouth to an unconscious person.
Inhalation: Remove to fresh air. Give artificial respiration if necessary. Call physician.

5. FIRE FIGHTING MEASURES

Flammable Properties: During a fire, irritating and highly toxic gases may be generated by thermal decomposition.
Flash Point: Not applicable
Method: Not applicable
Flammability Limits:
Lower Explosion Limits: Not applicable
Upper Explosion Limits: Not applicable
Autoignition Temperature: Not determined
Hazardous Combustion Products: May emit toxic and corrosive fumes.
Fire / Explosion Hazards: Not combustible.
Static Discharge: None reported.
Mechanical Impact: None reported
Extinguishing Media: Dry chemical. Carbon dioxide Water.
Fire Fighting Instruction: As in any fire, wear self-contained breathing apparatus pressure-demand and full protective gear.

6. ACCIDENTAL RELEASE MEASURES

Spill Response Notice:
Only persons properly qualified to respond to an emergency involving hazardous substances should respond to a spill involving chemicals. See Section 13, Special Instructions for disposal assistance.
Containment Technique: Cover spilled solid material with sand or other inert material. Stop spilled material from being released to the environment.
Clean-up Technique: Scoop up spilled material into a large beaker and dissolve with water. Adjust to a pH between 6 and 9 with an acid, such as sulfuric or citric. Flush reacted material to the drain with a large excess of water. Decontaminate the area of the spill with a soap solution.
Evacuation Procedure: Evacuate local area (15 foot radius or as directed by your facility's emergency response plan) when: any quantity is spilled. If conditions warrant, increase the size of the evacuation.
D.O.T. Emergency Response Guide Number: 154

7. HANDLING / STORAGE

Handling: Avoid contact with eyes skin clothing Do not breathe dust. Wash thoroughly after handling. Maintain general industrial hygiene practices when using this product.
Storage: Protect from: heat moisture Store away from: acids / acid fumes.

8. EXPOSURE CONTROLS / PROTECTIVE EQUIPMENT

Engineering Controls: Have an eyewash station nearby. Have a safety shower nearby. Use a fume hood to avoid exposure to dust, mist or vapor. Maintain general industrial hygiene practices when using this product.
Personal Protective Equipment:
Eye Protection: safety glasses with top and side shields
Skin Protection: disposable latex gloves lab coat
Inhalation Protection: adequate ventilation
Precautionary Measures: Avoid contact with: eyes skin clothing Do not breathe: dust Wash thoroughly after handling. Keep away from: acids/acid fumes metals
TLV: Not established
PEL: Not established

9. PHYSICAL / CHEMICAL PROPERTIES

Appearance: White powder
Physical State: Solid

Molecular Weight: Not applicable
Odor: Chlorine
pH: of a 5% solution = 12.33
Vapor Pressure: Not applicable
Vapor Density (air = 1): Not applicable
Boiling Point: Not applicable
Melting Point: >240 °C, >464 °F
Specific Gravity (water = 1): 1.783
Evaporation Rate (water = 1): Not applicable
Volatile Organic Compounds Content: None reported
Coefficient of Water / Oil: Not applicable
Solubility:
Water: Soluble
Acid: Soluble
Other: Not determined
Metal Corrosivity:
Steel: 0.00 in/yr
Aluminum: 0.803 in/yr

10. STABILITY / REACTIVITY

Chemical Stability: Stable when stored under proper conditions.
Conditions to Avoid: Heating to decomposition. Extreme temperatures Excess moisture
Reactivity / Incompatibility: Incompatible with: acids
Hazardous Decomposition: Contact with acids releases toxic and/or corrosive fumes of: chlorides nitrogen oxides
Hazardous Polymerization: Will not occur.

11. TOXICOLOGICAL INFORMATION

Product Toxicological Data:
LD50: None Reported
LC50: None Reported
Dermal Toxicity Data: None Reported
Skin and Eye Irritation Data: None Reported
Mutation Data: None Reported
Reproductive Effects Data: None Reported
--
Ingredient Toxicological Data: Sodium Citrate Oral rat LD50 > 8 g/k; Sodium Tartrate Oral rabbit LD50 = 5290 mg/kg; Lithium Hydroxide Oral rat LD50 = 225 mg/kg; Sodium Dichloroisocyanurate Oral rat LD50 = 1400 mg/kg

12. ECOLOGICAL INFORMATION

Product Ecological Information: --
No ecological data available for this product.
Ingredient Ecological Information: --
No ecological data available for the ingredients of this product.

13. DISPOSAL CONSIDERATIONS

Special Instructions (Disposal): Dilute to 3 to 5 times the volume with cold water. Adjust to a pH between 6 and 9 with an acid, such as sulfuric or citric. Open cold water tap completely, slowly pour the reacted material to the drain. Flush system with plenty of water.
Empty Containers: Rinse three times with an appropriate solvent. Dispose of empty container as normal trash.
NOTICE (Disposal): These disposal guidelines are based on federal regulations and may be superseded by more stringent state or local requirements. Please consult your local environmental regulators for more information.

14. TRANSPORT INFORMATION

T.D.G.:

Proper Shipping Name: Corrosive Solid, N.O.S.
(Lithium Hydroxide Mixture)
Hazard Class: 8
PIN: 1759
Group: II
Subsidiary Risk: NA
Additional Information: This product may be shipped as part of a chemical kit composed of various compatible dangerous goods for analytical or testing purposes. This kit would have the following classification: Proper Shipping Name: Chemical Kit Hazard Class: 9 UN Number 3316

15. REGULATORY INFORMATION

National Inventories:
Canadian Inventory Status: All ingredients of this product are DSL Listed.
This product has been classified in accordance with the hazard criteria of the CPR and the MSDS contains all of the information required by the CPR.

16. OTHER INFORMATION

References: NIOSH Registry of Toxic Effects of Chemical Substances, 1985-86. Cincinnati: U.S. Department of Health and Human Services, April, 1987. Patty, Frank A. Industrial Hygiene and Toxicology, 3rd Revised Edition. Volume 2. New York: A Wiley-Interscience Publication, 1981. Gosselin, R. E. et al. Clinical Toxicology of Commercial Products, 5th Ed. Baltimore: The Williams and Wilkins Co., 1984. Technical Judgment. In-house information. Air Contaminants, Federal Register, Vol. 54, No. 12. Thursday, January 19, 1989. pp. 2332-2983. TLV's Threshold Limit Values and Biological Exposure Indices for 1992-1993. American Conference of Governmental Industrial Hygienists, 1992.

Legend:

NA - Not Applicable	w/w - weight/weight
ND - Not Determined	w/v - weight/volume
NV - Not Available	v/v - volume/volume

USER RESPONSIBILITY: Each user should read and understand this information and incorporate it in individual site safety programs in accordance with applicable hazard communication standards and regulations.

THE INFORMATION CONTAINED HEREIN IS BASED ON DATA CONSIDERED TO BE ACCURATE. HOWEVER, NO WARRANTY IS EXPRESSED OR IMPLIED REGARDING THE ACCURACY OF THESE DATA OR THE RESULTS TO BE OBTAINED FROM THE USE THEREOF.

HACH COMPANY ©2005

Reagent for Ammonia Test – Ammonia Salicylate Reagent

NOTE: Check for updated MSDS annually

World Headquarters
Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

MSDS No: M00127

MATERIAL SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: Ammonia Salicylate Reagent
Catalog Number: 2653299

Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

Emergency Telephone Numbers:
(Medical and Transportation)
(303) 623-5716 24 Hour Service
(515)232-2533 8am - 4pm CST

MSDS Number: M00127
Chemical Name: Not applicable
CAS No.: Not applicable
Chemical Formula: Not applicable
Chemical Family: Not applicable
PIN: NA
Intended Use: Reagent for ammonia test
Date of MSDS Preparation:
Day: 22
Month: 09
Year: 2005
MSDS Prepared: MSDS prepared by Product Compliance Department extension 3350

2. COMPOSITION / INFORMATION ON INGREDIENTS

Sodium Salicylate
Percent Range: 40.0 - 50.0
Percent Range Units: weight / weight
CAS No.: 54-21-7
LD50: Oral rat LD_{50} = 1200 mg/kg; Oral mouse LD_{50} = 540 mg/kg; Oral rabbit LD_{50} = 1700 mg/kg.
LC50: None reported.
TLV: Respirable particles: 3 mg/m^3; Inhalable particles: 10 mg/m^3
PEL: Total dust: 15 mg/m^3; Respirable fraction: 5 mg/m^3
Ingredient WHMIS Symbol: Other Toxic Effects

Sodium Nitroferricyanide
Percent Range: < 1.0
Percent Range Units: weight / weight
CAS No.: 14402-89-2
LD50: Oral rat LD_{50} = 99 mg/kg (anhydrous).
LC50: None reported.
TLV: 5 mg/m^3 as CN^-
PEL: 5 mg/m^3 as CN^-
Ingredient WHMIS Symbol: Other Toxic Effects

Other components, each
Percent Range: 0.1 - 1.0
Percent Range Units: weight / weight
CAS No.: Not applicable
LD50: Not applicable

LC50: Not applicable
TLV: Not established
PEL: Not established
Ingredient WHMIS Symbol: Not applicable

Sodium Citrate
Percent Range: 40.0 - 50.0
Percent Range Units: weight / weight
CAS No.: 68042
LD50: Oral rat LD50 >8 g/Kg
LC50: None Reported
TLV: Not established
PEL: Not established
Ingredient WHMIS Symbol: Not applicable

Sodium Tartrate
Percent Range: 10.0 - 20.0
Percent Range Units: weight / weight
CAS No.: 610627
LD50: Oral rabbit LD50 = 5290 mg/kg
LC50: None Reported
TLV: Not established
PEL: Not established
Ingredient WHMIS Symbol: Not applicable

3. HAZARDS IDENTIFICATION

Emergency Overview:
Appearance: Tan powder
Physical State: Solid
Odor: None
HARMFUL IF SWALLOWED, INHALED OR ABSORBED THROUGH SKIN MAY CAUSE EYE, SKIN AND RESPIRATORY TRACT IRRITATION

CONTACT WITH ACIDS FORMS TOXIC FUMES

HMIS:
Health: 3
Flammability: 1
Reactivity: 0
Protective Equipment: X - See protective equipment, Section 8.
Potential Health Effects:
Eye Contact: May cause irritation
Skin Contact: May cause irritation
Skin Absorption: Harmful if absorbed through the skin Effects similar to those of ingestion Sodium nitroferricyanide produces a delayed cyanide poisoning reaction.
Target Organs: Central nervous system Blood
Ingestion: Sodium nitroferricyanide produces a delayed cyanide poisoning reaction. May cause: headache nausea vomiting central nervous system effects
Target Organs: Central nervous system Blood
Inhalation: Sodium nitroferricyanide produces a delayed cyanide poisoning reaction. May cause: headache nausea, vomiting central nervous system effects
Target Organs: Central nervous system Blood
Medical Conditions Aggravated: Allergies or sensitivity to aspirin or salicylates.
Chronic Effects: Chronic overexposure may cause confusion diarrhea fatigue weakness death Salicylates may cause ringing in the ears (tinnitus), abnormal bleeding, gastric ulceration, mental deterioration, skin eruption, temporary vision loss, and other optical effects.
Cancer / Reproductive Toxicity Information:

This product does NOT contain any IARC listed chemicals.

This product does NOT contain any NTP listed chemicals.

Additional Cancer / Reproductive Toxicity Information: Contains: an experimental mutagen. an experimental teratogen.
Toxicologically Synergistic Products: None reported
WHMIS Hazard Classification: Class D, Division 2, Subdivision A - Very toxic materials (other toxic effects)
WHMIS Symbols: Other Toxic Effects

4. FIRST AID

Eye Contact: Immediately flush eyes with water for 15 minutes. Call physician.
Skin Contact (First Aid): Wash skin with soap and plenty of water. Remove contaminated clothing. Call physician immediately.
Ingestion (First Aid): Induce vomiting using syrup of ipecac or by sticking finger down throat. Never give anything by mouth to an unconscious person. Call physician immediately.
Inhalation: Remove to fresh air. Give artificial respiration if necessary. Call physician.

5. FIRE FIGHTING MEASURES

Flammable Properties: During a fire, this product decomposes to form toxic gases.
Flash Point: Not applicable
Method: Not applicable
Flammability Limits:
Lower Explosion Limits: Not applicable
Upper Explosion Limits: Not applicable
Autoignition Temperature: Not determined.
Hazardous Combustion Products: May emit acrid smoke and fumes.
Fire / Explosion Hazards: This product will not burn or explode.
Static Discharge: None reported.
Mechanical Impact: None reported
Extinguishing Media: Dry chemical. Carbon dioxide Alcohol foam.
Fire Fighting Instruction: As in any fire, wear self-contained breathing apparatus pressure-demand and full protective gear. Evacuate area and fight fire from a safe distance.

6. ACCIDENTAL RELEASE MEASURES

Spill Response Notice:
Only persons properly qualified to respond to an emergency involving hazardous substances should respond to a spill involving chemicals. See Section 13, Special Instructions for disposal assistance.
Containment Technique: Releases of this material may contaminate the environment. Stop spilled material from being released to the environment.
Clean-up Technique: Avoid contact with spilled material. Sweep up material. Dilute with a large excess of water. Flush the spilled material to the drain with a large excess of water. Decontaminate the area of the spill with a soap solution.
Evacuation Procedure: Evacuate local area (15 foot radius or as directed by your facility's emergency response plan) when: a pound or more of loose powder is spilled. If conditions warrant, increase the size of the evacuation.
D.O.T. Emergency Response Guide Number: None

7. HANDLING / STORAGE

Handling: Avoid contact with eyes skin clothing Do not breathe dust. Wash thoroughly after handling. Maintain general industrial hygiene practices when using this product.
Storage: Store between 10° and 25°C. Keep away from: acids / acid fumes. oxidizers

8. EXPOSURE CONTROLS / PROTECTIVE EQUIPMENT

Engineering Controls: Have an eyewash station nearby. Use a fume hood to avoid exposure to dust, mist or vapor.
Personal Protective Equipment:
Eye Protection: safety glasses with top and side shields

Skin Protection: lab coat disposable latex gloves
Inhalation Protection: laboratory fume hood
Precautionary Measures: eyes skin clothing Do not breathe: dust Wash thoroughly after handling. Use with adequate ventilation. Keep away from: acids/acid fumes oxidizers
TLV: Not established.
PEL: Not established.

9. PHYSICAL / CHEMICAL PROPERTIES

Appearance: Tan powder
Physical State: Solid
Molecular Weight: Not applicable
Odor: None
pH: 7.84 (5% solution)
Vapor Pressure: Not applicable
Vapor Density (air = 1): Not applicable
Boiling Point: Not applicable
Melting Point: 97°C (206.6°F)
Specific Gravity (water = 1): 1.689
Evaporation Rate (water = 1): Not applicable
Volatile Organic Compounds Content: None.
Coefficient of Water / Oil: Not applicable
Solubility:
Water: Soluble.
Acid: Soluble.
Other: Not determined.
Metal Corrosivity:
Steel: Not applicable
Aluminum: Not applicable

10. STABILITY / REACTIVITY

Chemical Stability: Stable when stored under proper conditions.
Conditions to Avoid: Heating to decomposition. Extreme temperatures
Reactivity / Incompatibility: Incompatible with: acids iodine iron salts lead acetate organic materials oxidizers silver nitrate sodium phosphate
Hazardous Decomposition: Contact with acids/acid fumes releases toxic cyanide gas. Heating to decomposition releases toxic and/or corrosive fumes of: cyanide nitrogen oxides sodium oxides
Hazardous Polymerization: Will not occur.

11. TOXICOLOGICAL INFORMATION

Product Toxicological Data:
LD50: None reported.
LC50: None reported.
Dermal Toxicity Data: None reported.
Skin and Eye Irritation Data: None reported.
Mutation Data: None reported.
Reproductive Effects Data: None reported.
--
Ingredient Toxicological Data: Sodium Salicylate: Oral rat LD_{50} = 1200 mg/kg; Sodium Citrate: Oral rat LD_{50} > 8 g/kg; Sodium Tartrate: Oral rabbit LD_{50} = 5290 mg/kg; Sodium Nitroferricyanide: Oral rat LD_{50} = 99 mg/kg.

12. ECOLOGICAL INFORMATION

Product Ecological Information: --
No ecological data available for this product.
Ingredient Ecological Information: --
No ecological data available for the ingredients of this product.

13. DISPOSAL CONSIDERATIONS

Special Instructions (Disposal): Dilute to 3 to 5 times the volume with cold water. Flush system with plenty of water.
Empty Containers: Rinse three times with an appropriate solvent. Dispose of empty container as normal trash.
NOTICE (Disposal): These disposal guidelines are based on federal regulations and may be superseded by more stringent state or local requirements. Please consult your local environmental regulators for more information.

14. TRANSPORT INFORMATION

T.D.G.:
Proper Shipping Name: Not Currently Regulated
--
Hazard Class: NA
PIN: NA
Group: NA
Subsidiary Risk: NA
Additional Information: This product may be shipped as part of a chemical kit composed of various compatible dangerous goods for analytical or testing purposes. This kit would have the following classification: Proper Shipping Name: Chemical Kit Hazard Class: 9 UN Number 3316

15. REGULATORY INFORMATION

National Inventories:
Canadian Inventory Status: All ingredients of this product are DSL/NDSL Listed.
This product has been classified in accordance with the hazard criteria of the CPR and the MSDS contains all of the information required by the CPR.

16. OTHER INFORMATION

References: TLV's Threshold Limit Values and Biological Exposure Indices for 1992-1993. American Conference of Governmental Industrial Hygienists, 1992. Technical Judgment. Sixth Annual Report on Carcinogens, 1991. U.S. Department of Health and Human Services. Rockville, MD: Technical Resources, Inc. 1991. Sax, N. Irving. Dangerous Properties of Industrial Materials, 7th Ed. New York: Van Nostrand Reinhold Co., 1989. List of Dangerous Substances Classified in Annex I of the EEC Directive (67/548) - Classification, Packaging and Labeling of Dangerous Substances, Amended July 1992. In-house information. IARC Monographs on the Evaluation of the Carcinogenic Risks to Humans. World Health Organization (Volumes 1-42) Supplement 7. France: 1987. Gosselin, R. E. et al. Clinical Toxicology of Commercial Products, 5th Ed. Baltimore: The Williams and Wilkins Co., 1984. Cassaret and Doull's Toxicology, 3rd Ed. New York: Macmillan Publishing Co., Inc., 1986. Air Contaminants, Federal Register, Vol. 54, No. 12. Thursday, January 19, 1989. pp. 2332-2983. 29 CFR 1900 - 1910 (Code of Federal Regulations - Labor).

Legend:

NA - Not Applicable	w/w - weight/weight
ND - Not Determined	w/v - weight/volume
NV - Not Available	v/v - volume/volume

USER RESPONSIBILITY: Each user should read and understand this information and incorporate it in individual site safety programs in accordance with applicable hazard communication standards and regulations.

THE INFORMATION CONTAINED HEREIN IS BASED ON DATA CONSIDERED TO BE ACCURATE. HOWEVER, NO WARRANTY IS EXPRESSED OR IMPLIED REGARDING THE ACCURACY OF THESE DATA OR THE RESULTS TO BE OBTAINED FROM THE USE THEREOF.

HACH COMPANY ©2005

Reagent for Nitrate Test – NitraVer® 5

NOTE: Check for updated MSDS annually

World Headquarters
Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

MSDS No: M00049

MATERIAL SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: NitraVer ® 5 Nitrate Reagent
Catalog Number: 2106169

Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

Emergency Telephone Numbers:
(Medical and Transportation)
(303) 623-5716 24 Hour Service
(515)232-2533 8am - 4pm CST

MSDS Number: M00049
Chemical Name: Not applicable
CAS No.: Not applicable
Chemical Formula: Not applicable
Chemical Family: Not applicable
PIN: NA
Intended Use: Determination of nitrate
Date of MSDS Preparation:
Day: 23
Month: 09
Year: 2005
MSDS Prepared: MSDS prepared by Product Compliance Department extension 3350

2. COMPOSITION / INFORMATION ON INGREDIENTS

Potassium Phosphate, Monobasic
Percent Range: 30.0 - 40.0
Percent Range Units: weight / weight
CAS No.: 7778770
LD50: Oral rat LD50 = 7100 mg/kg
LC50: None reported
TLV: Not established
PEL: Not established
Ingredient WHMIS Symbol: Not applicable

Other components, each
Percent Range: < 1.0
Percent Range Units: weight / weight
CAS No.: Not applicable
LD50: Not applicable
LC50: Not applicable
TLV: Not established
PEL: Not established
Ingredient WHMIS Symbol: Not applicable

Magnesium Sulfate
Percent Range: 5.0 - 15.0
Percent Range Units: weight / weight
CAS No.: 10034-99-8
LD50: Oral mouse LDLo = 5000 mg/kg
LC50: None reported

TLV: Not established
PEL: Not established
Ingredient WHMIS Symbol: Not applicable

Cadmium
Percent Range: 5.0 - 10.0
Percent Range Units: weight / weight
CAS No.: 7440439
LD50: Oral rat LD50 = 225 mg/kg
LC50: Inhalation rat LC50 = 25 mg/m^3/30min
TLV: 0.01 mg/m^3
PEL: 0.005 mg/m^3
Ingredient WHMIS Symbol: Acute Poison Other Toxic Effects

Gentisic Acid
Percent Range: 15.0 - 25.0
Percent Range Units: weight / weight
CAS No.: 490-79-9
LD50: Oral rat LD50 = 800 mg/kg, Oral mouse LD50 = 4500 mg/kg
LC50: None reported
TLV: Not established
PEL: Not established
Ingredient WHMIS Symbol: Not applicable

Sulfanilic Acid
Percent Range: 25.0 - 35.0
Percent Range Units: weight / weight
CAS No.: 121-57-3
LD50: Oral rat LD50 = 12300 mg/kg
LC50: None reported
TLV: Not established
PEL: Not established
Ingredient WHMIS Symbol: Other Toxic Effects

3. HAZARDS IDENTIFICATION

Emergency Overview:
Appearance: Gray powder
Physical State: Solid
Odor: None
HARMFUL IF INHALED MAY CAUSE EYE, SKIN AND RESPIRATORY TRACT IRRITATION
CONTAINS CADMIUM: CANCER HAZARD CAN CAUSE LUNG AND KIDNEY DISEASE

HMIS:
Health: 4*
Flammability: 1
Reactivity: 0
Protective Equipment: X - See protective equipment, Section 8.
Potential Health Effects:
Eye Contact: May cause irritiation
Skin Contact: May cause irritiation
Skin Absorption: None Reported
Target Organs: None Reported
Ingestion: May cause: salivation vomiting abdominal pain anemia diarrhea kidney failure central nervous system effects cardiac depression
Target Organs: Kidneys Reproductive system Central nervous system

Inhalation: May cause: coughing headache nausea, vomiting chest pain pneumonitis respiratory tract irritation lung damage kidney damage
Target Organs: Kidneys Reproductive system Lungs
Medical Conditions Aggravated: Pre-existing: Respiratory conditions Kidney conditions Liver conditions
Chronic Effects: Chronic overexposure may cause cancer liver damage kidney damage bone damage (osteosclerosis)
Cancer / Reproductive Toxicity Information:
An ingredient of this mixture is: IARC Group 1: Recognized Carcinogen
Cadmium
An ingredient of this mixture is: NTP Listed Group 1: Recognized Carcinogen
Cadmium
Additional Cancer / Reproductive Toxicity Information: Contains: an ACGIH A2 suspected human carcinogen.
Toxicologically Synergistic Products: None reported
WHMIS Hazard Classification: Class D, Division 1, Subdivision A - Very toxic materials (immediate effects)
WHMIS Symbols: Acute Poison Other Toxic Effects

4. FIRST AID

Eye Contact: Immediately flush eyes with water for 15 minutes. Call physician.
Skin Contact (First Aid): Wash skin with soap and plenty of water. Call physician if irritation develops.
Ingestion (First Aid): Administer milk or beaten egg whites at frequent intervals. Induce vomiting using syrup of ipecac or by sticking finger down throat. Never give anything by mouth to an unconscious person. Call physician immediately.
Inhalation: Remove to fresh air. Give artificial respiration if necessary. Call physician.

5. FIRE FIGHTING MEASURES

Flammable Properties: Can burn in fire, releasing toxic vapors.
Flash Point: Not applicable
Method: Not applicable
Flammability Limits:
Lower Explosion Limits: Not applicable
Upper Explosion Limits: Not applicable
Autoignition Temperature: Not available
Hazardous Combustion Products: Toxic fumes of: cadmium oxide nitrogen oxides. sulfur oxides. phosphorus oxides
Fire / Explosion Hazards: May react violently with: strong oxidizers hydrazoic acid ammonium nitrate
Static Discharge: None reported.
Mechanical Impact: None reported
Extinguishing Media: Water. Carbon dioxide Dry chemical.
Fire Fighting Instruction: As in any fire, wear self-contained breathing apparatus pressure-demand and full protective gear.

6. ACCIDENTAL RELEASE MEASURES

Spill Response Notice:
Only persons properly qualified to respond to an emergency involving hazardous substances should respond to a spill involving chemicals. See Section 13, Special Instructions for disposal assistance.
Containment Technique: Releases of this material may contaminate the environment. Stop spilled material from being released to the environment.
Clean-up Technique: Avoid breathing spilled material. Avoid contact with spilled material. Sweep up material. Dispose of material in an E.P.A. approved hazardous waste facility. Decontaminate the area of the spill with a soap solution.
Evacuation Procedure: Evacuate general area (50 foot radius or as directed by your facility's emergency response plan) when: any quantity is spilled. If conditions warrant, increase the size of the evacuation.
D.O.T. Emergency Response Guide Number: None

7. HANDLING / STORAGE

Handling: Avoid contact with eyes skin clothing Do not breathe dust. Wash thoroughly after handling. Maintain general industrial hygiene practices when using this product. Use with adequate ventilation.
Storage: Store between 10° and 25°C. Keep away from: oxidizers hydrazoic acid ammonium nitrate

8. EXPOSURE CONTROLS / PROTECTIVE EQUIPMENT

Engineering Controls: Have an eyewash station nearby. Maintain adequate ventilation to keep vapor level below TWA for chemicals in this product. Use a fume hood to avoid exposure to dust, mist or vapor.
Personal Protective Equipment:
Eye Protection: safety glasses with top and side shields
Skin Protection: disposable latex gloves lab coat
Inhalation Protection: laboratory fume hood and / or half-face respirator with HEPA filter
Precautionary Measures: Avoid contact with: eyes skin clothing Do not breathe: dust Wash thoroughly after handling. Keep away from: oxidizers
TLV: Not established
PEL: Not established

9. PHYSICAL / CHEMICAL PROPERTIES

Appearance: Gray powder
Physical State: Solid
Molecular Weight: Not applicable
Odor: None
pH: 5% solution = 2.8
Vapor Pressure: Not applicable
Vapor Density (air = 1): Not applicable
Boiling Point: Not applicable
Melting Point: 180°C; 356°F
Specific Gravity (water = 1): 2.0
Evaporation Rate (water = 1): Not applicable
Volatile Organic Compounds Content: Not applicable
Coefficient of Water / Oil: Not applicable
Solubility:
Water: Soluble
Acid: Soluble
Other: Not determined
Metal Corrosivity:
Steel: 0.081 in/yr
Aluminum: 0.000 in/yr

10. STABILITY / REACTIVITY

Chemical Stability: Stable when stored under proper conditions.
Conditions to Avoid: Heat
Reactivity / Incompatibility: Incompatible with: oxidizers hydrazoic acid ammonium nitrate sulfur
Hazardous Decomposition: Heating to decomposition releases toxic and/or corrosive fumes of: phosphorus oxides sulfur oxides carbon dioxide carbon monoxide nitrogen oxides
Hazardous Polymerization: Will not occur.

11. TOXICOLOGICAL INFORMATION

Product Toxicological Data:
LD50: Oral rat LD50 = 1500 mg/kg
LC50: None reported
Dermal Toxicity Data: None reported
Skin and Eye Irritation Data: Sulfanilic acid: Skin rabbit 500 mg/24H - Standard Draize - MILD; Eye rabbit 100 mg/24H - Standard Draize - MODERATE
Mutation Data: Cadmium - Cytogenetic analysis - hamster ovary 1 µmol/l
Reproductive Effects Data: Cadmium: Oral male rat TDLo = 155 mg/kg - 13 weeks pre-mating - effects on newborn growth and behavior; Oral female rat TDLo = 23 mg/kg - 1-22 days after conception - blood and lymphatic system abnormalities
Magnesium Sulfate: Intraperitoneal at TDLo = 750 mg/kg (17 -21D pregnant): TER Sharp reduction in both the number and weight of offspring was observed
Ingredient Toxicological Data: Cadmium: Oral rat LD50 = 225 mg/kg, Inhalation rat LC50 = 25 mg/m^3/30 min; Gentisic acid Oral rat LD50 = 800 mg/kg; Sulfanilic acid Oral rat LD50 = 12.3 g/kg; KH_2PO_4 Oral rat LD50 = 7100 mg/kg

12. ECOLOGICAL INFORMATION

Product Ecological Information: --
No ecological data available for this product.
Ingredient Ecological Information: --
No ecological data available for the ingredients of this product.

13. DISPOSAL CONSIDERATIONS

Special Instructions (Disposal): Dispose of material in an E.P.A. approved hazardous waste facility.
Empty Containers: Rinse three times with an appropriate solvent. Rinsate from empty containers may contain sufficient product to require disposal as hazardous waste. Dispose of empty container as normal trash.
NOTICE (Disposal): These disposal guidelines are based on federal regulations and may be superseded by more stringent state or local requirements. Please consult your local environmental regulators for more information.

14. TRANSPORT INFORMATION

T.D.G.:
Proper Shipping Name: Not Currently Regulated
--
Hazard Class: NA
PIN: NA
Group: NA
Subsidiary Risk: NA
Additional Information: This product may be shipped as part of a chemical kit composed of various compatible dangerous goods for analytical or testing purposes. This kit would have the following classification: Proper Shipping Name: Chemical Kit Hazard Class: 9 UN Number 3316

15. REGULATORY INFORMATION

National Inventories:
Canadian Inventory Status: All ingredients of this product are DSL Listed.
This product has been classified in accordance with the hazard criteria of the CPR and the MSDS contains all of the information required by the CPR.

16. OTHER INFORMATION

References: 29 CFR 1900 - 1910 (Code of Federal Regulations - Labor). Air Contaminants, Federal Register, Vol. 54, No. 12. Thursday, January 19, 1989. pp. 2332-2983. TLV's Threshold Limit Values and Biological Exposure Indices for 1992-1993. American Conference of Governmental Industrial Hygienists, 1992. CCINFO RTECS. Canadian Centre for Occupational Health and Safety. Hamilton, Ontario Canada: 30 June 1993. Gosselin, R. E. et al. Clinical Toxicology of Commercial Products, 5th Ed. Baltimore: The Williams and Wilkins Co., 1984. IARC Monographs on the Evaluation of the Carcinogenic Risks to Humans. World Health Organization (Volumes 1-42) Supplement 7. France: 1987. List of Dangerous Substances Classified in Annex I of the EEC Directive (67/548) - Classification, Packaging and Labeling of Dangerous Substances, Amended July 1992. The Merck Index, 11th Ed. Rahway, New Jersey: Merck and Co., Inc., 1989. Technical Judgment. In-house information.

Legend:

NA - Not Applicable	w/w - weight/weight
ND - Not Determined	w/v - weight/volume
NV - Not Available	v/v - volume/volume

USER RESPONSIBILITY: Each user should read and understand this information and incorporate it in individual site safety programs in accordance with applicable hazard communication standards and regulations.

THE INFORMATION CONTAINED HEREIN IS BASED ON DATA CONSIDERED TO BE ACCURATE. HOWEVER, NO WARRANTY IS EXPRESSED OR IMPLIED REGARDING THE ACCURACY OF THESE DATA OR THE RESULTS TO BE OBTAINED FROM THE USE THEREOF.

APPENDIX G - LAND COVER CATEGORIES - EXAMPLE

CLOCA Cultural Land Cover Categories

Current version – March 2007

Land Cover	Examples
aggregate	quarries, clean fill storage
agriculture facility	barns, greenhouses, outbuildings, farm houses
athletic field	soccer fields, baseball diamonds (excludes institutional greenspace)
commercial	retail facilities, storage yards, marinas
crop field	grain, sod, tree nursery, hay
golf facility	golf course, driving range
industrial	factories, warehouses, scrap yards
institutional building	schools, hospitals, libraries, sports arena, community centre
institutional greenspace	school fields, manicured lawns
landfill	landfill
park	city park, community garden, cemetery
pasture	grazing/hay fields
pond	unvegetated stormwater, irrigation, and other man-made ponds
rural residential	estate residential, other rural residential
transportation corridor	roads, railways
transportation greenspace	mowed grassy verge
treed field	orchard, Christmas tree farm
urban residential	subdivision, hamlet, trailer park
utility corridor	pipelines, hydro lines
utility transfer station	hydro sub-station, gas pressure station, cellular/microwave towers

The **CLOCA Cultural Land Cover Categories** are intended to provide a classification system for areas within the CLOCA jurisdiction that can not be categorized by the Ecological Land Classification (ELC) for Southern Ontario (Lee et al. 1998). This classification system will provide a base from which queries, calculations, and mapping products can be produced through GIS applications.

The CLOCA land cover categories are not intended to be an end product to be distributed without manipulation. This system is subject to change pending revisions to the ELC first approximation. ELC takes precedence over CLOCA land cover categories and will be used when overlap occurs between the two.

Agriculture

Agriculture Facility:
Area containing buildings for agricultural production. Houses associated with the operation will be included, i.e. farm houses.

Crop Field:
Area that is tilled sometime during the year(s) for agricultural production. Some hay fields (short-term 2-3 years) may be included if the area is determined to be used exclusively for crop production and eventually tilled.

Pasture:
Area that is used for pasturing livestock and or hay production and probably will not be tilled in the future.

Treed Field:
Area containing an orchard or Christmas tree plantation.

Manicured Greenspace

Golf Facility:
Area containing a golf course or driving range.

Athletic Field:
Area containing an athletic field, e.g. community soccer field, baseball diamond. This does not include an athletic field that is associated with an institution, e.g. school soccer field, school baseball diamond.

Park:
Area containing a park, community garden, or cemetery.

Residential

Urban Residential:
Area containing a subdivision, hamlet, or trailer park.

Rural Residential:
Area containing residencies not covered by subdivision, hamlet, or trailer park.

Note: Official Plan Urban Boundaries will also be used to designate "Urban Residential".

Industrial & Commercial

Industrial:
Area containing factories and warehouses.

Commercial:
Area containing retail facilities.

Landfill & Aggregate

Landfill:
Area containing a landfill (active and non-active). This can also include the storage of scrap materials.

Aggregate:
Area containing a quarry or clean fill storage.

Institutional

Institutional Building:
Area containing a school, hospital, or library.

Institutional Greenspace:
Area containing greenspace associated with an institution, e.g. school soccer field or baseball diamond.

Transportation & Utility

Transportation Corridor:
Area containing a transportation corridor. This area generally includes land between property fence lines on both sides of the corridor. The corridor consists of remaining area after other land-use polygons have been mapped.

Utility Corridor:
Area containing a utility corridor. Since ELC and other land cover polygons often take precedence, utility corridors will have to be represented on a separate layer.

Utility Transfer Station:
Area containing a utility transfer station. This may include hydro sub-stations and natural gas pressure stations.