Central Lake Ontario Conservation

2009

Durham Region Coastal Wetland Monitoring Report

What we do on the land is mirrored in the water

Working In Partnership:

DURHAM REGION

Conservation ONTARIO Natural Champions

Report No.:

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Acknowledgements

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EXECUTIVE SUMMARY

The Durham Region Coastal Wetland Monitoring Project (DRCWMP) is a joint project carried out by the Central Lake Ontario Conservation Authority and Environment Canada with the assistance of the TRCA and GRCA. The project has evolved from an initial concept and agreement in principle in 1999, to a detailed monitoring plan that was implemented in 2002 and has been carried out through 2009. Fifteen coastal wetlands were originally identified for monitoring within Durham Region, and three additional wetlands were added to the project in 2007. The primary goal of the Durham Region Coastal Wetland Monitoring Project is to implement a long-term monitoring program that enables reporting on the condition of coastal wetlands in the Region. Through the DRCWMP the following biological and geophysical conditions were monitored in 18 coastal wetlands in 2009:

Geophysical

- Water Quality
- Water Levels

Biological

- Submerged Plant Community
- Fish Community
- Breeding Bird Community
- Amphibian Community
- Macroinvertebrate Community
- Wetland and Adjacent Upland Ecological Land Classification

In terms of wetland health, the geophysical conditions and biological communities of the Durham Region Coastal Wetlands are all impaired to some degree. Development and agricultural use of surrounding land, contamination and nutrient enrichment of waterways, loss of natural water level variability, and the introduction and spread of invasive species have all contributed to this impairment.

The degradation of water quality is a primary issue for all of the coastal wetlands. All of the wetlands but one were founded to have degraded water quality. This reflects the conditions of the watershed and inputs to watercourses that ultimately lead to the wetland. Urbanization, agriculture and a lack of natural cover are all contributing factors to the poor water quality found in these marshes.

Poor water quality and a lack of wetland and adjacent habitat contribute to the degradation of biological communities. . The SAV and amphibian communities were in ‘Fair’ condition on average in 2009. Submerged aquatic vegetation is stationary and amphibians live in the water for much of their life cycle and have permeable skin. These communities are therefore highly impacted by changes in water quality. The fish community was also in “Fair” condition on average in 2009. It is evident that poor water quality and a lack of habitat are also limiting the fish populations in all of the marshes. Those marshes that are disconnected from the lake also have poor fish communities since fish have little opportunity to enter these wetlands.

Bird communities were found to be in ‘Good’ condition on average in 2009. High bird IBIs appeared to be associated with availability of emergent marsh habitat. Bird communities were the healthiest at wetlands where habitat restoration efforts had occurred.

The Macroinvertebrate Community was also in ‘Good” condition on average in 2009. The health of macroinvertebrate communities is often used as an indicator of water quality, however the ‘Good’ condition on this community does not reflect the overall degraded condition of water quality found at all of the coastal marshes. Sampling effort and timing of surveys may have influenced these results.

Invasive species are increasingly becoming a problem in our coastal wetlands. They influence coastal wetlands by outcompeting and/ or preying upon important native species, as well as degrading habitat and water quality. Each year new invasive species are found in Durham’s wetlands or existing invasive species are found in wetlands they have not been previously encountered.

It is evident that the coastal wetlands of Durham Region have many negative influences that reduce their condition. Continued monitoring and examination of the impacts to these wetlands is necessary to evaluate the state of Durham’s coastal wetlands, trends in coastal wetland health over time, and how these wetlands can best be managed for the future.

1.0 INTRODUCTION

1.1 Project History

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 and has been carried out through 2009. A complete history of the project is described in the DRCWMP: 6-Year Technical Report (EC and CLOCA Draft) which is in draft and will be released in 2010. This report represents the culmination of data available through six years of the DRCWMP.

1.2 Project Goals

The primary goal of the DRCWMP is to implement a long-term monitoring program that enables reporting on the condition of coastal wetlands in the Durham Region. The information collected through the monitoring program will be used to assess the impacts of human activities on these wetlands and provide direction for future restoration efforts.

Through the DRCWMP the following biological and geophysical conditions are monitored:

Biological

- Submerged Plant Community
- Fish Community
- Breeding Bird Community
- Amphibian Community
- Macroinvertebrate Community
- Wetland and Adjacent Upland Ecological Land Classification

Geophysical

- Water Quality
- Water Levels
- Sediment Quality
- Wetland Bathymetry
- Watershed Natural and Cultural Land Cover
- Land Cover Changes in Adjacent Uplands
- Public Ownership of Watershed Lands
- Sediment/Nutrient Loading

Many of the conditions listed above are monitored at each wetland annually; however some are updated over a longer time period for conditions that change on a slower time scale. The following table outlines the monitoring schedule for all of the conditions.

Table 1. Monitoring schedule for conditions monitored in the DRCWMP.

Condition	Monitoring Schedule
Biological	
Submerged Plant Community	Annually
Fish Community	Annually
Breeding Bird Community	Annually
Amphibian Community	Annually
Macroinvertebrate Community	Annually
Submerged Plant Community	Annually
Wetland and Adjacent Upland Ecological Land Classification	Every 5-10 years
Geophysical	
Water Quality	Annually
Water Levels	Annually
Sediment Quality	Every 5 years
Wetland Bathymetry	As needed
Watershed Natural and Cultural Land Cover	Updates as needed or as data becomes available
Land Cover Changes in Adjacent Uplands	Updates as needed or as data becomes available
Public Ownership of Watershed Lands	Updates as needed or as data becomes available
Sediment/Nutrient Loading	As needed

Managers, policy-makers and society-at-large can use this information to decide if current wetland conditions are acceptable, to set biological goals for the wetlands, and to assist in the development of conservation and/or restoration activities.

1.3 Study Sites

Within Durham Region, 15 coastal wetlands were originally identified for monitoring. Recent wetland evaluations conducted by the Ontario Ministry of Natural Resources (OMNR) resulted in three additional coastal wetlands receiving Provincially Significant Wetland status (OMNR 2006, 2007a/b). In recognition of these new designations, the DRCWMP has taken steps (starting in 2007) to extend the DRCWMP framework to include monitoring of these wetlands. Eighteen wetlands throughout the Region are now being monitored (Figure 4). These wetlands vary in size, level of disturbance and hydrogeomorphic features. The source of hydrologic input to the wetland is an important factor in determining the influence of adjacent human activities on the biological condition of the wetland. For this reason, coastal wetlands are divided into two classes based on the geomorphic formation and dominant hydrological input, i.e., barrier beach lagoon or drowned river-mouth (Table 1).

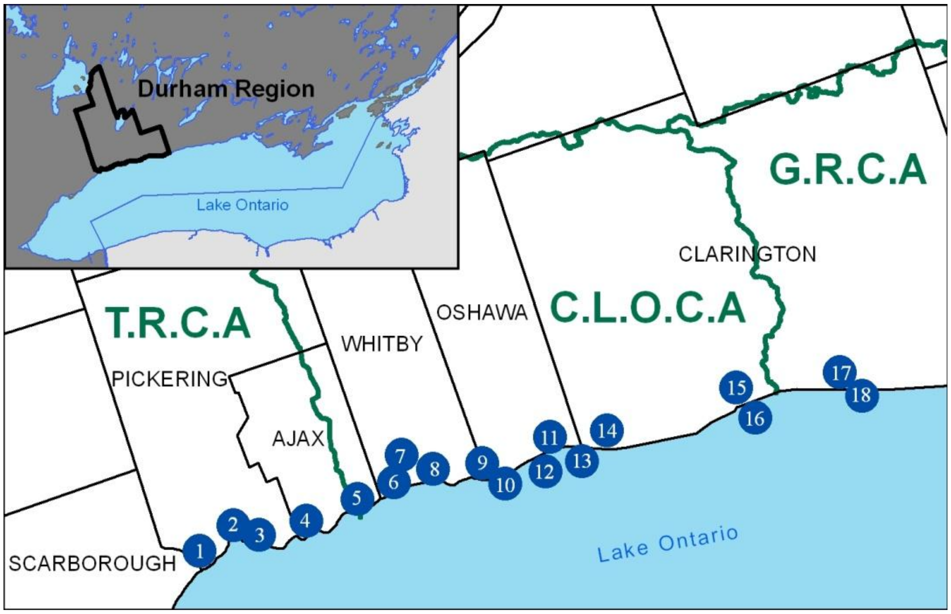

Figure 1. The location of the 18 Durham Region coastal wetlands. Wetlands associated with keymap numbers are located in Table 1.

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

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

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

Table 2. Durham Region coastal wetlands included in the monitoring program. Wetlands are ordered from west to east.

Wetland Name	Keymap Number	Wetland Type*	Conservation Authority**	Area (hectares)
Rouge River Marsh	1	DR	TRCA	59
Frenchman's Bay Marsh	2	BB	TRCA	23
Hydro Marsh	3	BB	TRCA	24
Duffins Creek Marsh	4	DR	TRCA	69
Carruthers Creek Marsh	5	DR	TRCA	141
Cranberry Marsh	6	BB	CLOCA	47
Lynde Creek Marsh	7	DR	CLOCA	130
Whitby Harbour Marsh	8	DR	CLOCA	8

Wetland Name	Keymap Number	Wetland Type*	Conservation Authority**	Area (hectares)
Corbett Creek Marsh	9	DR	CLOCA	21
Gold Point Marsh	10	DR	CLOCA	4
Oshawa Creek Marsh	11	DR	CLOCA	20
Pumphouse Marsh	12	BB	CLOCA	7
Oshawa Second Marsh	13	BB	CLOCA	133
McLaughlin Bay Marsh	14	BB	CLOCA	42
Westside Marsh	15	BB	CLOCA	45
Bowmanville Marsh	16	DR	CLOCA	29
Wilmot Creek Marsh	17	DR	GRCA	26
Port Newcastle Marsh	18	DR	GRCA	8

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

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

1.4 Report Purpose

The purpose of this report is to summarize the results derived from field data collected in 2009, which includes monitoring for all of the biological community condition parameters, as well as geophysical parameters including water quality and water levels. The other geophysical parameters (listed under Section 1.2) have been previously reported on (EC and CLOCA 2004).

2.0 METHODS

2.1 Field Survey Methods

In 2009, field sampling protocols for all 18 coastal wetlands followed those found in the Durham Region Coastal Wetland Monitoring Project: Methodology Handbook (EC and CLOCA 2007) with the following exceptions:

Annual Water Quality

- Chlorophyll a was not sampled as it has been determined that the data obtained from previous years is not consistently accurate using the method set out in the methodology handbook.
- In each wetland, three additional locations were sampled for water quality, for a total of six replicates. However, only three replicates were done at Gold Point Marsh due to the limited amount of suitable habitat for sampling.

Fish

- Gold Point Marsh was not sampled for fish due to insufficient open water area to use the Electro-fishing boat.
- Cranberry Marsh was also not sampled as the water depth is too shallow to use the Electro-fishing boat.

Submerged Aquatic Vegetation (SAV)

- Gold Point Marsh was not sampled as SAV habitat is not present (no slow-moving shallow water areas).

Birds/Amphibians

- Whitby Harbour Marsh, being one of the three newly added wetlands, was not sampled as a Marsh Monitoring route has not yet been established for this wetland. It is anticipated that bird/amphibian monitoring will begin in 2010.

Many of the surveys undertaken for the monitoring of birds and amphibians are carried out by volunteers. Without the generous help of these volunteers it would not be possible to complete all of the surveys each year.

2.2 Wetland Assessment Methods

To report on the condition of biological communities, EC and CLOCA (2004) developed Indices of Biotic Integrity (IBIs) from data collected in coastal wetlands across the Canadian side of Lake Ontario. The development of IBIs is a multimetric approach. Metrics are biological attributes that are known to respond in specific and predictable ways to changes in wetland condition. Once a suite of suitable metrics are defined for a biotic community, the metrics are scored, standardized and combined. The multimetric IBI incorporates several suitable biological attributes to increase the accuracy in describing the condition of the particular biological community. This creates an IBI (scored out of 100) for the particular community. Five IBI condition classes were identified using methods outlined in EC and CLOCA (2004) according to ranges in IBI scores: 'Poor' (0-20), 'Fair' (20-40), 'Good' (40-60), 'Very Good' (60-80), and 'Excellent' (80-100). Details of the scoring, standardizing, and combining of metrics are described in Section 3.2 of EC and CLOCA (2004), and EC and CLOCA (2005). Information about the adaptive development associated with biological community IBIs can be found in Section 2.1 of the 6-Year Technical Report (EC and CLOCA Draft).

3.0 GEOPHYSICAL CONDITION

3.1 Water Levels

Results

In 2009, water levels were measure at nine coastal wetlands that are either permanently or periodically disconnected from Lake Ontario. Wetlands that were closed off from the lake throughout the growing season (Cranberry, Pumphouse, McLaughlin Bay) showed similar water level trends that were higher than Lake Ontario water levels (Figure 2). These wetlands have small watersheds with no main creek inflow. Inputs to the wetlands are primarily from overland flow and piped drainage. The low levels of inflow at Pumphouse and McLaughlin Bay keep water levels in the wetland perched above Lake Ontario but not high enough that they exert enough pressure on the barrier beach to break it open. The water level at Cranberry Marsh is managed by a water-control structure along the barrier beach which isolates the wetland from the lake. In 2009, the control structure kept the wetland's water level higher than Lake Ontario.

Lynde Creek and Wilmot Creek water levels were fairly stable and followed the Lake Ontario level throughout the season. Lynde Creek's water level was slightly higher than Lake Ontario while Wilmot Creek was at approximately the same level. Both of these wetlands have a steady inflow from a large river and remained open to the lake throughout the growing season.

Westside and Corbett showed high water level variation throughout the growing season. Westside Marsh remained separated from the lake for the first few months of the season. The water level was consistently higher than Lake Ontario during that time until about the end of July when the water level was high enough that the pressure caused the barrier beach to break open and water drained out of the wetland (see photo to the right). The beach stayed open for a couple of weeks during which time the water level stabilized to that of Lake Ontario. The beach quickly built up again and closed and the water level in the wetland went back up above the Lake Ontario level for the remainder of the growing season. Corbett Creek was open to the lake for most of the growing season, however the opening to the lake was small, and flashy conditions in the creek caused the water level to rise and fall over short periods of time.

Oshawa Second Marsh had a stable water level that was slightly higher, but similar, to that in Lake Ontario. The water level at this wetland is controlled by a water-control structure and a pump managed by Ducks Unlimited. The water-control structure was vandalized in 2009, resulting in the marsh being left open to Farewell Creek, and therefore Lake Ontario, for much of the season.

Data retrieved from the water level logger revealed that the Gold Point water level closely followed that of Lake Ontario until the end of July when the level dropped significantly below the Lake Ontario level.

When the water level logger was retrieved in the September, its holder had fallen over. This likely happened around the end of the July resulting in inaccurate lower water level readings. Gold Point remained open to the lake throughout the growing season and despite the data, it is more likely that water levels were maintained close to those of the Lake.

Staff are able to compare the wetland water levels to the Lake Ontario water level through information provided by the Canadian Hydrographic Service (http://charts.gc.ca/pun/en/). The water level in Lake Ontario was fairly consistent from April –August and then began to lower from late August to October.

Discussion

Overall in 2009, wetlandwater levels could be classified into three groups in the monitored coastal wetlands. In the first group the marshes remained open to the lake throughout the growing season and water levels closely followed that of Lake Ontario (Lynde Creek Marsh, Gold Point Marsh, Oshawa Second Marsh, Wilmot Creek Marsh). In the second group the marshes remained separated from the lake by a barrier beach throughout the growing season and water levels remained perched above that of Lake Ontario (Cranberry Marsh, Pumphouse Marsh, McLaughlin Bay Marsh). In the third group marshes were periodically open and closed to the lake throughout the growing season resulting in fluctuating water levels (Corbett Creek Marsh, Westside Marsh). When the barrier beach was closed these marshes had water levels perched above Lake Ontario until water pressure built up to the point where the beach broke open. As the marsh drained, water levels in the marshes lowered to that of Lake Ontario. When the barrier beach built back up again, water levels began to rise in the marshes.

In addition to the effects of barrier beach formation, there were minor fluctuations in water levels in all of the wetlands over a shorter time scale (days). For those wetlands open to the lake, short-term fluctuations in water level may be the result of influences from storm surges, lake seiches and wind pushing water from Lake Ontario into and out of the wetland. For those wetlands closed off from the lake, water level fluctuations are the result of precipitation events and the associated runoff that enters the wetland.

Both barrier beach dynamics and short-term water level influences can result in rapid changes in water level over a short period of time, which the plants and animals inhabiting these communities must be adapted to. Depending on the timing and magnitude of these changes, significant effects on wildlife can occur. During the fish spawning and marsh bird nesting seasons, extreme water level fluctuations can affect the availability of suitable habitat and the successful production of offspring.

All of the wetlands in 2009 followed a general seasonal water level trend with higher water levels in the spring and lower water levels in autumn. Lake Ontario's water levels followed this same seasonal trend. In the spring water levels are higher due to runoff, increased groundwater flow and spring rainfall. As the season progresses the combined effects of higher air temperatures, increased evaporation and reduced runoff lead to a decline in water levels through the autumn. Plants and wildlife are generally adapted to this seasonal variation. Higher water levels in spring and early summer benefit wildlife during the breeding season as they provide suitable habitat for breeding and nesting.

Fluctuations in water levels over the long-term (years-decades) are important for coastal wetlands. Water level fluctuations are necessary to maintain high vegetation species diversity in wetlands: dominant emergent species (e.g., *Typha* spp.) can be curtailed when water levels are not suitable for them. In addition, fluctuating water levels help flush out the wetlands and, during low water periods, favourable conditions for seed germination often occur in exposed sediments. However, since 1958, Lake Ontario water levels have been regulated at the Saunders-Moses dam in Cornwall, which results in less extreme water level fluctuations than would otherwise naturally occur.

Because of the importance of long-term water level fluctuations in coastal wetlands, water level control is often used in the management or restoration of these wetlands. Such has been the case for restoration projects involving Cranberry Marsh and Oshawa Second Marsh. Water level control structures have been put in place at both of these wetlands so that periodic water level drawdowns can be implemented to promote seed germination, maintain the open water – emergent vegetation balance, increase species diversity and maintain healthy aquatic habitats.

The continued monitoring of coastal wetland water levels will enable the tracking of changes over time and the comparison of water levels to biological parameters.

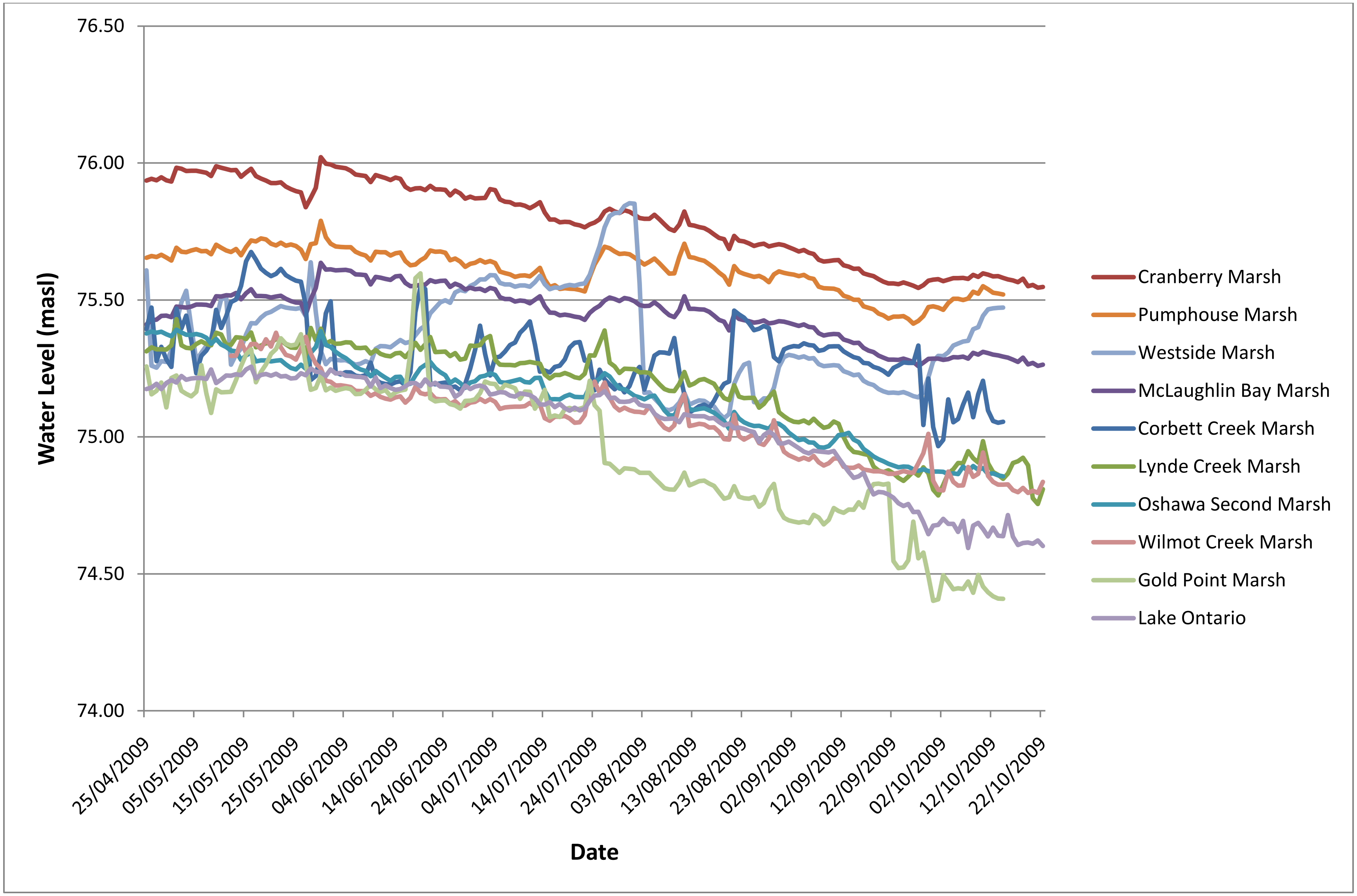

Figure 2. Water Levels from nine Durham Region coastal wetlands with actual or potential hydrologic isolation from Lake Ontario (through barrier beach formation).

3.2 Annual Water Quality

Results

Chow-Fraser (2006) developed a Water Quality Index (WQI) to report on water quality in Great Lakes coastal wetlands. The WQI used for this project is based on 4 water quality variables: pH, conductivity, turbidity and temperature. Based on the range of WQI scores for Great Lakes wetlands, Chow-Fraser (2006) divided the dataset into six categories (Table 3) ranging from greater than -3 to less than +3. These same ratings have been applied to WQIs calculated for Durham Region wetlands in this report.

Table 3. WQI scores and categories based on Chow-Fraser (2006).

WQI Score	Category
+3 to +2	Excellent
+2 to +1	Very Good
+1 to 0	Good
0 to -1	Moderately Degraded
-1 to -2	Very Degraded
-2 to -3	Highly Degraded

In each sampling year, a mean WQI score for each wetland was calculated based on the average water parameter value for all of the annual replicate sampling stations sampled.

In 2009, WQI values ranged from 0.28 ('Good') to -2.17 ('Highly Degraded') as can be seen in Table 3. Cranberry Marsh was the only wetland to receive a 'Good' WQI score. This marsh had considerably lower conductivity and turbidity than the other marshes. The majority of the marshes scored in the 'Moderately Degraded' and 'Very Degraded' categories. The two marshes with the poorest water quality scored in the 'Highly Degraded' category, Gold Point Marsh (WQI of -2.17) and McLaughlin Bay Marsh (WQI of -2.02). Gold Point Marsh had higher turbidity and conductivity readings than all of the other marshes. McLaughlin Bay Marsh had high values in all water quality parameters in comparison to the other marshes.

Table 4. Mean water quality parameter values and Water Quality Index (WQI) scores for 2009.

Wetland	Temperature	pH	Conductivity	Turbidity	WQI	Condition
Rouge River Marsh	21.80	7.60	710.22	7.02	**-0.66**	**Moderately Degraded**
Frenchman's Bay Marsh	20.65	8.10	544.35	8.80	**-0.63**	**Moderately Degraded**
Hydro Marsh	22.79	7.94	876.99	16.44	**-1.38**	**Very Degraded**
Duffins Creek Marsh	21.33	8.43	570.65	9.18	**-0.76**	**Moderately Degraded**
Carruthers Creek Marsh	19.62	8.09	774.25	23.97	**-1.43**	**Very Degraded**
Cranberry Marsh	20.27	7.22	295.33	4.78	**0.28**	**Good**
Lynde Creek Marsh	19.17	7.37	688.83	21.77	**-1.19**	**Very Degraded**
Whitby Harbour Marsh	19.40	7.35	1022.67	35.08	**-1.74**	**Very Degraded**
Corbett Creek Marsh	19.41	7.14	740.50	14.93	**-0.99**	**Moderately Degraded**
Goldpoint Marsh	20.51	7.57	1315.00	47.38	**-2.17**	**Highly**

Wetland	Temperature	pH	Conductivity	Turbidity	WQI	Condition
						Degraded
Pumphouse Marsh	19.49	7.45	524.17	14.34	**-0.77**	**Moderately Degraded**
Oshawa Creek Marsh	18.92	7.73	852.17	13.22	**-1.07**	**Very Degraded**
Oshawa Second Marsh	21.58	7.54	733.33	27.88	**-1.48**	**Very Degraded**
McLaughlin Bay Marsh	23.87	8.10	961.83	39.55	**-2.02**	**Highly Degraded**
Westside Marsh	23.25	7.50	820.67	10.76	**-1.04**	**Very Degraded**
Bowmanville Marsh	21.36	7.47	420.17	7.91	**-0.33**	**Moderately Degraded**
Wilmot Creek Marsh	17.16	7.51	583.00	16.40	**-0.84**	**Moderately Degraded**
Port Newcastle Marsh	20.41	7.51	454.00	22.98	**-1.00**	**Very Degraded**
AVERAGE					**-1.07**	**Very Degraded**

In addition to the water quality parameters used in the WQI, several other water quality measurements were obtained as part of the annual water quality monitoring in 2009. These include dissolved oxygen, alkalinity, total phosphorus (TP), nitrate nitrogen (NO_3), and ammonia (NH_4). A summary of all of the annual water quality values for 2009 can be found in Table 4.

Dissolved oxygen levels were highest at Wilmot Creek Marsh (12.32 mg/L) and McLaughlin Bay Marsh (11.31 mg/L) and were lowest at Cranberry Marsh (3.63 mg/L) and Pumphouse Marsh (3.64 mg/L). Alkalinity was also highest at Wilmot Creek Marsh (196.67 mg/L) and lowest at Pumphouse Marsh (83.33 mg/L).

Both ammonia and nitrate nitrogen levels were highest at Whitby Harbour Marsh (0.28 and 8.73 mg/L respectively). Ammonia levels were lowest at Cranberry Marsh (0.02 mg/L) and nitrate nitrogen levels were lowest at Rouge River Marsh (0 mg/L).

Total phosphorus level were highest at Oshawa Second Marsh (0.23 mg/L) and lowest at Duffins Creek Marsh (0.03 mg/L).

Discussion

These results show that water quality is in a state of some degree of degradation in all of Durham's coastal wetlands. Degradation of water quality can occur for a variety of reasons such as: nutrient and sediment inputs from upstream sources related to anthropogenic land uses in the watershed, point-source inputs from surrounding facilities, and increased turbidity from Common Carp activity in the wetland. All of these factors influence the parameters measured as part of the annual water quality monitoring, thereby influencing overall water quality as measured by the WQI.

Poor water quality has further implications for the biological communities in the marsh. For example, turbid waters generally have poorer SAV species richness and growth because light is unable to penetrate deep within the water column. This decrease in aquatic vegetation also makes the wetland less suitable for birds, fish, amphibians and macroinvertebrates that rely on it for food and/or habitat. High turbidity can also affect the rate of prey capture by piscivorous (fish-eating) fish, which acts as an advantage to prey fish species.

Higher water temperatures reduce the ability of water to hold oxygen, therby decreasing dissolved oxygen concentrations, which has negative impacts on fish and other aquatic organisms that rely on oxygen in the water for respiration.

Optimal pH values for freshwater systems are between 6 and 8.5 (Kalff, 2002). Deviations from this norm can lead to reduced species richness of biota in the wetland when organisms are not adapted to such conditions.

High nutrient levels (nitrogen and phosphorus) lead to eutrophication of aquatic systems. Eutrophication results in an increase in primary production which is often accompanied by algal blooms, increased growth of macrophytes, increased turbidity, and reduced nighttime dissolved oxygen levels. These changes can have several negative effects on wetland ecosystems including reduced biodiversity, changes in species composition and dominance, as well as toxicity effects on aquatic organisms.

While it is difficult to detect causal relationships between poor water quality and changes in biological community condition, the degraded water quality and poor condition of many biological communities in Durham's coastal marshes is definitely a cause for concern.

Continued water quality monitoring is necessary to assess the effects of anthropogenic activities and Common Carp on the health of these coastal wetlands. The existing poor water quality results, and associated implications for biological communities, underlie the need for restoration and remediation efforts to restore and conserve wetland functions.

Table 5. Mean annual water quality values for Durham Region coastal wetlands in 2009 based on daily mean values recorded in July.

Wetland	C	pH	Dissolved Oxygen mg/L	Conductivity µS/cm	Turbidity NTU	Alkalinity mg/L	NO_3 mg/L	Total Phosphorus mg/L	NH_4 mg/L
Rouge River Marsh	21.80	7.60	4.73	710.22	7.02	186.67	0.00	0.07	0.04
Frenchman's Bay Marsh	20.65	8.10	9.01	544.35	8.80	150.00	0.93	0.10	0.11
Hydro Marsh	22.79	7.94	8.89	877.32	16.63	190.00	0.53	0.17	0.04
Duffins Creek Marsh	20.60	8.15	8.57	587.02	11.90	183.33	0.40	0.03	0.07
Carruthers Creek Marsh	19.62	8.09	8.04	774.25	23.97	180.00	0.28	0.07	0.14
Cranberry Marsh	20.27	7.22	3.63	295.33	4.78	94.17	1.13	0.20	0.02
Lynde Creek Marsh	19.17	7.37	7.00	688.83	21.78	146.67	0.30	0.09	0.11
Whitby Harbour Marsh	19.40	7.35	6.98	1022.67	35.08	117.50	8.73	0.18	0.28
Corbett Creek Marsh	19.41	7.14	5.93	740.50	14.93	130.00	0.28	0.07	0.20
Goldpoint Marsh	20.51	7.57	7.53	1315.00	47.38	176.67	0.10	0.10	0.13
Oshawa Creek Marsh	18.92	7.73	7.87	852.17	13.23	179.17	0.63	0.05	0.16
Oshawa Second Marsh	21.58	7.54	7.20	733.33	27.88	174.17	0.07	0.23	0.08
McLaughlin Bay Marsh	23.87	8.10	11.31	961.83	39.55	120.00	0.07	0.13	0.11
Pumphouse Marsh	19.49	7.45	3.64	524.17	14.34	83.33	0.25	0.09	0.04
Westside Marsh	23.25	7.50	7.02	820.67	10.76	175.00	0.17	0.05	0.04
Bowmanville Marsh	21.36	7.47	6.70	420.17	7.91	165.00	0.47	0.08	0.04
Wilmot Creek Marsh	17.16	7.51	12.32	583.00	16.40	196.67	1.07	0.05	0.06
Port Newcastle Marsh	20.41	7.51	7.26	454.00	22.98	171.67	0.17	0.05	0.07

3.3 Monthly Water Quality

Results

In addition to annual water quality measurements, monthly water quality samples were also taken at each of the coastal wetlands throughout the growing season (May-Sept). From 2002-2007 turbidity values were collected. Beginning in 2008, several additional values were collected at many of the wetlands including water temperature, pH, conductivity, total dissolved solids (TDS) and salinity. Table 5 summarizes the average monthly water quality values collected for each of the coastal wetlands in 2009.

Table 6. Mean water quality values for Durham coastal wetlands in 2009 based on monthly mean values recorded from May to September. Monthly mean values are based on daily means of multiple readings in the wetland recorded in one day.

Wetland	Turbidity Average (NTU)	C)	Conductivity Average (µS/cm)	pH Average	TDS Average (ppm)	Salinity Average (ppm)
Rouge River Marsh	20.81	18.06	675.29	7.95	510.29	--
Frenchman's Bay Marsh	16.12	19.34	459.67	9.08	336.50	--
Hydro Marsh	35.45	20.58	877.00	7.85	679.44	--
Duffins Creek Marsh	51.98	20.78	497.23	8.64	357.80	--
Carruthers Creek Marsh	47.25	20.67	708.50	8.32	513.33	--
Cranberry Marsh	3.51	19.67	340.50	8.46	227.50	162.83
Lynde Creek Marsh	20.84	18.64	767.63	8.40	512.88	371.75
Whitby Harbour Marsh	18.17	18.98	1300.00	7.99	795.67	708.67
Corbett Creek Marsh	24.76	19.99	1515.55	8.27	1016.15	762.90
Goldpoint Marsh	20.20	19.85	3546.42	8.48	2298.33	1891.50
Pumphouse Marsh	3.52	24.00	762.44	9.61	512.81	372.06
Oshawa Creek Marsh	14.86	17.52	856.33	8.64	551.67	507.25
Oshawa Second Marsh	31.34	22.26	713.06	8.10	479.00	344.75
McLaughlin Bay Marsh	38.57	21.28	1025.58	8.73	673.75	502.67
Westside Marsh	15.04	20.87	896.08	8.33	599.00	435.67
Bowmanville Marsh	14.04	19.02	504.25	8.28	339.25	242.58
Port Newcastle Marsh	18.58	16.40	474.58	8.40	--	--
Wilmot Creek Marsh	12.88	13.49	612.08	8.54	--	--

-- indicates that data was not recorded for that wetland in 2009.

Based on the average monthly values observed in 2009, Gold Point Marsh had the highest conductivity (3546.42 µS/cm), TDS (2298.33 ppm), and salinity (1891.5 ppm) values. On the other hand, Cranberry Marsh had the lowest conductivity (340.5 µS/cm), TDS (227.5 ppm) and salinity (162.83 ppm) values.

C). Pumphouse Marsh also had the highest pH value (9.61) and the lowest pH value was at Hydro Marsh (7.85).

A turbidity reading of 30 Nephelometric Turbidity Units (NTU) was used as a benchmark for high turbidity in coastal wetlands (Canadian Council of Ministers of Environment 1999). Five wetlands were found to have average monthly values above this benchmark, including Duffins Creek Marsh (51.98) Carruthers Creek Marsh (47.25), McLaughlin Bay Marsh (38.57), Hydro Marsh (35.45) and Oshawa Second Marsh (31.34). The lowest turbidity values were found at Cranberry Marsh (3.51) and Pumphouse Marsh (3.52).

Discussion

Monthly water quality measurements are collected as supplemental information to the annual water quality data. These measurements give a better picture of the water quality conditions in the marsh throughout the growing season rather than at just one point in time. Initially only turbidity readings were recorded, however since 2008 water temperature, conductivity, pH, total dissolved solids and salinity data are also being collected.

As mentioned in the previous section, high turbidity levels can have detrimental effects on biological communities in the marsh. Five wetlands in 2009 were found to have average monthly turbidity readings above 30 NTUs which is a sign that turbidity levels are high enough to be having these detrimental effects.

Conductivity, Total Dissolved Solids and Salinity measurements are all related variables as they measure the amount of dissolved ions in the water. High levels in these three parameters may signal significant pollutant input sources such as wastewater, urban runoff and agricultural runoff, all of which contribute dissolved ions to water. Gold Point Marsh was found to have the highest average values for all three of these parameters. This marsh is in a small watershed which is highly industrialized. The stream which runs through it where water quality is collected, receives a large amount of urban runoff that likely contributes to the dissolved ion concentrations in the water. Cranberry marsh was found to have the lowest values for these parameters. Cranberry marsh has a small, primarily naturally vegetated watershed and has no stream inputs.

Water temperature affects the amount of dissolved oxygen that can be held in the water with warmer waters having reduced ability to hold oxygen. The highest average water temperature was recorded at Pumphouse Marsh. While reduced oxygen may impact some aquatic organisms at this marsh, effects to fish will be minimal since the marsh does not generally support a large fish population as it is generally isolated from Lake Ontario and has no stream inputs. Low average water temperatures were found at Wilmot Creek Marsh and Port Newcastle Marsh which have large cool water streams flowing through them as they are located in less developed watersheds than the other marshes. Fish populations tend to be healthier in these wetlands.

As mentioned above, pH values outside the normal range (6-8.5) for freshwater systems can lead to reduced species richness of biota in the wetland since most freshwater organisms are not adapted to such conditions. Durham coastal wetlands were generally within this normal range, with the exceptions of Frenchman's Bay Marsh (9.08) and Pumphouse Marsh (9.61) which were slightly above this range. It is possible that high pH levels at these marshes are resulting in the loss of aquatic organisms or are increasing the toxicity of other compounds.

Due to the variability in people collecting the monthly water quality data, not all of this data was collected consistently in 2008 and 2009. As this program progresses it is anticipated that all six variables will be collected on a monthly basis at each wetland and that the data may eventually be used to calculate Water Quality Index (WQI) values representative of average growing season conditions.

4.0 Biological Condition

4.1 Wetland and Adjacent Upland Ecological Land Classification

Results

Ecological Land Classification (ELC), to the Vegetation Type level (Lee *et al.* 1998) where possible, was completed for the Oshawa Creek Coastal Wetland. This included all community polygons within the wetland itself as well as the uplands within 500 m of the delineated wetland edge. An existing ELC Community Series layer was adjusted and several polygons were re-digitized to allow classification to the Vegetation Type level. The ELC communities have been summarized to Ecosite, or Vegetation Type where possible, in Table 7.

Table 7. Summary of ELC Ecosites/Vegetation Types in the Oshawa Creek Coastal Wetland and within 500 meters of its wetland boundary.

ELC Ecosite/ Vegetation Type	ELC Code	Number of Polygons	Hectares	Percent of Total Study Area
Cultural				
Mineral Cultural Meadow Ecosite	CUM1	6	8.07	2.54%
Coniferous Plantation Ecosite	CUP3	1	0.60	0.19%
Mineral Cultural Thicket Ecosite	CUT1	1	0.54	0.17%
Mineral Cultural Woodland Ecosite	CUW1	2	1.75	0.55%
Total		**10**	**10.97**	**3.45%**
Forest				
Dry-Fresh Deciduous Forest Ecosite	FOD4	4	0.67	0.21%
Dry-Fresh Beech Deciduous Forest	FOD4-1	1	4.52	1.42%
Fresh-Moist Ash Lowland Deciduous Forest	FOD7-2	3	3.29	1.03%
Fresh-Moist Lowland Deciduous Forest Ecosite	FOD7	5	13.52	4.25%
Fresh-Moist Willow Lowland Deciduous Forest	FOD7-3	4	6.56	2.06%
Fresh-Moist Hemlock Mixed Forest	FOM6	3	3.72	1.17%
Total		**20**	**32.28**	**10.15%**
Marsh				
Reed-canary Grass Mineral Meadow Marsh	MAM2-2	3	3.92	1.23%
Mineral Meadow Marsh Ecosite	MAM2	3	1.19	0.37%
Mineral Shallow Marsh Ecosite	MAS2	3	0.78	0.25%
Total		**9**	**5.89**	**1.85%**
Swamp				
Willow Mineral Deciduous Swamp	SWD4-1	4	12.69	3.99%
Willow Mineral Thicket Swamp	SWT2-2	1	0.30	0.10%
Total		**5**	**12.99**	**4.09%**
Open Water				
Open Aquatic	OAO	5	17.80	5.60%
Beach/Bar				
Mineral Open Beach Ecosite	BBO1	1	0.43	0.14%
Total		**50**	**80.36**	**25.27%**
Total Study Area			**317.95**	**100%**

Overall, within Oshawa Creek Marsh and the 500 meter buffer study area, 25.27% (80.36 ha) of the land is occupied by natural and cultural ELC communities. Forests have the highest overall land cover in the study area occupying 32.28 ha in total. All of the forest communities are associated with the valleys of Oshawa and Montgomery Creeks. The lowland forest communities are dominated by Reddish Willow (*Salix x rubens*)and Manitoba Maple (*Acer negundo*) in the canopy with an abundance of Garlic Mustard(*Alliaria petiolata*), Wood Nettle (*Laportea Canadensis*), Slender Stinging Nettle (*Urtica dioica ssp. gracilis*)and Spotted Jewel-weed (*Impatiens capensis*) in the ground layer. The upland forests are dominated by Manitoba Maple in the canopy with some American Beech (*Fagus grandifolia*), Sugar Maple (*Acer saccharum ssp. saccharum*), Hemlock (*Tsuga canadensis*) and Black Cherry (*Prunus serotina*) as well. There are also several Mixed Forests with canopies dominated by Hemlock, White Cedar (*Thuja occidentalis*), Manitoba Maple, White Pine (*Pinus strobus*),and Sugar Maple.

The second most dominant community is the Open Aquatic ELC type which has a total land cover of 17.8 ha. The majority of this area is found in the open water of Oshawa Harbour and Lake Ontario, the rest is comprised of Oshawa Creek and Montgomery Creek which feed into the harbour from the northwest and northeast respectively.

Swamps occupy 4.09 % (12.99ha) of the study area (see photo to the right). The Willow Mineral Deciduous Swamps are located in the lowland riparian areas of Oshawa Creek. They are dominated by Reddish Willow, Green Ash (*Fraxinus pennsylvanica*) and Manitoba Maple canopies with an abundance of Wood Nettle, Ostrich Fern (*Matteuccia struthiopteris var. pensylvanica*), Spotted Jewel-weed and Garlic Mustard in the ground layer. There is also a Willow Mineral Thicket Swamp adjacent to a small tributary that feeds Montgomery Creek.

Marshes occupy a smaller portion of the study area with a total coverage of 5.89 ha. The most extensive area of marsh is a Reed Canary Grass Mineral Meadow Marsh adjacent to Oshawa Creek, immediately west of Simcoe Street. The other meadow marshes are small pockets associated with the riparian zones of the creeks and their tributaries. Meadow marshes in the study area have an abundance of Reed Canary Grass (*Phalaris arundinacea*), Spotted Jewel-weed, Tall goldenrod (*Solidago altissima var. altissima*), Narrow-leaved Cattail (*Typha angustifolia*), Purple Loosestrife (*Lythrum salicaria*), Lake-bank Sedge (*Carex lacustris*) and Canada Blue-joint (*Calamagrostis canadensis*). There are also three small shallow marsh communities located in the lowland areas next to Oshawa Creek. Reed-canary Grass, Spotted Jewel-weed, Horsetail (*Equisetum sp*.), Lesser Duckweed (*Lemna minor*) and Red-osier Dogwood (Cornus sericea ssp. sericea) are abundant in these communities.

There is one Mineral Open Beach community in the study area with a total coverage of 0.43 ha. This community is located along the shore of Lake Ontario and is very sparsely vegetated.

The remaining communities have cultural vegetation cover and include cultural meadows, woodland, thicket and plantation. These communities are found along the edges of the Oshawa and Montgomery

Creek valleys adjacent to lands with anthropogenic uses. Figure 3 shows all of the ELC communities that were mapped within the study area.

Discussion

Within Oshawa Creek Marsh and its 500 meter buffer only 25% of the land is occupied by ELC vegetation communities. These communities are primarily forested – upland and lowland forests and swamps. Almost all of the vegetation communities in the study area are associated with valleys and watercourses as the rest of the land has been built up with anthropogenic land uses or has been converted to park land. The natural ELC communities are adjacent to the watercourses or are in low-lying areas, and the cultural communities are located between the natural communities and the adjacent anthropogenic land uses. The cultural communities represent successional areas where the land was once cleared or used for anthropogenic purposes but has been left to regenerate in recent years.

The existing vegetation communities within the study area are important for the wetland as they provide a number of ecological functions including provision of wildlife habitat, floodwater storage, nutrient retention, water filtration, and erosion control. However, because of the high percentage of anthropogenic land uses in the study area, significant degradation of these vegetation communities has occurred. One of the most destructive impacts to these communities has been the introduction and spread of non-native and invasive plant species. Invasive species reproduce and spread rapidly and out-compete native species. The spread of these plants has resulted in a loss of biodiversity in these communities and the degradation of available habitat for wildlife. Additional anthropogenic impacts observed in the study area include yard waste and garbage dumping, noise, erosion of valley walls, sedimentation, nutrient and contaminant inputs, trails, recreational use and earth displacement. All of these impacts have resulted in vegetation communities which are unhealthy and have reduced the ability of these communities to provide the ecological functions listed above.

The monitoring of ELC communities provides information on the type, size, location and health of vegetation communities in the wetland and its surrounding area. It is critical to monitor vegetation patterns to determine if management, restoration, invasive species removal or other activities are required to maintain or enhance wetland health. Future ELC updates will be necessary to monitor how these communities are changing over time and where improvements or further degradation has taken place.

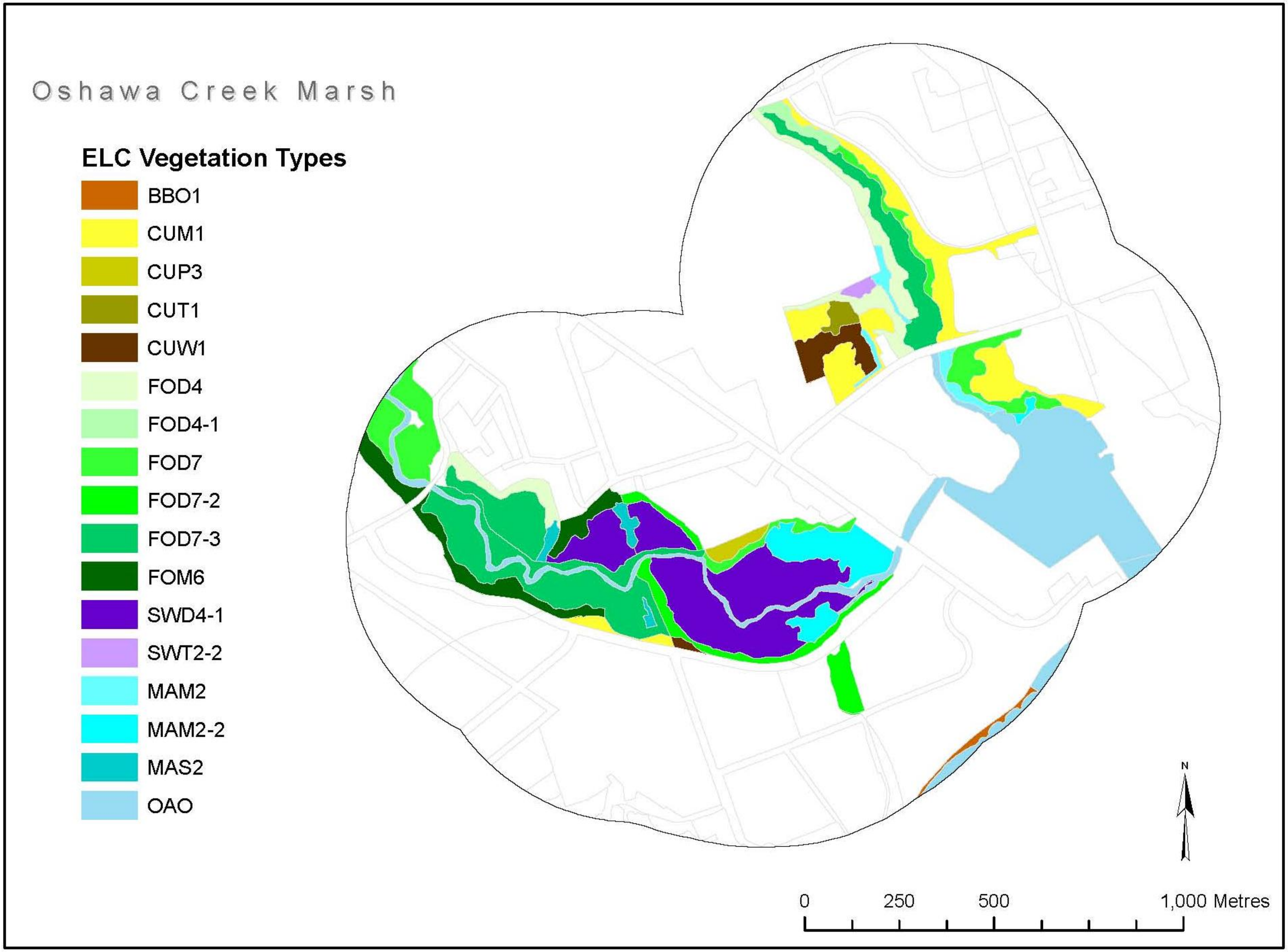

Figure 3. Ecological Land Classification (ELC) at Oshawa Creek Marsh and within 500 meters of its boundary.

4.2 Submerged Plant Community

Results

Submerged Aquatic Vegetation (SAV) Indices of Biotic Integrity (IBI) were calculated for all wetlands, with the exception of Gold Point Marsh, in 2009. Gold Point Marsh does not contain habitat for SAV.

In 2009 most wetlands had IBIs under 40 (poor or fair condition) with the exception of Rouge River Marsh (43.59), Pumphouse Marsh (50.34) and Oshawa Second Marsh (40.14) which were all in good condition. These three wetlands all had turbidity-intolerant species present to some degree as well as high metric values for native plant species richness (SNAT) and Floristic Quality Index (FQI).

The overall richness and abundance of turbidity-intolerant species (SINT and PINT) was non-existent or low for all wetlands in 2009 (Table 8). This is comparable to past year's data (EC and CLOCA 2004). Sites where turbidity intolerant SAV species (see Appendix A for a list of species) were recorded were Rouge River Marsh (*Myriophyllum sibiricum, Potamogeton zosteriformis*), Frenchman's Bay Marsh (*Vallisneria Americana*), Duffins Creek Marsh (*Najas flexilis*), Pumphouse Marsh (*Najas flexilis*) and Oshawa Second Marsh (*Myriophyllum sibiricum*).

The native plant species richness metric (SNAT) was quite variable in 2009 with values as low as 0.29 for McLaughlin Bay Marsh and as high as 7.34 for Corbett Creek Marsh. McLaughlin Bay Marsh had only 1 quadrat out of 20 with SAV species present which accounts for its low value in this metric as well as the other SAV metrics. Corbett Creek Marsh had one or more native species present at 19 of the 20 quadrats surveyed.

The Floristic Quality Index (FQI) metric was also quite variable ranging from 0.35 for Westside Marsh to 9.19 for Whitby Harbour Marsh. The wetlands with very low (<1) FQI values have poorly developed SAV communities in general with SAV species present at very few quadrats. The high FQI score at Whitby Harbour Marsh resulted from the presence of Nuttall Waterweed *Elodea nuttallii* at 14 quadrats. These plants were thought to be the rarer Nuttall Waterweed as opposed to the more common Common Waterweed (*Elodea Canadensis*) due to certain morphological characters. However, this observation should be regarded with caution since the character traits of Nuttall Waterweed and Common Waterweed overlap and can lead to misidentification. The presence of Common Waterweed would have resulted in a much lower FQI metric for this wetland.

The percent cover metric (PCOV) was generally low for most marshes, eight marshes had values less than one. The highest PCOV values were found at Pumphouse Marsh (10) and Cranberry Marsh (8.83). The SAV at Pumphouse and Cranberry Marsh is dominated by the filamentous algae *Chara* which forms dense mats in the shallow, stagnant waters of these marshes.

Table 8. Standardized SAV community metrics, IBIs and condition classes for 2009.

Wetland	SAV Community Metrics					IBI	Condition
	SINT	PINT	FQI	PCOV	SNAT		
Rouge River Marsh	1.61	0.63	6.22	6.43	6.91	43.59	Good
Frenchman's Bay Marsh	0.40	0.48	6.56	3.24	5.76	32.86	Fair
Hydro Marsh	0.00	0.00	0.49	0.02	0.58	2.18	Poor

Duffins Creek Marsh	0.60	0.03	4.87	5.38	4.61	30.98	Fair
Carruthers Creek Marsh	0.00	0.00	2.01	0.51	2.16	9.35	Poor
Cranberry Marsh	0.00	0.00	3.37	8.83	5.62	35.63	Fair
Lynde Creek Marsh	0.00	0.00	2.19	0.96	2.16	10.62	Poor
Whitby Harbour Marsh	0.00	0.00	9.19	2.76	5.76	35.40	Fair
Corbett Creek Marsh	0.00	0.00	7.70	4.70	7.34	39.49	Fair
Gold Point Marsh	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Pumphouse Marsh	1.21	0.22	6.54	10.00	7.20	50.34	Good
Oshawa Creek Marsh	0.00	0.00	0.89	0.53	0.86	4.56	Poor
Oshawa Second Marsh	1.61	1.35	7.10	4.25	5.76	40.14	Good
McLaughlin Bay Marsh	0.00	0.00	0.43	0.41	0.29	2.26	Poor
Westside Marsh	0.00	0.00	0.35	0.61	0.43	2.77	Poor
Bowmanville Marsh	0.00	0.00	1.79	1.74	1.58	10.22	Poor
Wilmot Creek Marsh	0.00	0.00	0.64	0.28	0.43	2.69	Poor
Port Newcastle Marsh	0.00	0.00	3.76	0.84	2.16	13.52	Poor
AVERAGE						**21.56**	**Fair**

SINT Number of turbidity-intolerant species
SNAT Number of native species
FQI Floristic Quality Index
PINT Relative percent cover turbidity-intolerant species
PCOV Percent cover

In total 27 SAV species were found in Durham coastal wetlands in 2009 that were used in the SAV IBI. Two of the species are liverworts, one is an algae species which resembles vascular plants and 24 are vascular plants. A complete listing of the species can be found in Appendix A. Of the 27 species found, eight are considered uncommon and seven are considered rare in Durham Region (Varga *et al.* 2000).

Discussion

Overall, the condition of the SAV community in Durham Region coastal wetlands is degraded with 9 out of 17 wetlands scoring in the 'Poor' IBI condition category. Wetlands that scored in the 'Poor' category had low values in all metrics and generally have little to no SAV community present. SAV growth at these wetlands is limited by a number of factors including water quality, light penetration, common carp activity and water flows. Significant improvements to the conditions at these wetlands will be necessary to facilitate the growth of submerged aquatic vegetation.

Five of the wetlands had a 'Fair' IBI condition in 2009. These included Frenchman's Bay marsh, Duffins Creek Marsh, Cranberry marsh, Whitby Harbour Marsh and Corbett Creek Marsh. These wetlands had higher values in the Floristic Quality Index, Percent Cover and Number of Native Species metrics than the wetlands in 'Poor' condition but had very little or no turbidity-intolerant species present. These results indicate that turbidity limits SAV growth in some of these wetlands. In Cranberry Marsh in particular, the algae species *Chara* dominates the wetland, and may be out-competing other submerged aquatic vegetation and limiting the diversity of the SAV community.

Three wetlands, Rouge River Marsh, Pumphouse Marsh and Oshawa Second Marsh had a 'Good' IBI condition in 2009. These wetlands scored higher in the Floristic Quality Index, Percent Cover and Number of Native Species metrics than the 'Poor' condition wetlands and had some turbidity-intolerant species present. While the SAV community is in better condition in these wetlands, diversity and cover of species is still limited by water quality impairments.

The results of the 2009 SAV IBIs show that surrounding land use is affecting water quality in the marshes and having subsequent impacts on the SAV community condition. These impacts to SAV have further implications for other biological communities as SAV provides valuable habitat and/or food sources for breeding birds, amphibians, fish, and macroinvertebrates.

Continued monitoring is required to be able to isolate the causes of SAV community degradation and to identify opportunities where improvements can be made to promote SAV growth and diversity.

4.3 Fish Community

Results

Fish Indices of Biotic Integrity were calculated for all coastal wetlands, with the exceptions of Gold Point Marsh and Cranberry Marsh, in 2009. Water levels at these two marshes were too low to conduct electro-fishing.

In 2009, IBI scores ranged from 6.29 (poor condition) for Whitby Harbour Marsh to 52.07 (good condition) for Frenchman's Bay Marsh. Marshes toward the bottom of the spectrum, including Whitby Harbour Marsh and Pumphouse Marsh, had low or 0 values for all of the metrics included in the IBI. Neither marsh had any piscivores or Yellow Perch, Whitby Harbour had no centrarchid species, and Pumphouse Marsh had a high percentage of non-indigenous fish biomass. Conversely, Frenchman's Bay Marsh had high numbers of native species including centrarchids and a high percentage of piscivore biomass and a low percentage of non-indigenous fish biomass. See Table 9 for a summary of the metric scores and IBI values for each wetland in 2009.

Metric scores for the number of native species (SNAT) ranged from 0.8 to 7.17 in Durham Region wetlands in 2009. The lowest metric scores were found at Whitby Harbour Marsh, Corbett Creek Marsh and Duffins Creek Marsh. The highest scores were found at Bowmanville Marsh, Oshawa Second Marsh and Port Newcastle Marsh. Overall, metric scores for the number of native individuals (NNAT) were quite low (less than 3.5) with the exception of Pumphouse Marsh (5) and Oshawa Second Marsh (10). In total, 20 native fish species were found in Durham Region coastal wetlands in 2009; Pumpkinseed

(*Lepomis gibbosus*), Brown Bullhead (*Ameiurus nebulosus*), and Yellow Perch (*Perca flavescens*) were the most widespread species (found at 14, 12, and 10 wetlands respectively).

Mean metric scores for numbers of centrarchid species (SCEN) ranged from 0 to 10 at Durham Region wetlands in 2009. The lowest SCEN metric score (0) was found at Whitby Harbour Marsh where no centrarchid species were found. The highest SCEN score was found at Oshawa Second Marsh (10) where a centrarchid species (Pumkinseed or Bluegill) was found at all 9 transects. In total, five centrarchid species were found in Durham Region wetlands in 2009: Black Crappie (*Pomoxis nigromaculatus*), Bluegill (*Lepomis macrochirus*), Largemouth Bass (*Micropterus salmoides*), Pumpkinseed, and Smallmouth Bass (*Micropterus dolomieui*).

Metric scores for percentage of piscivore biomass (PPIS) varied among Durham Region wetlands in 2009. Piscovorous species were not found(PPIS equals 0) in any of the following marshes: Rouge River Marsh, Duffins Creek Marsh, Corbett Creek Marsh, Pumphouse Marsh, Oshawa Second Marsh, Bowmanville Marsh and Whitby Harbour Marsh. The highest PPIS scores were found at Frenchman's Bay Marsh (10), Carruthers Creek Marsh (10), Hydro Marsh (8.9) and Oshawa Creek Coastal Wetland (10) in 2009. In total, four piscivorous fish species were caught in Durham Region wetlands in 2009; these included Bowfin (*Amia calva*), Largemouth Bass, Northern Pike (*Esox lucius*), and Smallmouth Bass.

Percent non-indigenous biomass of fish (PBNI) varied widely among Durham Region wetlands whereby low metric scores indicated high percentage biomass of non-indigenous fish. The lowest PBNI metric scores (0) were found at Pumphouse Marsh, Oshawa Second Marsh and McLaughlin Bay Marsh. Common Carp (*Cyprinus carpio*) was found at all three wetlands, Goldfish (*Carassius auratus*) was found at Oshawa Second Marsh and Pumphouse Marsh, and White Perch (*Morone americana*) was found at McLaughlin Bay. Maximum PBNI scores (10) were found at Hydro Marsh, Duffins Creek Marsh, Lynde Creek Marsh, Corbett Creek Marsh and Bowmanville Marsh where no non-indigenous species were caught in 2009.

In total, five non-indigenous fish species were caught in Durham Region wetlands in 2009; these included Alewife (*Alosa pseudoharengus*), Common Carp, Goldfish, Round Goby (*Neogobius melanostomus*) and White Perch. Alewives were caught at two marshes in 2009, Carruthers Creek Marsh and Port Newcastle Marsh, however they have been found in small numbers at 10 different marshes throughout the period of study. Common carp were caught at seven marshes in 2009, they have been found at all 16 marshes throughout the study. Goldfish were caught at two marshes in 2009, Oshawa Second Marsh and Pumphouse Marsh, where they have been caught throughout the study period. While Round Goby has been caught at Frenchman's Bay Marsh throughout the study, this is the first year it was caught at Oshawa Creek Marsh, Wilmot Creek Marsh, Port Newcastle Marsh and Rouge River Marsh. White Perch were caught only at McLaughlin Bay Marsh where they have been found throughout the study period.

Overall, metric scores for biomass of Yellow Perch (BYPE) were low with scores below 3.5 at all but one Durham Region wetland in 2009. No Yellow Perch were caught at Duffins Creek Marsh, Carruthers Creek Marsh, Whitby Harbour Marsh, Corbett Creek Marsh, Pumphouse Marsh, or Wilmot Marsh. The highest mean BYPE score (7.55) was found at Port Newcastle Marsh where a total of fifteen Yellow Perch were caught during sampling efforts (377.7g in total).

Table 9. Standardized fish community metrics, IBIs and condition classes for 2009.

Wetland	Fish Community Metrics						IBI	Condition
	SNAT	SCEN	PPIS	NNAT	PBNI	BYPE		
Rouge River Marsh	3.82	6.62	0.00	1.51	9.86	0.67	37.48	Fair
Frenchman's Bay Marsh	4.35	7.36	10.00	0.83	7.83	0.87	52.07	Good
Hydro Marsh	2.39	3.15	8.90	0.42	10.00	3.16	46.72	Good
Duffins Creek Marsh	1.49	0.92	0.00	0.37	10.00	0.00	21.31	Fair
Carruthers Creek Marsh	3.07	2.10	10.00	0.46	5.71	0.00	35.59	Fair
Cranberry Marsh								N/A
Lynde Creek Marsh	2.87	1.47	6.44	0.76	10.00	1.26	38.00	Fair
Whitby Harbour Marsh	0.80	0.00	0.00	0.09	2.89	0.00	6.29	Poor
Corbett Creek Marsh	1.33	0.82	0.00	0.30	10.00	0.00	20.74	Fair
Gold Point Marsh								
Pumphouse Marsh	2.99	1.84	0.00	5.00	0.00	0.00	16.37	Poor
Oshawa Creek Marsh	3.26	4.01	10.00	0.86	4.11	0.09	37.22	Fair
Oshawa Second Marsh	6.64	10.00	0.00	10.00	0.00	0.24	44.79	Good
McLaughlin Bay Marsh	5.58	4.09	0.13	1.29	0.00	1.30	20.66	Fair
Westside Marsh	3.59	5.52	0.54	0.98	3.21	1.13	24.93	Fair
Bowmanville Marsh	7.17	5.52	0.00	2.63	10.00	2.06	45.64	Good
Wilmot Creek Marsh	3.98	2.45	5.01	1.40	4.67	0.00	29.17	Fair
Port Newcastle Marsh	6.11	5.72	2.64	3.33	2.10	7.55	45.76	Good
AVERAGE							**32.67**	**Fair**

SNAT Number of native species
SCEN Number of centrarchid species
PPIS Percent piscivore biomass
NNAT Number of native individuals
PBNI Percent non-indigenous biomass
BYPE Biomass of yellow perch

In total 24 fish species were caught in Durham coastal wetlands in 2009 that were used in the Fish IBI. A complete listing of the species can be found in Appendix B. Of the 24 species found, none are considered federally or provincially rare or at risk.

Discussion

The condition of the fish community in Durham Region coastal wetlands is moderately impaired with the majority of wetlands scoring in the 'Fair' or 'Good' IBI classifications. Only two wetlands scored in the 'Poor' IBI category, Whitby Harbour Marsh and Pumphouse Marsh. Both of these marshes had a very small fish community, completely lacked piscovorus or Yellow Perch fishes and scored low in the other metrics (SNAT, SCEN, NNAT, PBNI). Pumphouse Marsh is consistently separated from Lake Ontario by a barrier beach and does not have any stream inputs. Therefore fish have difficulty entering the marsh and the fish population is consistently low in this marsh. Whitby Harbour Marsh has 'Very Degraded' water quality and a 'Fair' SAV community which may be limiting the fish population at this wetland. Historical sampling by the Ministry of Environment also found high levels of toxic furans and dioxins in the soils, sediment and biota in Whitby Harbour (MOE, 2009) which likely also contributes to the poor fish population as these chemicals become more concentrated as they move up the food chain.

Nine of 16 wetlands scored in the 'Fair' fish community condition. All of these wetlands had native fish species and centrarchid species present to some degree (SNAT, SCEN, NNAT), however the abundance of piscovorus species and non-indigenous species varied. All of the wetlands had a very small abundance or complete lack of Yellow Perch. Degraded water quality and a lack of SAV community may be limiting the fish population at many of these marshes.

Five wetlands, Frenchman's Bay Marsh, Hydro Marsh, Oshawa Second Marsh, Bowmanville Marsh and Port Newcastle marsh, scored a 'Good' fish IBI condition in 2009. Habitat restoration works (at Frenchman's bay, Hydro marsh and Second Marsh) and consistent openings to Lake Ontario may contribute to the slightly higher fish IBIs at these marshes. However, the fish populations are still limited by impaired water quality and SAV communities.

Cranberry Marsh and Gold Point Marsh have never been sampled for fish. Cranberry Marsh is permanently isolated from Lake Ontario by a barrier beach and does not have any stream inputs; therefore fish access to the marsh is quite limited. This isolation coupled with low water levels reduces the ability of this marsh to support a fish population. Gold Point Marsh is a small shallow marsh community. While fish may be present in the adjacent stream, open water marsh habitat does not exist at this site.

4.4 Breeding Bird Community

Results

Bird Indices of Biotic Integrity were calculated for all coastal wetlands in 2009, with the exception of Whitby Harbour Marsh. A Marsh Monitoring route has not yet been established for Whitby Harbour Marsh. Bird Community IBIs ranged from 14.14 ('Poor condition') to 85.51 ('Excellent' condition) in 2009. The majority of marshes were in the Fair and Good categories. Two marshes, Gold Point Marsh and Port Newcastle Marsh scored in the 'Poor' category. On the other end of the scale three marshes, Lynde Creek Marsh, Oshawa Second Marsh and Westside Marsh, scored in the 'Very Good' category and one marsh, Cranberry Marsh scored in the 'Excellent' category.

Overall the metric scores for the species richness of area-sensitive marsh nesting obligates (SAMNO) were very low. Only three wetlands, Duffins Creek Marsh, Frenchman's Bay Marsh and Cranberry

Marsh, had area-sensitive marsh nesting obligate species present (scores higher than 0). The area-sensitive marsh nesting obligates found at these marshes were American Coot found at Duffins Creek Marsh and Cranberry Marsh, and Least Bittern which was found at all three marshes. A complete list of area-sensitive marsh nesting obligate species included in this metric category can be found in Appendix C.

Metric scores for the relative abundance of marsh nesting obligates (PMNO) ranged between 1.11 and the maximum 10. The four wetlands with an overall 'Very Good' or "Excellent' condition were the only wetlands to score over 5 in this metric. All four marshes had numerous records of Swamp Sparrow, Marsh Wren and Virginia Rail. Westside Marsh, Second Marsh and Cranberry Marsh also had Common Moorhen present. While Westside Marsh had overall fewer birds observed than the other marshes, a high percentage of the species observed were marsh nesting obligates, resulting in the maximum score for this metric. A complete list of marsh nesting obligate species included in this metric category can be found in Appendix C.

Metric scores for the relative abundance of non-aerial foragers (PNAF) ranged between 3.13 and the maximum 10. The majority of wetlands scored over 5 in this metric, with non-aerial foragers quite common in all of the wetlands. Duffins Creek Marsh, Lynde Creek Marsh, Oshawa Second Marsh and Westide Marsh all had a maximum score of 10 in this metric. A complete list of non-aerial foragers included in this metric category can be found in Appendix C.

Table 10. Standardized bird community metrics, IBIs and condition classes for 2009.

Wetland	Bird Community Metrics			IBI	Condition
	SAMNO	PMNO	PNAF		
Rouge River Marsh	0	4.75	6.96	39.04	Fair
Frenchman's Bay Marsh	2.92	3.1	6.52	41.76	Good
Hydro Marsh	0	2.43	6.43	29.53	Fair
Duffins Creek Marsh	3.5	4.42	10	59.74	Good
Carruthers Creek Marsh	0	2.67	6.55	30.72	Fair
Cranberry Marsh	7.5	10	8.15	85.51	Excellent
Lynde Creek Marsh	0	8.23	10	60.78	Very Good
Whitby Harbour Marsh				N/A	N/A
Corbett Creek Marsh	0	1.74	8.63	34.57	Fair
Gold Point Marsh	0	1.8	3.38	17.27	Poor
Pumphouse Marsh	0	4.26	9.46	45.76	Good
Oshawa Creek Marsh	0	1.2	8.32	31.73	Fair
Oshawa Second Marsh	0	9.01	10	63.37	Very Good
McLaughlin Bay Marsh	0	3.42	7.86	37.6	Fair
Westside Marsh	0	10	10	66.67	Very Good
Bowmanville Marsh	0	1.94	8.18	33.73	Fair
Wilmot Creek Marsh	0	3.06	6.93	33.31	Fair
Port Newcastle Marsh	0	1.11	3.13	14.14	Poor
AVERAGE				**42.66**	**Good**

SAMNO Species richness of area-sensitive marsh nesting obligates
PMNO Relative abundance of marsh nesting obligates
PNAF Relative abundance of non-aerial foragers

There are 10 focal species in the Marsh Monitoring Program (MMP) that are of particular interest as they rely on marsh habitat for one or more stages of their life cycle and their presence generally reflects good marsh habitat conditions for birds. Of the 10 focal species, 6 were heard and/or observed during the marsh monitoring surveys in 2009. These include Virginia Rail, Sora, Pied-billed Grebe, Least Bittern, American Coot and Common Moorhen. Virginia Rail was the most widespread focal species and was documented at 12 marshes. Sora were documented at Frenchman's Bay Marsh, Hydro Marsh, Pumphouse Marsh, Cranberry Marsh and Rouge River Marsh in 2009. This is the first time Sora has been found at Pumphouse Marsh during MMP surveys. American Coot was found at Duffins Creek Marsh and Cranberry Marsh during the MMP surveys. Pied-billed Grebe were observed at Hydro Marsh and Cranberry Marsh. Least Bittern was found at Duffins Creek Marsh, Frenchman's Bay Marsh and Cranberry Marsh. This species is listed as both a federally threatened (Committee on the Status of Wildlife in Canada - COSEWIC) and provincially (Committee on the Status of Species at Risk in Ontario - COSSARO) threatened species. Common Moorhen was found Westside Marsh, Cranberry Marsh and Oshawa Second Marsh.

In addition to the birds observed as part of the MMP, several other bird species of interest were observed in the marshes in 2009 which are summarized in the table below.

Table 11. List of bird species of interest observed at Durham Region coastal wetlands in 2009.

Common Name	Wetland(s) Observed	Date(s) Observed (# observed)	Comments
Trumpeter Swan	Cranberry Marsh	July 21, Sep 9	Rare summer resident Swans were observed with young at Cranberry Marsh indicating that they may be breeding at this marsh.
	Corbett Creek Marsh	May 12 (1)	
	Westside Marsh	May 19 (1), July 28 (1)	
	Oshawa Second Marsh	May 20 (2), June 13 (1), Jun 24 (1)	
Northern Shoveler	Cranberry Marsh	May 5 (2)	Rare summer resident Pair observed
Ruddy Duck	Cranberry Marsh	May 5 (3)	Rare summer resident, Rare migrant
Peregrine Falcon	Oshawa Second Marsh	May 20 (1)	Rare summer resident Special Concern- Federally (COSEWIC), Threatened-Provincially (COSSARO)
Caspian Tern	Oshawa Second Marsh	May 20 (several), Jun 24 (3), July 30 (1), Aug 25 (1)	Rare summer resident, Rare migrant
	Duffins Creek Marsh	June 5 (1), July 10 (1)	
	Lynde Creek Marsh	June 2 (4)	
	McLaughlin Bay Marsh	June 10 (1)	
	Bowmanville Marsh	June 11 (1), June 25 (1)	
	Pumphouse Marsh	June 10 (1), June 30 (1)	
Black Tern	Oshawa Second Marsh	May 20 (1)	Rare summer resident
American Pelican	Oshawa Second Marsh	Aug 25 (1)	Non-breeding vagrant

			Threatened-Provincially (COSSARO)
Osprey	Westside Marsh	May 19 (2), June 5 (1), June 22 (2), July 28 (2)	Rare summer resident Observed building nest at Westside Marsh in 2009, but no young were seen in the nest
	Duffins Creek Marsh	May 11 (1)	
	Lynde Creek Marsh	June 24 (1)	
	Bowmanville Marsh	May 19 (1), June 25 (1), Jul 27 (1)	
	Oshawa Second Marsh	May 5 (1), July 30 (1)	
American Avocet	Whitby Harbour Marsh	Aug 26 (1)	Non-breeding vagrant

Discussion

In general, wetlands that scored low in the bird IBI (Gold Point Marsh, Port Newcastle Marsh) have a small amount of marsh habitat, and wetlands that scored high in the bird IBI (Cranberry Marsh, Lynde Creek Marsh, Oshawa Second Marsh, Westside Marsh) have the largest areas of emergent marsh habitat for birds. This suggests that habitat availability may be the most important factor for this community. Area-sensitive marsh nesting obligate species were very rarely encountered during the surveys, which indicate that large areas of marsh habitat are lacking in the Durham Region. However, non-area sensitive marsh nesting obligates and non-aerial foragers were quite abundant in the majority of the marshes. While the marshes may not be large enough to support certain species, the habitat available is suitable for a number of marsh birds.

Several of the marshes have undergone restoration efforts aimed at increasing marsh habitat (Oshawa Second Marsh, Westside Marsh, Duffins Creek Marsh, Cranberry Marsh). The high bird IBIs in these wetlands indicates that increasing marsh habitat availability may be the most beneficial restoration goal for marsh bird communities.

In regards to the particular species found in the wetlands, it was encouraging that 6 of the 10 focal species were encountered in 2009. Of particular importance are the two observations of Least Bittern as this is a threatened species in Ontario.

In addition to the focal species, several other bird species were observed that are of interest due to their rarity in Durham Region. Some of the species are rare summer residents that are only known to breed at one to a few coastal marshes. These include Trumpeter Swans, Ruddy Ducks, Peregrine Falcons, Osprey, Northern Shovelers, Caspian Terns and Black Terns. Ruddy Ducks are known to breed at Cranberry Marsh and Trumpeter Swans were also observed with young at this marsh in 2009. Previous records of breeding for Peregrine Falcon (Oshawa Second Marsh 2004) and Black Tern (Lynde Creek Marsh 1993) also exist. Nesting platforms were installed at Westside Marsh for Osprey and they have been observed breeding at this marsh for several years. Many of these species are also found as migrants which are encountered infrequently in the Durham Region and are typically using the coastal marshes as stopovers on their way to or from their breeding grounds. There are also a couple of species (American Pelican – see photo, American Avocet) that are non-breeding vagrants. These species are rare visitors to Durham Region as this area is outside the species' normal range.

4.5 Amphibian Community

Results

Amphibian Indices of Biotic Integrity (IBIs) were calculated for all coastal wetlands in 2009, with the exception of Whitby Harbour Marsh. A Marsh Monitoring route has not yet been established for Whitby Harbour Marsh. Amphibian Community IBIs ranged from 4.07 ('Poor' condition) to 66.27 ('Very Good' condition) in 2009. The majority of marshes (9) were in 'Poor' condition. Two marshes, Corbett Creek Marsh and Oshawa Second Marsh scored in the 'Fair' condition category. Four marshes scored in the 'Good' condition category and one marsh, Rouge River Marsh, was in 'Very Good' condition.

Metric scores for the mean total species richness (rTOT) ranged from 1.22 to 4.88. This indicated that the average number of species across survey stations at all of the wetlands was low ranging from 0.5 to 2 species. There are a total of 10 species of calling frogs and toads whose range overlaps with Durham Region and might be expected to be heard during the surveys. This list of species can be found in Appendix D. A total of 5 out of the possible 10 species were heard calling during the 2009 surveys.

Metric scores for mean species richness of woodland associated amphibian species (rWOOD) ranged from 0 to 5. Scores for the probability of detection of woodland associated amphibian species (pWOOD) ranged from 0 to 10. Nine of the 17 wetlands surveyed scored 0 in both metrics, with no woodland species found at any of the survey stations. The remaining wetlands averaged between 0.33 and 1 woodland associated species across survey stations. There are four possible woodland associated amphibian species that can be found in Durham Region (Spring Peeper, Wood Frog, Chorus Frog and Gray Treefrog). Two of these species, Wood Frog and Chorus Frog, were heard during the 2009 surveys.

Table 12. Standardized amphibian community metrics, IBIS and condition classes for 2009.

Wetland	Amphibian Community Metrics			IBI	Condition
	rTOT	rWOOD	pWOOD		
Rouge River Marsh	4.88	5	10	66.27	Very Good
Frenchman's Bay Marsh	4.88	0	0	16.27	Poor
Hydro Marsh	2.44	0	0	8.13	Poor
Duffins Creek Marsh	4.88	0	0	16.27	Poor
Carruthers Creek Marsh	3.66	0	0	12.2	Poor
Cranberry Marsh	2.44	5	10	58.13	Good
Lynde Creek Marsh	2.44	1	2	18.13	Poor
Whitby Harbour Marsh				N/A	N/A
Corbett Creek Marsh	3.25	1.67	3.33	27.51	Fair
Gold Point Marsh	4.88	0	0	16.27	Poor

Wetland	Amphibian Community Metrics			IBI	Condition
	rTOT	rWOOD	pWOOD		
Pumphouse Marsh	2.44	0	0	8.13	Poor
Oshawa Creek Marsh	2.44	0	0	8.13	Poor
Oshawa Second Marsh	2.24	1.67	3.33	24.12	Fair
McLaughlin Bay Marsh	4.88	3.33	6.67	49.6	Good
Westside Marsh	1.22	0	0	4.07	Poor
Bowmanville Marsh	3.25	3.33	6.67	44.18	Good
Wilmot Creek Marsh	3.25	3.33	6.67	44.18	Good
Port Newcastle Marsh	2.44	0	0	8.13	Poor
AVERAGE				**25.28**	**Fair**

rTOT Total species richness
rWOOD Woodland species richness
pWOOD Probability of detection of woodland species

Discussion

Frogs and toads are sensitive to changes in both aquatic and terrestrial environments. They spend a large portion of their life cycle in water and have permeable skin which makes them sensitive to water quality impairments. They also require adjacent terrestrial habitat for other stages of their life cycle including feeding and dispersal. This makes them sensitive to both aquatic and terrestrial habitat loss and degradation. For these reasons, amphibians and frogs are good indicators of wetland health.

Overall, the majority of amphibian communities in Durham Region coastal wetlands scored in the 'Poor' to 'Fair' condition in 2009. There were a few exceptions to this including Cranberry Marsh, Bowmanville Marsh, Wilmot Creek Marsh and McLaughlin Bay Marsh which were in 'Good' condition and Rouge River Marsh which was in 'Very Good' condition. In general, very few species were found in the wetlands, and the most abundant species found (American Toad, Green Frog, Leopard Frog and Wood Frog) are fairly ubiquitous species in Ontario, found in a wide range of habitat conditions.

In those wetlands where Wood Frogs were found, wetlands scored in the 'Fair' to 'Good' condition IBI classifications. Wood Frogs are considered a woodland associated species in the IBI since they spend a large portion of their life cycle in woodland habitats. The presence of this species led to higher scores in the woodland species richness (rWOOD) and probability of detection of woodland species (pWOOD) metrics. Chorus Frogs were found at several stations at Rouge River Marsh which had the best overall IBI with a 'Very Good' condition. Chorus Frogs are also considered woodland species and its presence resulted in high scores in the rWOOD and pWOOD metrics. Woodland frog species are good indicators of wetland health as they are particularly sensitive to landscape disturbance as well as sensitive to changes in water quality. No detection of woodland species in many (9) of the marshes indicates that water quality and lack of wetland and adjacent habitat may be limiting frog and toad populations in these wetlands.

In addition to being a sensitive woodland species, Chorus Frogs are considered federally threatened by COSEWIC in this part of Ontario. The observation of this species is encouraging as it was the first MMP record of Chorus Frog at Rouge River Marsh and it is rarely recorded in Durham Region coastal marshes.

While the timing of surveys is set up to try to capture the breeding of all the frog and toad species, this is not always possible given the nature of their breeding cycles. Wood Frogs in particular have a short peak breeding season that occurs over only a few days. If this breeding time is captured in some surveys and missed in others, this can skew the results of the Amphibian IBI, because Wood Frogs contribute the most to both the rWOOD and pWOOD metrics in Durham Region. This must therefore be taken into consideration when evaluating the results of this metric in comparing wetlands or changes in one wetland from year to year.

4.6 Macroinvertebrate Community

Results

Macroinvertebrate IBIs were calculated for all Durham Region coastal wetlands in 2009. Macroinvertebrate Community IBIs ranged from 22.52 ('Fair' condition) to 68.64 ('Very Good' condition). The majority of marshes (10) were in 'Good' condition. Six marshes scored slightly lower in 'Fair' condition and two marshes, Westside Marsh and Wilmot Creek Marsh, were in 'Very Good' condition.

Metric scores for the mean number of Ephemeroptera and Trichoptera genera ranged from 3.33 to 10, indicating that all of the marshes had at least some representation of these two orders in their macroinvertebrate assemblages.

Metric scores for the mean total number of families ranged from 3.02 to 9.86, indicating that there was some diversity in families in all of the wetlands.

Metrics scores for the mean percent Crustacea and Mollusca varied widely from 0 to 9.93. Five marshes, Whitby Harbour Marsh, Goldpoint Marsh, McLaughlin Bay Marsh, Wilmot Creek Marsh and Port Newcastle Marsh did not have any macroinvertebrates present from the Crustacea or Mollusca phyla.

Metric scores for the mean percent Trichoptera ranged from 0 to 10. Twelve of the 18 marshes scored 0 in this metric, with no Trichoptera found in these marshes. One marsh, Westside Marsh, received the maximum score of 10 in this metric.

Mean Percent Diptera metrics also ranged widely from 0 to 10. Five marshes, Hydro Marsh, Whitby Harbour Marsh, Oshawa Creek Marsh, Oshawa Second Marsh and McLaughlin Bay Marsh scored 0 in this metric, which indicates a large percentage of Diptera present. One marsh, Cranberry Marsh, received the maximum score of 10 in this metric.

Table 13. Standardized macroinvertebrate community metrics, IBIs and condition clases for 2009.

Wetland	Macroinvertebrate Community Metrics					IBI	Condition
	NETG	NFAM	PCRM	PTRI	PDIP		
Rouge River Marsh	10.00	9.50	1.41	3.31	2.48	53.41	Good
Frenchman's Bay Marsh	5.00	4.10	1.20	5.26	3.83	38.79	Fair
Hydro Marsh	5.00	6.98	0.66	0.00	0.00	25.29	Fair
Duffins Creek Marsh	5.00	6.26	6.11	1.14	7.30	51.62	Good
Carruthers Creek Marsh	3.33	6.98	9.40	0.00	6.03	51.49	Good
Cranberry Marsh	3.33	4.82	9.93	0.00	10.00	56.17	Good
Lynde Creek Marsh	5.00	6.98	6.43	0.00	7.18	51.17	Good
Whitby Harbour Marsh	5.00	6.26	0.00	0.00	0.00	22.52	Fair
Corbett Creek Marsh	5.00	6.62	6.68	0.00	7.98	52.55	Good
Goldpoint Marsh	6.67	9.86	0.00	0.00	5.67	44.39	Good
Pumphouse Marsh	5.00	8.42	6.73	0.00	8.82	57.95	Good
Oshawa Creek Marsh	6.67	6.62	1.63	0.00	0.00	29.84	Fair
Oshawa Second Marsh	10.00	8.42	1.06	0.00	0.00	38.96	Fair
McLaughlin Bay Marsh	10.00	3.02	0.00	7.69	0.00	41.42	Good
Westside Marsh	10.00	6.98	4.17	10.00	3.17	68.64	Very Good
Bowmanville Marsh	8.33	4.46	5.71	0.00	2.13	41.27	Good
Wilmot Creek Marsh	10.00	9.86	0.00	4.85	5.41	60.24	Very Good
Port Newcastle Marsh	6.67	5.90	0.00	0.00	6.09	37.32	Fair
AVERAGE						**45.72**	**Good**

NETG Number of Ephemeroptera + Trichoptera genera
NFAM Total number of families
PCRM Percent Crustacea* + Mollusca (*not including microcrustaceans)
PTRI Percent Trichoptera
PDIP Percent Diptera

Discussion

Macroinvertebrates have been found to be good indicators of water quality for a number of reasons including: they live in the water for all or part of their lives, they are easy to sample, they have fairly limited mobility, they have life cycles which reflect the average condition of the water, and certain groups have predictable responses to changes in water quality. Several groups were found to respond to changes in water quality in the development of the macroinvertebrate IBI for this project. The Percent Crustacea and Mollusca, Percent Trichoptera, and Number of Trichoptera and Ephemoptera metric groups, were found to respond negatively to disturbance (decreased water quality). The percent Diptera metric group was found to respond positively to disturbance. Trichopterans (caddisflies) and Ephmeropterans (mayflies) are known indicators of good water quality and Dipterans (true flies) are tolerant of a wide range of environmental conditions, which would explain their differing responses to water quality impairments. In addition to these taxonomic groups, biodiversity in the form of total number of families was also found to respond negatively to disturbance.

Overall, the condition of the macroinvertebrate community in Durham Region coastal wetlands was found to be moderately impaired with the majority of wetlands scoring in the 'Fair' or 'Good' IBI condition categories in 2009. Only two wetlands scored in the 'Very Good' IBI category, Westside Marsh and Wilmot Creek Marsh. Both of these marshes had a high number of Ephemeroptera and Trichoptera genera, a high number of total families, a high percentage of Trichoptera genera and a moderate percentage of Diptera genera in their macroinvertebrate assemblages. While the WQI values show that there is significant impairment of water quality in these marshes, it appears as though macroinvertebrate assemblages are not as severely impacted here as in other Durham Region marshes.

The wetlands with the worst macroinvertebrate IBIs (Hydro Marsh, Whitby Harbour Marsh and Oshawa Creek Marsh) scored 0 in the percent Trichoptera metric (had no Trichoptera genera present) and 0 in the percent Diptera metric (had an abundance of Diptera genera present). These wetlands have 'Moderately Degraded' and 'Very Degraded' water quality as indicated by the 2009 WQI values. As mentioned previously, historical sampling by the Ministry of Environment also found high levels of toxic furans and dioxins in the soils, sediment and biota in Whitby Harbour (MOE, 2009) which likely contributes to the poorer macroinvertebrate population at this marsh. Hydro Marsh and Oshawa Creek Marsh also have 'Poor' SAV communities as indicated by 2009 SAV IBIs. SAV provides habitat and a food source for macroinvertebrates. Degraded water quality and poor SAV communities may therefore be limiting Trichoptera genera at these marshes while allowing the more tolerant Diptera genera to survive.

While the macroinvertebrate communities in Durham Region were in 'Good' condition on average, the scores do not reflect the degraded condition of water quality which was found across the region. It is possible that sampling bias may have skewed the macroinvertebrate IBI results. This is because the species associated with good water quality tend to be larger and easier to pick out for the samples, which would lead to higher IBIs. Regardless, it is clear that there are impairments to both water quality and macroinvertebrate community condition at all of the Durham Region coastal wetlands. In order to improve the condition of this biotic community, improvements to the quality of water entering these marshes must be made. Ongoing monitoring is essential to document any further changes to this community as a result of increased disturbance or restoration efforts.

5.0 SUMMARY

All of the monitoring activities were completed successfully at the majority of Durham Region coastal wetlands in 2009. For those wetlands where surveys were not completed or data is lacking, every attempt will be made in 2010 to make sure this information is collected.

In terms of wetland health, the geophysical conditions and biological communities of the Durham Region coastal wetlands are all impaired to some degree. Development and agricultural use of surrounding land, contamination and nutrient enrichment of waterways, loss of natural water level variability, and the introduction and spread of invasive species have all contributed to this impairment. The loss of surrounding land to development is evident in the Ecological Land Classification map of Oshawa Creek Marsh and its 500 meter buffer (Figure 3). With the exception of the existing wetland and valley lands the surrounding land use has been converted to residential, industrial and recreational uses. These anthropogenic land uses contribute to the impairment of water quality and biological communities. Similar situations can be seen on surrounding lands at most of the Durham Region coastal wetlands.

The degradation of water quality is a primary issue for all of the coastal wetlands. With the exception of Cranberry Marsh, all of the wetlands were found to have degraded water quality. This reflects the conditions of the watershed and inputs to watercourses that ultimately lead to the wetland. Urbanization, agriculture and a lack of natural cover are all contributing factors to the poor water quality found in these marshes.

Poor water quality and a lack of wetland and adjacent habitat contribute to the degradation of biological communities. The SAV and amphibian communities were in 'Fair' condition on average in 2009. Submerged aquatic vegetation is stationary and exists completely within the water column and it therefore impacted greatly by conditions in the water. Amphibians are also closely tied to water for much of their life cycle and have permeable skin which makes them quite susceptible to changes in water quality. The fish community was also in "Fair" condition on average in 2009. It is evident that poor water quality and a lack of habitat are also limiting the fish populations in all of the marshes. Those marshes that are disconnected from the lake also have poor fish communities since fish have little opportunity to enter these wetlands (Cranberry Marsh, Pumphouse Marsh, McLaughlin Bay Marsh).

Bird communities were found to be in 'Good' condition on average in 2009. High bird IBIs appeared to be associated with availability of emergent marsh habitat. Bird communities were the healthiest at wetlands where habitat restoration efforts had occurred (Oshawa Second Marsh, Duffins Creek Marsh, Cranberry Marsh and Westside Marsh).

The Macroinvertebrate Community was also in 'Good" condition on average in 2009. The health of macroinvertebrate communities is often used as an indicator of water quality, however the 'Good' condition on this community does not reflect the overall degraded condition of water quality found at all of the coastal marshes. Sampling effort and timing of surveys may have influenced these results.

Invasive species are increasingly becoming a problem in our coastal wetlands. They influence coastal wetlands by outcompeting and/ or preying upon important native species, as well as degrading habitat and water quality. Each year new invasive species are found in Durham's wetlands or existing invasive species are found in wetlands they have not been previously encountered.

It is evident that the coastal wetlands of Durham Region face many negative influences that impair their condition. Continued monitoring and examination of the impacts to these wetlands is necessary to evaluate the state of Durham Region's coastal wetlands, trends in coastal wetland health over time, and how these wetlands can best be managed for the future.

6.0 REFERENCES

Albert D. A., J. Ingram, T. Thompson, and D. Wilcox. 2003. Great Lakes Coastal Wetlands Classification: *First Revision (July 2003)*. www.glc.org/wetlands.

Albert, D. A., D A. Wilcox, J. W. Ingram, and T. A. Thompson. 2005. Hydrogeomorphic classification for Great Lakes coastal wetlands. Journal of Great Lakes Research 31(Supplement 1): 129-146.

Canada Council of Ministers of the Environment. 1999. Canadian water quality guidelines for the protection of aquatic life. In: *Canadian Environmental Quality Guidelines*. Canadian Council of Ministers of the Environment, Winnipeg.

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: *Coastal Wetlands of the Laurentian Great Lakes: Health, Habitat and Indicators*. Eds. Simon, T.P. and Stewart, P.M. Authorhouse, Bloomington, Indiana.

Environment Canada and Central Lake Ontario Conservation Authority. 2004. Durham Region Coastal Wetland Monitoring Project: Year 2 Technical Report. Downsview, ON: ECB-OR. 177 pp. + appendices.

Environment Canada and Central Lake Ontario Conservation Authority. 2005. Durham Region Coastal Wetland Monitoring Project: Year 3 Technical Report. June 2005. Downsview, ON: ECB-OR.

Environment Canada and Central Lake Ontario Conservation Authority. 2007. Durham Region Coastal Wetland Monitoring Project: Methodology Handbook.

Environment Canada and Central Lake Ontario Conservation Authority. Draft. Durham Region Coastal Wetland Monitoring Project: 6-Year Technical Report. Downsview, ON: ECB-OR.

Great Lakes Coastal Wetlands Consortium, 2008. Great Lakes Coastal Wetlands Monitoring Plan (USEPA-GLNPO #GL-97547303) http://www.glc.org/wetlands/final-report.html

Kalff, Jacob. 2002. Limnology: inland water ecosystems. Prentice-Hall, Inc. Upper Saddle River, NJ.

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.

Ministry of Environment (MOE). 2009. Request for Proposals ("RFP") detailed quantitative ecological risk assessment for Whitby Harbour/Pringle Creek and the floodplain.

Oldham, M.J., W.D. Bakowsky, and D.A. Sutherland. 1995. Floristic quality assessment system for southern Ontario. Natural Heritage Information Centre, Ontario Ministry of Natural Resources. Peterborough, ON.

OMNR. 2006. Wetland Evaluation of the Gold Point Wetland. Ontario Ministry of Natural Resources. Unpublished report on file at OMNR Aurora District office. December 2006.

OMNR. 2007a. Wetland Evaluation of the Oshawa Creek Wetland Complex. Ontario Ministry of Natural Resources. Unpublished report on file at OMNR Aurora District office. January 2007.

OMNR. 2007b. Wetland Evaluation of the Whitby Harbour Wetland Complex. Ontario Ministry of Natural Resources. Unpublished report on file at OMNR Aurora District office. January 2007.

Varga *et al*. 2000. Distribution and Status of the Vascular Plants of the Greater Toronto Area. Ontario Ministry of Natural Resources, Aurora District.

7.0 APPENDICES

APPENDIX A: SUBMERGED AQUATIC VEGETATION

Table A-1. Listing of submerged aquatic vegetation species found in Durham coastal wetlands in 2009. Species rarity ranks Globally (GRank), Provincially (SRank) and Regionally (Durham Status) are listed and species are denoted as native (N) or non-native (I), turbidity-tolerant (√) or turbidity intolerant (X), and corresponding coefficients of conservatism (cc) used in the calculation of the FQI for the SAV IBI.

Scientific Name	Common Name	SRank	Durham Status	Native Status	Tubidity-tolerant	cc
Chara sp.	Stonewort, Muskrass			N		
Ceratophyllum demersum	Common Hornwort	S5	U	N	√	4
Elodea canadensis	Broad Waterweed	S5	U	N	√	4
Elodea nuttallii	Nuttall Waterweed	S4		N		8
Heteranthera dubia	Grassleaf Mud-plantain	S5	R3	N	√	7
Hydrocharis morsus-ranae	Common Frogbit	SNA		I		0
Lemna minor	Lesser Duckweed	S5		N		2
Myriophyllum sibiricum	Common Water-milfoil	S5	R1	N	X	6
Myriophyllum spicatum	Eurasian Water-milfoil	SNA		I	√	0
Najas flexilis	Slender Naiad	S5	R8	N	X	5
Nuphar variegata	Bullhead Pond-lily	S5	U	N		4
Nymphaea odorata	Fragrant White Water-lily	S5		N		5
Polygonum amphibium	Water Smartweed	S5		N		5
Potamogeton crispus	Curly Pondweed	SNA		I	√	0
Potamogeton foliosus	Leafy Pondweed	S5	R4	N	√	4
Potamogeton gramineus	Grassy Pondweed	S5	R4	N		4
Potamogeton natans	Floating Pondweed	S5	U	N		5
Potamogeton pusillus	Slender Pondweed	S4S5	U	N	√	5
Potamogeton richardsonii	Richardson's Pondweed	S5	U	N		5
Potamogeton zosteriformis	Flatstem Pondweed	S5	U	N	X	5
Ranunculus longirostris	Great White Water Crowfoot	S4S5	R7	N	√	5
Riccia fluitans	Floating Slender Liverwort	S5		N		
Ricciocarpos natans	Purple-fringed Liverword	S5		N		
Spirodela polyrhiza	Common Water-flaxseed	S5	U	N		4
Stuckenia pectinatus	Sago Pondweed	S5		N	√	4
Utricularia macrorhiza	Greater Bladderwort	S5		N		4
Vallisneria americana	Eel-grass	S5	R3	N	X	6

LEGEND

SRanks:

S1: Critically Imperiled
S2: Imperiled
S3: Vulnerable
S4: Apparently Secure
S5: Secure
SNA: A conservation status rank is not applicable because the species is not a suitable target for conservation activities.

Durham Status:
U – Uncommon native species
R^x – Rare native species, x=number of stations observed

APPENDIX B: FISH

Table B-1. Listing of fish species caught in Durham coastal wetlands in 2009. Species rarity ranks Provincially (SRank) are listed and fish have been identified as native (N) or non-native (I), centrarchids (√)) or not (X) and given a trophic level designation (P=piscivorous species, S=specialist species, and G=generalist species).

Scientific Name	Common Name	SRank	Native	Trophic Level	Centrarchid
Alosa pseudoharengus	Alewife	SNA	I	S	X
Pomoxis nigromaculatus	Black Crappie	S4	N	S	√
Lepomis macrochirus	Bluegill	S5	N	S	√
Pimephales notatus	Bluntnose Minnow	S5	N	G	X
Amia calva	Bowfin	S4	N	P	X
Ameiurus nebulosus	Brown Bullhead	S5	N	G	X
Cyprinus carpio	Common Carp	SNA	I	G	X
Luxilis cornutus	Common Shiner	S5	N	G	X
Notropis atherinoides	Emerald Shiner	S5	N	S	X
Pimephales promelas	Fathead Minnow	S5	N	G	X
Dorosoma cepedianum	Gizzard Shad	S4	N	S	X
Notemigonus crysoleucas	Golden Shiner	S5	N	G	X
Carassius auratus	Goldfish	SNA	I	G	X
Etheostoma nigrum	Johnny Darter	S5	N	S	X
Micropterus salmoides	Largemouth Bass	S5	N	P	√
Percina caprodes	Logperch	S5	N	S	X
Esox lucius	Northern Pike	S5	N	P	X
Lepomis gibbosus	Pumpkinseed	S5	N	S	√
Neogobius melanostomus	Round Goby	SNA	I	S	X
Micropterus dolomieui	Smallmouth Bass	S5	N	P	√
Notropis hudsonius	Spottail Shiner	S5	N	S	X
Morone americana	White Perch	SNA	I	S	X
Catostomus commersoni	White Sucker	S5	N	S	X
Perca flavescens	Yellow Perch	S5	N	S	X

LEGEND

SRanks:
S1: Critically Imperiled
S2: Imperiled
S3: Vulnerable
S4: Apparently Secure
S5: Secure
SE: Exotic
SNA: A conservation status rank is not applicable because the species is not a suitable target for conservation activities.

APPENDIX C: BIRDS

Table C-1. Marsh bird members of each of the three guilds used in the calculation of the bird IBI: a) area-sensitive marsh nesting obligate species, b) marsh nesting obligate species, and c) non-aerial forager species. Common names indicated with an asterisk denote those species found in Durham Region wetlands from 2002 to 2009.

a) Area-sensitive marsh nesting obligate species

Code	Common Name	Species
AMBI	American bittern*	*Botaurus lentiginosus*
AMCO	American coot*	*Fulica americana*
BLTE	black tern*	*Chlidonias niger*
FOTE	Forster's tern	*Sterna forsteri*
KIRA	king rail	*Rallus elegans*
LEBI	least bittern*	*Ixobrychus exilis*
REDH	redhead	*Aythya americana*
RNGR	red-necked grebe	*Podiceps grisegena*
SACR	sandhill crane	*Grus canadensis*
YERA	yellow rail	*Coturnicops noveboracensis*

b) Marsh Nesting Obligate Species

Code	Common Name	Genus/Species
AMBI	American bittern*	*Botaurus lentiginosus*
AMCO	American coot*	*Fulica americana*
BLTE	black tern*	*Chlidonias niger*
COMO	common moorhen*	*Gallinula chloropus*
COSN	common snipe	*Gallinago gallinago*
FOTE	Forster's tern	*Sterna forsteri*
HOGR	horned grebe	*Podiceps auritus*
KIRA	king rail	*Rallus elegans*
LEBI	least bittern*	*Ixobrychus exilis*
LIGU	little gull	*Larus minutus*
MAWR	marsh wren*	*Cistothorus palustris*
PBGR	pied-billed grebe*	*Podilymbus podiceps*
REDH	redhead	*Aythya americana*
RNDU	ring-necked duck*	*Aythya collaris*
RNGR	red-necked grebe	*Podiceps grisegena*
SACR	sandhill crane	*Grus canadensis*
SORA	sora*	*Porzana carolina*
SWSP	swamp sparrow*	*Melospiza georgiana*
TRUS	trumpeter swan*	*Cygnus buccinator*
VIRA	Virginia rail*	*Rallus limicola*

YERA	yellow rail	*Coturnicops noveboracensis*
YHBL	yellow-headed blackbird*	*Xanthocephalus xanthocephalus*

c) Non-aerial Foragers Species

Code	Common Name	Species
AMCR	American crow*	*Corvus brachyrhynchos*
AMGO	American goldfinch*	*Carduelis tristis*
AMRE	American redstart*	*Setophaga ruticilla*
AMRO	American robin*	*Turdus migratorius*
AMWO	American woodcock*	*Scolopax minor*
ATSP	American tree sparrow	*Spizella arborea*
BAOR	Baltimore oriole*	*Icterus galbula*
BAWW	black-and-white warbler	*Mniotilta varia*
BBCU	black-billed cuckoo	*Coccyzus erythropthalmus*
BCCH	black-capped chickadee*	*Parus atricapillus*
BGGN	blue-gray gnatcatcher*	*Polioptila caerulea*
BHCO	brown-headed cowbird*	*Molothrus ater*
BLJA	blue jay*	*Cyanocitta cristata*
BOBO	bobolink	*Dolichonyx oryzivorus*
BRBL	Brewer's blackbird	*Euphagus cyanocephalus*
BRTH	brown thrasher	*Toxostoma rufum*
BTNW	black-throated green warbler	*Dendroica virens*
BWWA	blue-winged warbler	*Vermivora pinus*
CARW	carolina wren	*Thryothorus ludovicianus*
CAWA	Canada warbler	*Wilsonia canadensis*
CCSP	clay-colored sparrow	*Spizella pallida*
CHSP	chipping sparrow*	*Spizella passerina*
CMWA	Cape May warbler	*Dendroica tigrina*
COGR	common grackle*	*Quiscalus quiscula*
CORA	common raven	*Corvus corax*
COSN	common snipe	*Gallinago gallinago*
COYE	common yellowthroat*	*Geothlypis trichas*
CSWA	chestnut-sided warbler	*Dendroica pensylvanica*
CEDW	cedar waxwing*	*Bombycilla cedrorum*
DOWO	downy woodpecker*	*Picoides pubescens*
DUNL	dunlin*	*Calidris alpina*
EABL	eastern bluebird	*Sialia sialis*
EAME	eastern meadowlark	*Sturnella magna*
ETTI	eastern tufted titmouse	*Baeolophus bicolor*
FISP	field sparrow	*Spizella pusilla*
GRSP	grasshopper sparrow	*Ammodramus savannarum*
GRYE	greater yellowlegs	*Tringa melanoleuca*

Code	Common Name	Species
HAWO	hairy woodpecker	*Picoides villosus*
HETH	hermit thrush	*Catharus guttatus*
HOFI	house finch*	*Carpodacus mexicanus*
HOWR	house wren*	*Troglodytes aedon*
INBU	indigo bunting	*Passerina cyanea*
KILL	killdeer*	*Charadrius vociferus*
LESA	least sandpiper	*Calidris minutilla*
LCSP	Le Conte's sparrow	*Ammodramus leconteii*
LEYE	lesser yellowlegs*	*Tringa flavipes*
LISP	Lincoln's sparrow	*Melospiza lincolnii*
LOWA	Louisiana waterthrush	*Seiurus motacilla*
MAWA	magnolia warbler*	*Dendroica magnolia*
MAWR	marsh wren*	*Cistothorus palustris*
MODO	mourning dove*	*Zenaida macroura*
MOWA	mourning warbler	*Oporornis philadelphia*
NAWA	Nashville warbler	*Vermivora ruficapilla*
NOCA	northern cardinal*	*Cardinalis cardinalis*
NOFL	northern flicker*	*Colaptes auratus*
NOMO	northern mockingbird	*Mimus polyglottos*
NOPA	northern parula	*Parula americana*
NOWA	northern waterthrush	*Seiurus noveboracensis*
NSTS	Nelson's sharp-tailed sparrow	*Ammodramus nelsoni*
OROR	orchard oriole*	*Icterus spurius*
OVEN	ovenbird	*Seiurus aurocapillus*
PISI	pine siskin	*Carduelis pinus*
PIWA	pine warbler	*Dendroica pinus*
PIWO	pileated woodpecker	*Dryocopus pileatus*
PROW	prothonotary warbler	*Protonotaria citrea*
PUFI	purple finch	*Carpodacus purpureus*
RBGR	rose-breasted grosbeak*	*Pheucticus ludovicianus*
RBNU	red-breasted nuthatch	*Sitta canadensis*
RBWO	red-bellied woodpecker	*Melanerpes carolinus*
RCKI	ruby-crowned kinglet	*Regulus calendula*
REVI	red-eyed vireo*	*Vireo olivaceus*
RHWO	red-headed woodpecker	*Melanerpes erythrocephalus*
RIPH	ring-necked pheasant	*Phasianus colchicus*
RTHU	ruby-throated hummingbird*	*Archilochus colubris*
RUBL	rusty blackbird	*Euphagus carolinus*
RUGR	ruffed grouse	*Bonasa umbellus*
RUTU	ruddy turnstone	*Arenaria interpres*
RWBL	red-winged blackbird*	*Agelaius phoeniceus*

Code	Common Name	Species
SAVS	Savannah sparrow	*Passerculus sandwichensis*
SBDO	short-billed dowitcher*	*Limnodromus griseus*
SCTA	scarlet tanager	*Piranga olivacea*
SEPL	semipalmated plover*	*Charadrius semipalmatus*
SEWR	sedge wren*	*Cistothorus platensis*
SORA	sora*	*Porzana carolina*
SOSA	solitary sandpiper	*Tringa solitaria*
SOSP	song sparrow*	*Melospiza melodia*
SPSA	spotted sandpiper*	*Actitis macularia*
STSP	unidentified sharp-tailed sparrow	*Ammodramus spp.*
SWSP	swamp sparrow*	*Melospiza georgiana*
SWTH	Swainson's thrush	*Catharus ustulatus*
TEWA	Tennessee warbler	*Vermivora peregrina*
TUTI	tufted titmouse	*Parus bicolor*
VEER	veery	*Catharus fuscescens*
VIRA	Virginia rail*	*Rallus limicola*
WAVI	warbling vireo*	*Vireo gilvus*
WBNU	white-breasted nuthatch	*Sitta carolinensis*
WEVI	white-eyed vireo	*Vireo griseus*
WIPH	Wilson's phalarope	*Phalaropus tricolor*
WIWR	winter wren	*Troglodytes troglodytes*
WOTH	wood thrush	*Hylocichla mustelina*
WTSP	white-throated sparrow	*Zonotrichia albicollis*
YBCH	yellow-breasted chat	*Icteria virens*
YBCU	yellow-billed cuckoo	*Coccyzus americanus*
YBSA	yellow-bellied sapsucker	*Sphyrapicus varius*
YERA	yellow rail	*Coturnicops noveboracensis*
YHBL	yellow-headed blackbird*	*Xanthocephalus xanthocephalus*
YPWA	yellow palm warbler	*Dendroica palmarum*
YTVI	yellow-throated vireo	*Vireo flavifrons*
YWAR	yellow warbler*	*Dendroica petechia*

APPENDIX D: AMPHIBIANS

Table D-1. Listing of Great Lakes amphibian species (GLCWC, 2008). Species marked with a "1" are ten species which are expected to be found in Durham Region wetlands. Of these, four species marked with an "*" are woodland species used in the calculation of the amphibian IBI (i.e., metrics rWOOD and pWOOD).

Code	Common Name	Genus Species
AMTO	American Toad[1]	*Bufo americanus*
BCFR	Blanchard's Cricket Frog[2]	*Acris crepitans blanchardi*
BULL	Bullfrog[1]	*Rana catesbeiana*
CHFR	Chorus Frog[1]*	*Pseudacris maculata & Pseudacris triseriata*
FOTO	Fowler's Toad[2]	*Bufo woodhousei fowleri*
GRTR	Gray Treefrog[1]*	*Hyla versicolor*
GRFR	Green Frog[1]	*Rana clamitans melanota*
MIFR	Mink Frog[1]	*Rana septentrionalis*
NLFR	Northern Leopard Frog[1]	*Rana pipiens*
PIFR	Pickerel Frog[1]	*Rana palustris*
SPPE	Spring Peeper[1]*	*Pseudacris crucifer*
WOFR	Wood Frog[1]*	*Rana sylvatica*

[2] Species range of this species does not include Durham Region (Ministry of Natural Resources, 2001a,b).