

Detroit River and St. Clair River Areas of Concern: Coastal Wetland Habitat Assessment Report 2013 Update

March 2014



Environnement
Canada

Canadian Wildlife
Service

Environnement
Canada

Service canadien
de la faune

**Detroit River and St. Clair River Areas of Concern:
Coastal Wetland Habitat Assessment Report
2013 Update**

March 2014

Environment Canada – Canadian Wildlife Service

Executive Summary

The purpose of this document is to report on data collected in 2013 at selected coastal wetlands in the Detroit River Area of Concern (AOC), Area 1A of the St. Clair River AOC, and non-AOC wetlands along Lake St. Clair to assess the condition of coastal wetland habitat and biotic communities over time. Geophysical condition is assessed by calculating the Water Quality Index score, and biotic condition is assessed by using an Index of Biotic Integrity (IBI). IBI scores are assessed at selected wetlands in each AOC and non-AOC for the following specific biotic communities: submerged aquatic vegetation, breeding marsh birds, and aquatic macroinvertebrates.

Qualitative Water Quality Index score descriptors ranged from highly degraded to good, and are typically moderately degraded. Water quality was similar among AOC and non-AOC wetlands, indicating impacted conditions. The submerged aquatic vegetation (SAV) community IBI descriptors ranged from fair to very good, and are typically very good. SAV-IBI scores showed higher variation in the St. Clair River AOC, while the Detroit River AOC generally showed stable or improving conditions. The breeding marsh bird community Index of Biotic Integrity (Bird-IBI) descriptors ranged from poor to excellent. The bird-IBI for Detroit River AOC suggested impacted conditions, with IBI descriptors typically in fair or poor condition. In contrast, the St. Clair River AOC typically demonstrated good or very good conditions, approaching comparable conditions to that of the non-AOC, which ranged from good to excellent. This highlights a major difference in wildlife population condition in the region. The aquatic macroinvertebrate community IBI (Invert-IBI) descriptors ranged from good to excellent, and are typically very good. Similar to marsh birds, aquatic macroinvertebrate community condition is slightly poorer in the Detroit River AOC than either the non-AOC or St. Clair River AOC. This report augments the baseline data collected during recent sampling using the same standardized methods. These baseline data will continue to support the understanding of the natural variation and condition of these wetlands over time, therefore aiding in the development of quantifiable and achievable delisting criteria.

Table of Contents

Executive Summary	i
Table of Contents.....	ii
List of Tables	iii
1.0 Introduction	1
2.0 Purpose of This Report	4
3.0 Water Quality	4
<i>Methodology</i>	4
<i>Results</i>	5
<i>Discussion</i>	10
4.0 Submerged Aquatic Vegetation Community	11
<i>Methodology</i>	11
<i>Results</i>	11
<i>Discussion</i>	15
5.0 Breeding Bird Community	16
<i>Methodology</i>	16
<i>Results</i>	16
<i>Discussion</i>	18
6.0 Aquatic Macroinvertebrate Community.....	19
<i>Methodology</i>	19
<i>Results</i>	19
<i>Discussion</i>	21
7.0 Using indicators to report on delisting criteria	22
8.0 Summary.....	24
Literature Cited	27
Appendix 1	29
Appendix 2	31
Appendix 3.....	32
Appendix 4.....	35

List of Tables

Table 1. Water quality parameters measured in coastal wetlands including parameter relationships with increased disturbance.....	5
Table 2. Water Quality Index (WQI) score and associated category based on Chow-Fraser (2006).	5
Table 3. Water Quality Index (WQI) score and descriptor for selected coastal wetlands in the Detroit River and St. Clair River Areas of Concern (AOC) and non-AOC sites in Lake St. Clair.	6
Table 4. Mean water quality parameters used in the Water Quality Index (WQI) for selected coastal wetlands in the Detroit River and St. Clair River Areas of Concern (AOC) and non-AOC sites in Lake St. Clair.....	8
Table 5. Additional water quality parameters collected for selected coastal wetlands in the Detroit River and St. Clair River Areas of Concern (AOC) and non-AOC sites in Lake St. Clair.	9
Table 6. Index of biotic integrity (IBI) score and associated category based on EC-CLOCA (2004).	11
Table 7. Index of Biotic Integrity (IBI) score and descriptor for the condition of the submerged aquatic vegetation (SAV) community for selected coastal wetlands in the Detroit River and St. Clair River Areas of Concern (AOC) and non-AOC sites in Lake St. Clair.....	13
Table 8. SAV community IBI scores (out of 100) and standardized metrics (out of 10) for coastal wetlands sampled in 2013 in the Detroit River AOC, Lake St. Clair, and St. Clair River AOC.	14
Table 9. Marsh breeding bird community IBI (Bird-IBI) score and descriptor for selected coastal wetlands in the Detroit River and St. Clair River Areas of Concern (AOC) and non-AOC sites in Lake St. Clair.	17
Table 10. Breeding bird community IBIs (out of 100) and standardized metrics (out of 10) for coastal wetlands sampled in 2013.	18
Table 11. Index of Biotic Integrity (IBI) for the condition of the aquatic macroinvertebrate community for selected coastal wetlands in the Detroit River and St. Clair River Areas of Concern (AOC) and non-AOC sites in Lake St. Clair.....	20
Table 12. Aquatic Macroinvertebrate community IBIs (out of 100) and standardized metrics (out of 10) for coastal wetlands sampled in 2013.	21
Table 13. Summary of index scores and descriptors for water quality (from -3 to +3), submerged aquatic vegetation (SAV), aquatic macroinvertebrates (Invert), and breeding marsh bird communities (Bird) (from 0 to 100) of selected coastal wetlands in the Detroit River and St. Clair River Areas of Concern (AOC) and non-AOC sites in Lake St. Clair.	24

List of Figures

Figure 1. Representative wetland sampled in 2013 including all stations sampled for water quality, breeding marsh birds, submerged aquatic vegetation, and aquatic macroinvertebrates.	2
Figure 2. Coastal wetlands sampled from 2006 to 2013 in the Detroit River AOC, Lake St. Clair, and St. Clair River AOC.	3
Figure 3. Mean bird-IBIs for Detroit River (DR), Lake St. Clair (LSC), and St. Clair River (SCR) for the years 2007-2013, demonstrating AOC and non-AOC decline. Dashed lines indicate years not sampled.....	23

1.0 Introduction

In 1987, the International Joint Commission (IJC) identified the Detroit River and St. Clair River as two of 42 Great Lakes Areas of Concern (AOC) because they “*failed to meet the general or specific objectives of the Great Lakes Water Quality Agreement (GLWQA) where such failure has caused or is likely to cause impairment of beneficial uses or of the area’s ability to support aquatic life*”. The Detroit River failed to meet the objectives of the GLWQA due to several environmental issues of concern, such as contaminated sediments, point source pollution from urban and industrial sources, and non-point source inputs from surrounding watershed land uses. Other concerns in the Detroit River with respect to wildlife included changes in fish and wildlife community structure, habitat loss and degradation, water and sediment quality impacts on biota, and exotic species. The St. Clair River failed to meet the objectives of the GLWQA due to environmental and wildlife issues of concern, including high contaminant levels and the loss and degradation of aquatic habitat.

Beneficial Use Impairments (BUIs) are a standardized common set of impairments that were created by the International Joint Commission (IJC) to measure and assess the condition of the Great Lakes. BUIs cover a wide range of environmental and ecological concerns, and aim to include a number of stakeholders into the delisting process.

This report addresses impairments as they pertain to wildlife; namely, BUI #3 *Degradation of fish and wildlife populations* and BUI #14 *Loss of fish and wildlife habitat*. In addition to providing wildlife habitat, coastal wetlands also perform a number of ecological services and are therefore an important component of AOC remediation efforts. Past reporting on the Huron-Erie Corridor AOC (Environment Canada 2008, 2009b) presented standardized methods for assessing the geophysical and biotic condition of wetlands. Several wetlands in this report were sampled for a limited number of years, prior to the establishment of the core suite of wetlands included in AOC surveys; the purpose of their inclusion here is to provide context of past sampling. Previous Huron-Erie Corridor AOC assessment reports used IBIs developed for Lake Ontario to report on wetlands in the Huron-Erie Corridor. However, the Lake Ontario-based IBIs did not show a clear relationship with disturbance in the Huron-Erie Corridor (Environment Canada 2012b). Therefore, IBIs were redeveloped to better represent the conditions in the Huron-Erie Corridor. Crewe (2013) developed IBIs specific to disturbance conditions in the Huron-Erie Corridor for the marsh breeding bird and aquatic macroinvertebrate communities, both of which showed a strong relationship to the Great Lakes Environmental Index (GLEI) disturbance gradient. The SAV-IBI was redeveloped from Crewe’s calculations and showed a relationship with the Land Cover Rank Sum (LCRANK) disturbance gradient. The redeveloped IBIs are used in this report to better reflect the conditions in the Huron-Erie Corridor.

This report details the results of sampling conducted in 2013 at 12 select coastal wetlands within the Huron-Erie Corridor (HEC; Figure 1, Figure 2), providing a continuation of sampling efforts to build upon baseline data, which further allows for comparison among both Detroit and St. Clair AOCs and non-AOC wetlands within Lake St. Clair. The growing body of data within the HEC will aid in monitoring long-term conditions and in developing specific and quantifiable delisting criteria for these AOCs.

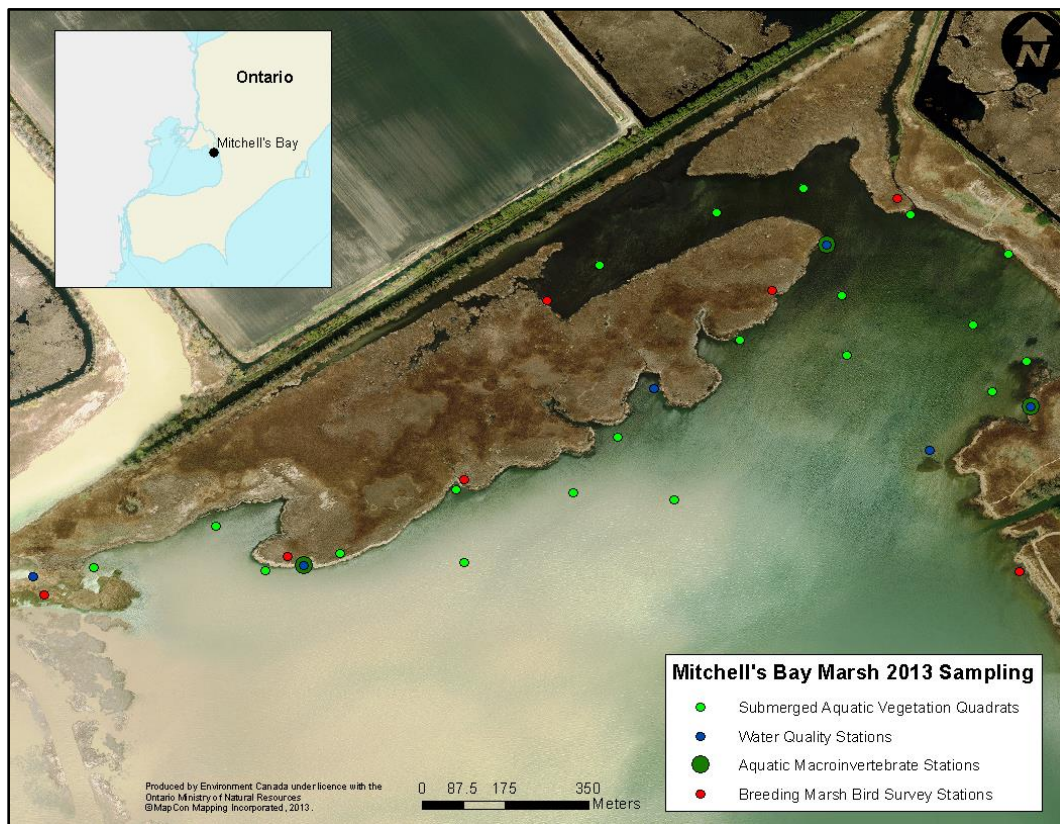


Figure 1. Representative wetland sampled in 2013 including all stations sampled for water quality, breeding marsh birds, submerged aquatic vegetation, and aquatic macroinvertebrates.

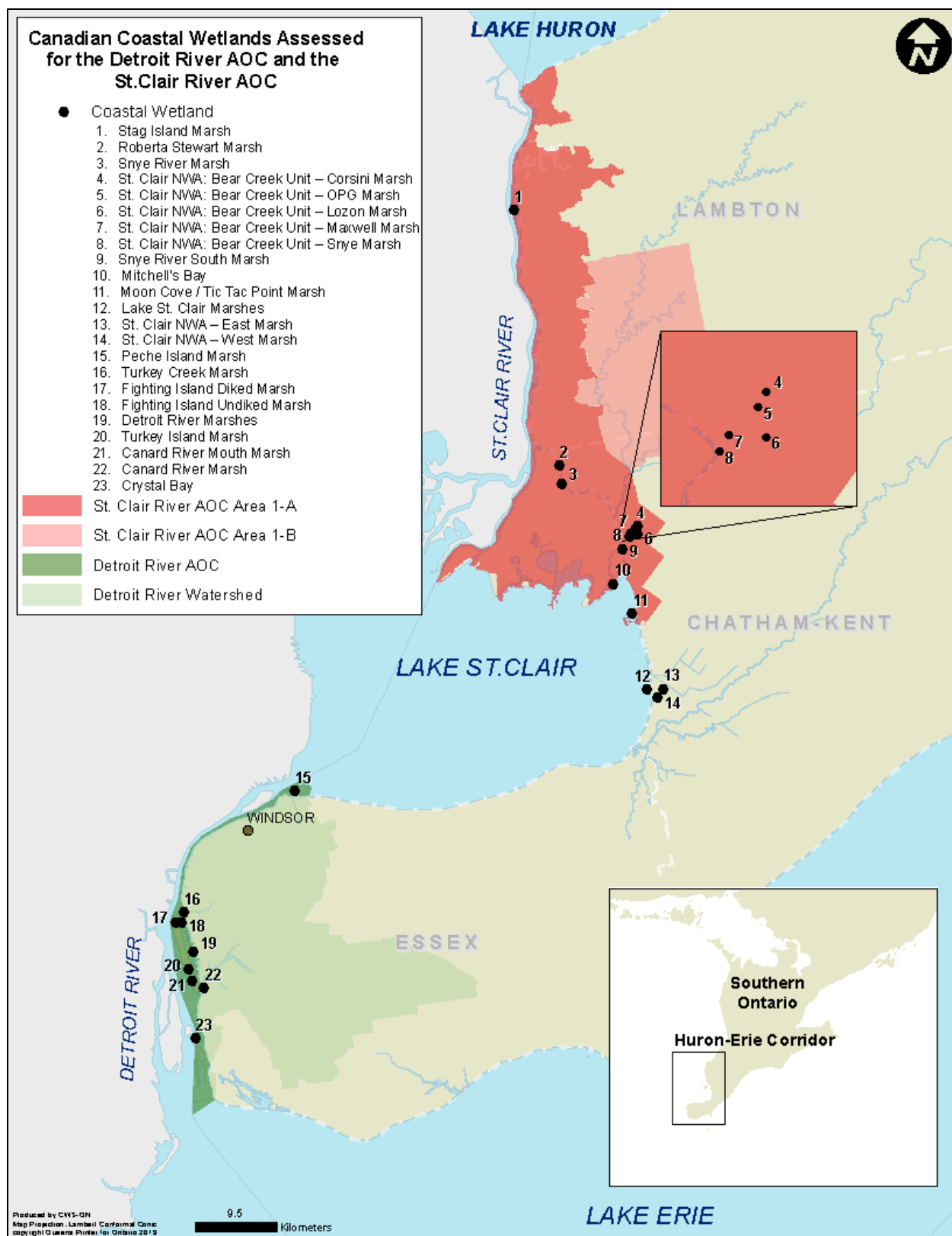


Figure 2. Coastal wetlands sampled from 2006 to 2013 in the Detroit River AOC, Lake St. Clair, and St. Clair River AOC.

2.0 Purpose of This Report

The purpose of this document is to assess and report on the quality of coastal wetlands over time in the Detroit River and St. Clair River Areas of Concern (AOC). Habitat and biotic community data were collected in coastal wetlands within the Detroit River AOC, in Area 1A of the St. Clair River AOC, and in non-AOC sites along Lake St. Clair (Figure 2). The focus of this report is the current conditions of wetlands from 2013 surveys and, where possible, comparisons with earlier sampling results.

A brief introduction and condensed methodologies are provided within each section. For more details about the Detroit River and St. Clair River AOCs, wildlife-related Beneficial Use Impairments, coastal wetland study sites, and methods used for sampling and reporting, refer to Environment Canada – Canadian Wildlife Service (2008, 2009a, 2009b, 2012a; herein EC–CWS) and Green et al. (2010).

3.0 Water Quality

Methodology

Water quality was measured using both *in situ* probes and chemical analyses. *In situ* water quality determination included four parameters (pH, conductivity [$\mu\text{S}/\text{cm}$], temperature [$^{\circ}\text{C}$], and turbidity [NTU]) and was collected using a Hydrolab MS5™ or Yellow Springs Institute (YSI) 6600V2™ multiprobe at mid depth of the water column adjacent to emergent vegetation. Multiprobe sampling was conducted at all water quality stations (typically six per wetland) and every measure was taken to resample past stations. The four parameters measured are used to calculate the Water Quality Index (WQI; Equation 1), a tool for determining coastal wetland water quality in the Great Lakes (Chow-Fraser 2006).

Equation 1:

$$\text{WQI} = (-1.36 * \log \text{TURB}) - (1.57 * \log \text{COND}) - (1.62 * \log \text{TEMP}) - (2.37 * \log \text{pH}) + 9.26$$

where TURB = turbidity, COND = conductivity, and TEMP = temperature

Water samples for three additional nutrient parameters (Table 1) were collected at each wetland and include: Total Nitrate Nitrogen (TNN), Total Ammonia Nitrogen (TAN), and Total Phosphorus (TP). From 2006-2012, individual samples of TNN and TAN were collected at three of the six stations and analyzed in a field lab within five hours of sampling using colorimetry (Hach DR890 Colorimeter). In 2013, the sampling protocol for TNN and TAN was modified to use a composite sample of water collected from three stations to obtain site-level values; these nitrogen samples were later sent for analysis to Environment Canada's National Laboratory for Environmental Testing (NLET; Burlington, Ontario). For all years, samples for TP were collected individually at three of the six stations at each wetland, acidified, and then later sent for analysis to NLET.

Table 1. Water quality parameters measured in coastal wetlands including parameter relationships with increased disturbance.

Parameter	Units	Relationship with Increased Disturbance
<i>In Situ</i>		
Turbidity	NTU	↑ turbidity from algae, suspended sediments, and bioturbation
Conductivity	µS/cm	↑ conductivity from agricultural, industrial, urban inputs
Temperature	°C	↑ temperature from industrial/urban runoff and riparian vegetation removal
pH	pH	↑ pH from photosynthesis affects nutrient availability
<i>Nutrient</i>		
Total Nitrate Nitrogen	mg/L	↑ nitrates from agricultural/urban runoff and wastewater and industrial discharge
Total Ammonia Nitrogen	mg/L	↑ ammonia from agricultural and industrial wastes, and from sewage and septic leachate
Total Phosphorus	µg/L	↑ phosphorus from agricultural runoff, urban stormwater, and industrial discharge

Ranking Water Quality

The WQI was developed as a relative ranking tool to report on coastal wetland water quality in the Great Lakes Basin. WQI scores range from -3 to +3 in which the numerical values correspond with the six ranked qualitative descriptor categories listed below (Table 2).

Table 2. Water Quality Index (WQI) score and associated category based on Chow-Fraser (2006).

WQI Score	Qualitative Descriptor
+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

Results

Coastal wetlands in the Huron-Erie Corridor show signs of both degradation and good condition with the majority of sites classified as moderately degraded (Table 3). More specifically, wetlands in the Detroit River AOC vary from very degraded to good but are typically moderately degraded. Wetlands in Lake St. Clair (non-AOC) vary from moderately degraded or good but are typically good. Wetlands in the St. Clair River AOC vary from highly degraded to good but are typically moderately degraded (Table 3). Elevated levels of conductivity and turbidity appeared to be the main drivers of low WQI scores. Sites with impaired water quality consistently had high levels of conductivity and turbidity.

In general, comparisons of WQIs over the sampling periods did not display clear differences in water quality across the region (Table 3). Some sites had similar WQI scores over multiple years, such as Canard River Marsh and Turkey Creek Marsh. Other sites generally showed improvements in water quality over the sample period, such as St. Clair NWA: Bear Creek Unit – Maxwell Marsh and Snye River Marsh. Some sites in recent years (2011 to 2013) showed a decline in WQI score but remained within the same descriptor as in previous years (e.g., good

at Stag Island Marsh, moderately degraded at Mitchell's Bay – Mudcreek Marsh and Snye River Marsh, and good at Peche Island Marsh). Moon Cove / Tic Tac Point Marsh and Lake St. Clair Marshes experienced large rain events prior to sampling in 2013; values for these wetlands, especially turbidity and conductivity, may not be indicative of baseline conditions but are included in this report for completeness.

Table 3. Water Quality Index (WQI) score and descriptor for selected coastal wetlands in the Detroit River and St. Clair River Areas of Concern (AOC) and non-AOC sites in Lake St. Clair.

Wetland Name	WQI						Mean	Descriptor*
	2006	2007	2008	2011	2012	2013		
St. Clair River AOC								
Stag Island Marsh	-	-	-	0.90	0.61	0.41	0.64	Good
Roberta Stewart Marsh	-1.03	-0.37	-1.43	-	-	-	-0.94	Moderately degraded
Snye River Marsh	-0.83	-	0.39	0.58	0.87	0.29	0.26	Good
St. Clair NWA: Bear Creek Unit – Corsini Marsh	-	-	-2.16	-	-	-	-2.16	Highly degraded
St. Clair NWA: Bear Creek Unit – OPG Marsh	-0.86	-0.16	-0.04	-0.14	-0.10	0.77	-0.09	Moderately degraded
St. Clair NWA: Bear Creek Unit – Lozon Marsh	-1.09	-0.04	-	-	-	-	-0.57	Moderately degraded
St. Clair NWA: Bear Creek Unit – Maxwell Marsh	-	0.04	-	-0.08	0.19	0.87	0.26	Good
St. Clair NWA: Bear Creek Unit – Snye Marsh	-1.26	-0.09	-0.86	-	-	-	-0.74	Moderately degraded
Snye River South Marsh	-	-	-0.94	-	-	-	-0.94	Moderately degraded
Mitchell's Bay – Mudcreek Marsh and Snye River Marsh	-0.85	-	-0.07	0.16	-0.10	-0.24	-0.22	Moderately degraded
Moon Cove / Tic Tac Point Marsh	-1.01	-	-0.17	-0.17	0.01	-0.98	-0.46	Moderately degraded
Lake St. Clair (Non-AOC)								
Lake St. Clair Marshes	-	-	-1.87	0.42	0.68	-0.74	-0.38	Moderately degraded
St. Clair NWA – East Marsh	-	-	0.21	-0.29	-0.23	0.64	0.08	Good
St. Clair NWA – West Marsh	-	0.25	-0.09	-	-	-	0.08	Good
Detroit River AOC								
Peche Island Marsh	-	-	0.13	0.75	-0.05	-0.30	0.13	Good
Turkey Creek Marsh	-1.07	-	-0.88	-1.08	-1.06	-1.38	-1.09	Very degraded
Fighting Island Diked Marsh	-	-	-0.09	-	-	-	-0.09	Moderately degraded
Fighting Island Undiked Marsh	-	-	-0.47	-	-	-	-0.47	Moderately degraded
Detroit River Marshes (North)	-	-	-	-	-0.83	-0.55	-0.69	Moderately degraded
Detroit River Marshes	-0.90	-	-0.35	0.49	-0.39	-0.22	-0.27	Moderately degraded
Turkey Island Marsh	-0.79	-	-0.32	-	-	-	-0.56	Moderately degraded
Canard River Mouth Marsh	-0.76	-	-0.10	-	-	-	-0.43	Moderately degraded
Canard River Marsh	-	-	-1.72	-1.76	-2.00	-2.06	-1.89	Very degraded
Crystal Bay	-	-	0.20	-	-	-	0.20	Good

* based upon mean WQI value for years sampled

There were no consistent patterns within sites among years with respect to levels of ammonium-nitrogen, nitrate-nitrogen, and total phosphorus (Table 5). In general, low levels of ammonia were measured during sampling events among wetlands and regions, as well as across years sampled. As described above, ammonium-nitrogen and nitrate-nitrogen were analyzed at the site level in 2013, while in previous years they were sampled individually at three of six water quality stations and then averaged to produce a mean value; this change in methodology may account for some of the differences observed. The detection limit of ammonia-nitrogen sampled in 2013 was 0.005 mg/L, and therefore some wetlands (e.g., St. Clair NWA: Bear Creek Unit – Maxwell Marsh and Detroit River Marshes) may have actual values lower than reported here. Several wetlands, particularly in the St. Clair River AOC, had ammonium-nitrogen levels at or near the detection limit of 0.005 mg/L in 2013. Previous years' levels are generally higher, although in some years the values are comparable to or lower than the detection limit. The Detroit River AOC had the two highest levels of ammonium-nitrogen of 0.153 and 0.101 mg/L at Peche Island Marsh and Canard River Marsh, respectively. Peche Island Marsh in previous years demonstrated much lower levels of ammonium-nitrogen, suggesting possible contamination of samples in 2013. The Lake St. Clair wetlands in the non-AOC demonstrated comparable ammonium-nitrogen levels to 2012 and previous years' levels.

Nitrate-nitrogen levels in 2013 varied among wetlands and regions. Wetlands in the St. Clair River AOC had nitrate-nitrogen levels generally lower than previous years, with the exceptions of Mitchell's Bay and Moon Cove/Tic Tac Point. It should be noted that sampling at Moon Cove/Tic Tac Point in 2013 may have been compromised by a storm event on the previous day, which may have contributed to the elevated nutrient levels seen here. Nitrate-nitrogen levels in most Detroit River AOC wetlands were significantly higher than in previous years, but in some cases were comparable to 2012 levels. Peche Island Marsh demonstrated elevated nitrate-nitrogen levels, which were also observed in the elevated ammonium-nitrogen levels at this wetland, suggesting possible contamination. Turkey Creek Marsh had strongly elevated nitrate-nitrogen levels as compared to previous years, although not in ammonium-nitrogen levels.

Total phosphorus levels for three sites were at or below the Provincial Water Quality Objectives (PWQO) limit of 0.03 mg/L while nine were above the limit during 2013. The highest total phosphorus level was recorded at Canard River Marsh (0.215 mg/L); these levels are comparable to levels in past years at this wetland. Water analyzed from 2007 samples exhibited abnormally high levels of phosphorus, which may indicate analytical errors and/or contamination.

Table 4. Mean water quality parameters used in the Water Quality Index (WQI) for selected coastal wetlands in the Detroit River and St. Clair River Areas of Concern (AOC) and non-AOC sites in Lake St. Clair.

Wetland Name	Conductivity (µS•cm-1)						Turbidity (NTU)						Temperature (°C)						pH					
	2006	2007	2008	2011	2012	2013	2006	2007	2008	2011	2012	2013	2006	2007	2008	2011	2012	2013	2006	2007	2008	2011	2012	2013
<i>St. Clair River AOC</i>																								
Stag Island Marsh	-	-	-	276.61	244.17	304.13	-	-	-	1.22	2.37	2.54	-	-	-	24.92	22.67	24.67	-	-	-	7.84	8.21	7.86
Roberta Stewart Marsh	318.00	412.82	412.79	-	-	-	24.80	5.63	27.86	-	-	-	25.17	23.29	29.86	-	-	-	8.19	8.99	8.42	-	-	-
Snye River Marsh	221.33	278.29	221.09	204.72	228.37	237.40	26.97	3.45	4.39	2.70	1.66	3.98	26.64	24.16	23.67	26.70	24.67	25.77	7.81	-	7.42	7.92	7.76	7.76
St. Clair NWA: Bear Creek Unit – Corsini Marsh	-	765.79	685.69	-	-	-	-	-	65.94	-	-	-	-	26.12	27.62	-	-	-	-	-	7.87	-	-	-
St. Clair NWA: Bear Creek Unit – OPG Marsh	307.00	352.22	384.93	237.33	280.33	208.57	18.77	5.47	4.52	7.86	5.95	1.55	26.82	22.84	25.01	25.18	24.58	28.37	8.00	8.34	7.36	8.09	8.32	8.54
St. Clair NWA: Bear Creek Unit – Lozon Marsh	350.33	381.26	-	-	-	-	31.40	5.54	-	-	-	-	22.68	20.05	-	-	-	-	7.57	7.71	-	-	-	-
St. Clair NWA: Bear Creek Unit – Maxwell Marsh	-	373.45	-	323.25	378.91	318.67	-	4.36	-	7.30	3.40	1.22	-	21.97	-	22.09	22.16	25.24	-	7.78	-	7.09	7.60	7.33
St. Clair NWA: Bear Creek Unit – Snye Marsh	524.00	451.55	362.05	-	-	-	23.27	3.56	17.89	-	-	-	24.31	24.71	26.37	-	-	-	7.78	8.04	7.45	-	-	-
Snye River South Marsh	-	-	245.68	-	-	-	-	-	26.90	-	-	-	-	-	25.07	-	-	-	-	-	8.51	-	-	-
Mitchell's Bay – Mudcreek Marsh and Snye River Marsh	266.83	219.52	254.07	221.17	224.02	415.13	24.44	8.83	10.11	4.54	6.45	5.30	24.94	22.91	23.08	27.20	25.93	25.50	8.01	-	8.01	8.24	8.87	7.68
Moon Cove / Tic Tac Point Marsh	213.33	199.27	217.31	223.17	208.85	386.20	32.70	17.70	7.85	6.29	6.71	22.20	26.04	20.34	26.59	29.48	22.56	22.49	8.68	-	9.01	8.83	8.98	7.84
<i>Lake St. Clair (Non-AOC)</i>																								
Lake St. Clair Marshes	-	354.72	436.89	249.75	264.17	603.67	-	2.33	57.25	2.30	1.42	8.72	-	28.58	29.47	28.00	24.10	23.83	-	-	8.24	8.56	9.41	7.61
St. Clair NWA – East Marsh	-	421.91	326.49	344.32	363.00	342.58	-	5.10	4.14	6.71	5.45	1.74	-	24.41	23.42	28.76	25.37	23.65	-	-	7.12	7.33	8.18	7.40
St. Clair NWA – West Marsh	-	427.63	348.58	-	-	-	-	2.88	5.13	-	-	-	-	18.20	28.27	-	-	-	-	-	8.38	7.03	-	-
<i>Detroit River AOC</i>																								
Peche Island Marsh	-	-	218.07	217.15	228.53	260.50	-	-	5.23	2.25	7.10	11.54	-	-	25.50	23.79	25.77	23.45	-	-	8.28	7.71	7.93	7.51
Turkey Creek Marsh	312.33	-	304.31	477.72	495.26	653.30	26.37	-	16.41	14.61	10.74	27.30	23.87	-	25.92	27.18	29.07	21.39	8.59	-	9.00	8.39	9.14	7.54
Fighting Island Diked Marsh	-	-	413.56	-	-	-	-	-	4.81	-	-	-	-	-	23.81	-	-	-	-	-	7.36	-	-	-
Fighting Island Undiked Marsh	-	-	222.03	-	-	-	-	-	14.69	-	-	-	-	-	25.35	-	-	-	-	-	8.11	-	-	-
Detroit River Marshes (North)	-	-	-	-	242.70	276.84	-	-	-	-	19.98	13.92	-	-	-	-	28.89	24.35	-	-	-	-	8.28	8.03
Detroit River Marshes	202.33	-	237.23	215.08	223.90	270.70	27.83	-	14.52	3.05	12.30	11.69	24.94	-	21.15	26.19	26.85	21.34	9.15	-	7.84	7.85	7.96	7.14
Turkey Island Marsh	218.33	-	219.13	-	-	-	25.57	-	10.43	-	-	-	23.37	-	24.18	-	-	-	8.56	-	8.84	-	-	-
Canard River Mouth Marsh	213.33	-	234.72	-	-	-	22.00	-	7.46	-	-	-	25.27	-	24.40	-	-	-	8.73	-	8.29	-	-	-
Canard River Marsh	-	-	452.51	522.72	627.20	454.53	-	-	50.72	43.06	52.90	121.46	-	-	28.03	29.60	27.27	23.74	-	-	7.79	7.79	8.12	7.32
Crystal Bay	-	-	220.25	-	-	-	-	-	4.02	-	-	-	-	-	25.76	-	-	-	-	-	8.91	-	-	-

Table 5. Additional water quality parameters collected for selected coastal wetlands in the Detroit River and St. Clair River Areas of Concern (AOC) and non-AOC sites in Lake St. Clair.

Wetland Name	Total Ammonia Nitrogen (mg/L)						Total Nitrate Nitrogen (mg/L)						Total Phosphorus (µg/L)					
	2006	2007	2008	2011	2012	2013*	2006	2007	2008	2011	2012	2013*	2006	2007	2008	2011	2012	2013
<i>St. Clair River AOC</i>																		
Stag Island Marsh	-	-	-	0.039	0.033	0.006	-	-	-	0.023	0.200	0.151	-	-	-	0.012	0.014	0.045
Roberta Stewart Marsh	0.070	0.117	0.021	-	-	-	0.277	0.075	0.000	-	-	-	0.262	0.400	0.200	-	-	-
Snye River Marsh	0.013	0.010	0.005	0.008	0.028	0.006	0.294	0.241	0.000	0.017	0.175	0.059	0.013	0.024	0.015	0.036	0.018	0.115
St. Clair NWA: Bear Creek Unit – Corsini Marsh	-	-	0.074	-	-	-	-	-	0.251	-	-	-	-	-	0.082	-	-	-
St. Clair NWA: Bear Creek Unit – OPG Marsh	0.003	0.036	0.008	0.002	0.020	0.006	0.226	0.023	0.081	0.012	0.075	0.009	0.051	0.276	0.052	0.067	0.051	0.034
St. Clair NWA: Bear Creek Unit – Lozon Marsh	0.028	0.023	-	-	-	-	0.753	0.053	-	-	-	-	0.268	0.224	-	-	-	-
St. Clair NWA: Bear Creek Unit – Maxwell Marsh	-	0.026	-	0.002	0.018	0.005	-	0.098	-	0.017	0.100	0.007	-	0.204	-	0.029	0.032	0.025
St. Clair NWA: Bear Creek Unit – Snye Marsh	0.028	0.026	0.010	-	-	-	0.211	0.083	0.119	-	-	-	0.037	0.142	0.040	-	-	-
Mitchell’s Bay – Mudcreek Marsh and Syne River Marsh	0.025	0.027	0.013	0.012	0.013	0.075	0.467	0.192	0.009	0.017	0.125	1.280	0.039	0.030	0.034	0.029	0.043	0.107
Moon Cove / Tic Tac Point Marsh	0.060	0.083	0.011	0.053	0.020	0.078	0.204	0.105	0.034	0.000	0.125	3.360	0.031	0.049	0.042	0.049	0.026	0.090
<i>Lake St. Clair (Non-AOC)</i>																		
Lake St. Clair Marshes	-	0.031	0.041	0.016	0.025	0.039	-	0.211	0.039	0.011	0.100	-	-	0.043	0.084	0.030	0.035	0.053
St. Clair NWA – East Marsh	-	0.034	0.005	0.023	0.023	0.029	-	0.181	0.000	0.017	0.100	0.006	-	0.039	-	0.066	0.060	0.070
St. Clair NWA – West Marsh	-	0.023	0.008	-	-	-	-	0.008	0.141	-	-	-	-	0.082	-	-	-	-
<i>Detroit River AOC</i>																		
Peché Island Marsh	-	-	0.018	0.029	0.030	0.153	-	-	0.035	0.057	0.075	0.309	-	-	0.042	0.065	0.091	0.133
Turkey Creek Marsh	0.031	-	0.016	0.062	0.005	0.018	0.136	-	0.103	0.040	0.250	0.715	0.035	-	0.020	0.070	0.057	0.095
Fighting Island Diked Marsh	-	-	0.047	-	-	-	-	-	0.075	-	-	-	-	-	0.116	-	-	-
Fighting Island Undiked Marsh	-	-	0.018	-	-	-	-	-	0.078	-	-	-	-	-	0.015	-	-	-
Detroit River Marshes (North)	-	-	-	-	0.040	0.012	-	-	-	-	0.150	0.404	-	-	-	-	0.023	0.050
Detroit River Marshes	0.016	-	0.011	0.000	0.018	0.005	0.083	-	0.052	0.034	0.075	0.109	0.030	-	0.025	0.044	0.033	0.054
Turkey Island Marsh	0.016	-	0.018	-	-	-	0.294	-	0.048	-	-	-	0.025	-	0.023	-	-	-
Canard River Mouth Marsh	0.011	-	0.042	-	-	-	0.173	-	0.060	-	-	-	0.027	-	0.023	-	-	-
Canard River Marsh	-	-	0.132	0.196	0.018	0.101	-	-	0.258	0.113	0.627	0.615	-	-	0.169	0.174	0.311	0.215
Crystal Bay	-	-	0.027	-	-	-	-	-	0.015	-	-	-	-	-	0.015	-	-	-

*TAN and TNN values for 2013 were a composite sample of the wetland, while TAN and TNN values for 2006-2012 were a mean value of three replicate samples.

Discussion

Water Quality Index scores indicate that HEC coastal wetlands are typically moderately degraded, although there are some wetlands that are very degraded and others that are in good condition. In general, AOC sites were comparable to non-AOC Lake St. Clair coastal wetlands. These data indicate that the condition of coastal wetlands in the region has been fairly consistent over time.

Prior to European settlement in Southern Ontario, Southwestern Ontario was one of the area's most wetland-rich regions, but since then has suffered the greatest rates of wetland loss from conversion to alternate land uses (Snell 1987, Ducks Unlimited Canada 2010). The remaining wetlands experience disturbance from nutrient and sediment loadings from high intensity agriculture throughout the region and from dense industry and urban centres along the Detroit and upper St. Clair rivers (Maynard and Wilcox 1997, Green et al. 2010). The ancillary water quality parameters collected (TAN, TNN, and TP) indicate non-point source pollution in the form of nitrogen derivatives and phosphorus, which are consistent with agricultural and urban runoff. The more disturbed wetlands tend to be those that have the greatest connectivity to the watershed (i.e., drowned river mouths), and the least disturbed wetlands tend to be along islands in large rivers.

Vegetated riparian buffers could play a large role in the improvement of tributary water quality, which would ultimately enhance wetland water quality downstream. The nutrient and sediment sequestering qualities of riparian buffers as well their ability to moderate water temperature would greatly benefit the region's wetlands. Creating wetland habitat at the end of drains would greatly limit the nutrient and sediment load on wetlands downstream.

4.0 Submerged Aquatic Vegetation Community

Methodology

The submerged aquatic vegetation community (SAV) was surveyed by sampling a one-metre square quadrat at 20 random locations in the open water basin of each wetland. Quadrat locations were randomly generated in a Geographic Information System (GIS; ESRI 2010) prior to sampling. Within each quadrat, total areal coverage and species-specific coverages for submerged and floating-leaved species were recorded (see Appendix 1 for a list of SAV species).

Submerged Aquatic Vegetation community condition is determined using an Index of Biotic Integrity (IBI). SAV species were grouped into two plant guilds based on growing tolerance (i.e., turbidity tolerant and turbidity intolerant) and native designation (Environment Canada and Central Lake Ontario Conservation Authority (herein, EC and CLOCA) 2004; Grabas et al. 2012). Species were also assigned a coefficient of conservatism (Oldham et al. 1995); values range from 0 to 10 where higher scores are given to vegetation species having lower disturbance tolerance and greater fidelity to a certain habitat. Six metrics were shown to significantly respond to disturbance: SNAT (total number of native species), PCOV (total coverage), PINT (relative percent cover of turbidity-intolerant species), STUR (number of turbidity-tolerant species), PALG (percent cover of filamentous algae), and SRES (number of nutrient-responsive species). Metrics were standardized into a range from 0 to 10 (EC and CLOCA 2004; Grabas et al. 2012). They were then added, multiplied by 10 and divided by the total number of metrics to create an IBI with scores between 0 and 100. Five classes were identified in which minimum detectable differences could be distinguished (Table 6).

Table 6. Index of biotic integrity (IBI) score and associated category based on EC-CLOCA (2004).

IBI Score	Qualitative Descriptor
81-100	Excellent
61-80	Very good
41-60	Good
21-40	Fair
0-20	Poor

Results

In general, SAV community condition in the Huron-Erie Corridor is good or very good (Table 7). With the exception of St. Clair NWA: Bear Creek Unit – OPG Marsh, wetlands in the core sampling suite scored in the good or better categories. The wetlands in the St. Clair River AOC showed comparable values in 2013 to previous years, and did not demonstrate either strong increases or decreases in SAV-IBI. St. Clair NWA: Bear Creek Unit – OPG Marsh had the highest increase of 11 points from the 2012 value (39.41 to 50.73), but the 2013 value is only marginally higher than the 2011 value of 49.90. Stag Island Marsh dropped 10 points from 2012 to 2013 (67.05 to 57.71), although the 2013 value is comparable to the 2011 value. Similarly, Moon Cove / Tic Tac Point Marsh dropped eight points in 2013 from 2012 (62.24 to 70.13), but is comparable to previous years' values. The St. Clair River AOC wetlands demonstrated the largest range in IBI descriptors, from fair to very good. Lake St. Clair wetlands are in very good condition with the exception of St. Clair NWA – West Marsh, which is in fair condition; this may

be due to West Marsh's single sampling year in 2007. Detroit River AOC wetland mean IBIs range from good to very good and in several cases approach or surpass the mean IBI average of the Lake St. Clair wetlands.

Wetlands in better condition typically have lower percent cover of filamentous algae, higher number of nutrient-responsive species, and higher number of turbidity-intolerant species. These sites were classified as good, and very good (Table 8). Wetlands in poorer condition typically exhibited low total cumulative coverage, percent cover of turbidity-intolerant species, and number of native species. These wetlands were classified as poor and fair (Table 8).

Table 7. Index of Biotic Integrity (IBI) score and descriptor for the condition of the submerged aquatic vegetation (SAV) community for selected coastal wetlands in the Detroit River and St. Clair River Areas of Concern (AOC) and non-AOC sites in Lake St. Clair.

Wetland by AOC	SAV Index of Biotic Integrity						Mean	Descriptor*
	2006	2007	2008	2011	2012	2013		
St. Clair River AOC								
Stag Island Marsh	-	-	-	52.43	67.05	57.71	59.06	Good
Roberta Stewart Marsh	26.35	31.75	21.98	-	-	-	26.69	Fair
Snye River Marsh	70.59	48.35	58.59	46.35	62.38	64.16	58.40	Good
St. Clair NWA: Bear Creek Unit – OPG Marsh	27.66	32.86	35.45	49.90	39.41	50.73	39.34	Fair
St. Clair NWA: Bear Creek Unit – Lozon Marsh	52.35	39.97	-	-	-	-	46.16	Good
St. Clair NWA: Bear Creek Unit – Maxwell Marsh	-	43.84	-	60.84	68.76	67.29	60.18	Good
St. Clair NWA: Bear Creek Unit – Snye Marsh	71.65	67.24	53.65	-	-	-	64.18	Very good
Mitchell’s Bay – Mudcreek Marsh and Snye River Marsh	59.64	39.84	56.28	52.10	47.33	53.54	51.46	Good
Moon Cove / Tic Tac Point Marsh	59.12	65.35	62.99	64.65	70.13	62.24	64.08	Very good
Lake St. Clair (Non-AOC)								
Lake St. Clair Marshes	-	53.29	69.61	61.00	62.28	59.72	61.18	Very good
St. Clair NWA – East Marsh	-	44.61	-	64.39	75.85	67.11	62.99	Very good
St. Clair NWA – West Marsh	-	34.79	-	-	-	-	34.79	Fair
Detroit River AOC								
Peche Island Marsh	-	-	48.28	56.55	34.40	51.66	47.72	Good
Turkey Creek Marsh	76.66	-	61.72	53.79	42.96	59.64	58.95	Good
Fighting Island Diked Marsh	-	-	44.13	-	-	-	44.13	Good
Fighting Island Undiked Marsh	-	-	63.54	-	-	-	63.54	Very good
Detroit River Marshes (North)	-	-	-	-	46.10	50.77	48.44	Good
Detroit River Marshes	76.36	-	76.20	63.37	66.33	58.42	68.14	Very good
Turkey Island Marsh	59.83	-	67.35	-	-	-	63.59	Very good
Canard River Mouth Marsh	75.50	-	69.19	-	-	-	72.35	Very good
Canard River Marsh	-	-	55.35	51.96	54.20	49.12	52.66	Good

*based on mean or most recent data

Table 8. SAV community IBI scores (out of 100) and standardized metrics (out of 10) for coastal wetlands sampled in 2013 in the Detroit River AOC, Lake St. Clair, and St. Clair River AOC.

SAV 2013 Metrics							
Wetland Name	SNAT	PCOV	PINT	STUR	PALG	SRES	2013 IBI
St. Clair River AOC							
Stag Island Marsh	3.43	4.38	7.00	6.43	5.38	8.02	57.71
Snye River Marsh	4.69	4.83	2.95	8.31	8.71	9.01	64.16
St. Clair NWA: Bear Creek Unit – OPG Marsh	7.90	9.74	4.16	0.00	8.17	0.47	50.73
St. Clair NWA: Bear Creek Unit – Maxwell Marsh	6.78	6.64	4.45	6.80	9.68	6.03	67.29
Mitchell's Bay – Mudcreek Marsh and Syne River Marsh	6.11	5.83	4.03	3.80	7.53	4.84	53.54
Moon Cove / Tic Tac Point Marsh	4.17	3.66	6.62	7.74	6.13	9.01	62.24
Lake St. Clair (Non-AOC)							
Lake St. Clair Marshes	4.10	4.44	6.97	8.87	3.44	8.02	59.72
St. Clair NWA – East Marsh	5.89	7.94	1.18	7.93	8.71	8.61	67.11
Detroit River AOC							
Peche Island Marsh	5.14	4.85	2.40	6.24	7.53	4.84	51.66
Turkey Creek Marsh	3.43	2.48	4.70	8.87	9.68	6.63	59.64
Detroit River Marshes (North)	3.73	2.54	5.51	6.99	5.27	6.43	50.77
Detroit River Marshes	6.03	4.82	4.33	5.68	9.36	4.84	58.42
Canard River Marsh	2.53	1.58	0.04	8.50	10.00	6.82	49.12
	SNAT	Number of native species					
	PCOV	Total cumulative coverage					
	PINT	Percent cover of turbidity-intolerant species					
	STUR	Number of turbidity-tolerant species					
	PALG	Percent cover of filamentous algae					
	SRES	Number of nutrient-responsive species					

Discussion

Among the three regions sampled, most Lake St. Clair wetlands are in very good condition. Although St. Clair NWA – West Marsh was in fair condition, this was based solely on 2007 data and may not be representative of the site overall; other Lake St. Clair wetlands in this year were similarly low. In 2013, the IBIs for the two sampled Lake St. Clair wetlands were very good and good. The mean IBIs for the Detroit River AOC wetlands had descriptors of very good or good. In particular, the mean IBIs for Detroit River Marshes and Turkey Creek Marsh are comparable to or surpass those of the Lake St. Clair wetlands, which suggest that the Detroit River AOC is approaching non-AOC conditions in these areas. However the 2013 SAV-IBIs in the Detroit River are all in the good category while Lake St. Clair's IBIs are very good or good. The St. Clair River AOC wetlands ranged from fair to very good, demonstrating higher levels of variation in SAV community condition than in the Detroit River AOC. Moon Cove / Tic Tac Point Marsh's mean IBI score surpassed that of St. Clair NWA – East Marsh, which had the highest IBI score in the non-AOC region. In 2013, St. Clair NWA: Bear Creek Unit – Maxwell Marsh had the highest individual IBI score among all the wetlands sampled in this year. Therefore, some wetlands in the St. Clair River AOC appear to be approaching conditions of the non-AOC areas, but several other wetlands remain in poor condition. Similarly, several wetlands exhibit stability in SAV condition and others exhibit considerable change over time.

In this report, consistent patterns in SAV community condition are not observed when 2013 data are compared to previous years' data. It is therefore recommended that SAV community sampling continue in order to better understand the natural levels of variability in SAV community conditions over time to aid in developing robust delisting criteria. Major contributors to poor SAV community condition include high turbidity, which impedes plant growth, as well as the exclusion of native species by invasive species. Improvements in water quality, especially turbidity, would greatly improve the condition of SAV communities and highlight the added benefits of enhancing wetland condition and connectedness of wetland functions.

5.0 Breeding Bird Community

Methodology

Breeding marsh bird communities were surveyed using a modification to the Marsh Monitoring Program (MMP) protocol (Meyer et al. 2006) to report on site-level or specific AOC wetland bird communities. The primary purpose of the MMP is to assess populations of common marsh bird species across broad geographic scales and/or long timeframes. Bird survey stations were identified using aerial photographs and set up at least 250 metres apart. Only those stations that had at least 50% of marsh habitat (i.e., non-woody emergent plants) within the sampling radius (100 m) were surveyed. Marsh bird surveys were conducted using a 15-minute point count sub-divided into three 5-minute components: five minutes of passive surveying followed by five minutes of call broadcasting for secretive species (e.g., Virginia Rail, Sora, Least Bittern, Common Moorhen/American Coot, and Pied-billed Grebe) followed by five minutes of passive surveying (see Appendix 2 for a list of bird species).

Surveyed birds have been categorized into one of two guilds: marsh nesting birds and marsh foraging birds (Grabas et al. 2008). Three metrics were shown to significantly respond to disturbance: RMN (richness of marsh nesters), PEMNO (percent of emergent marsh nesting obligates), and RAEMNO (richness of area-sensitive marsh nesting obligates). These metrics are expected to decrease with increasing disturbance.

Results

Overall, breeding bird community condition ranged from poor to very good in the Detroit River AOC wetlands, fair to excellent in St. Clair River AOC and good to excellent in Lake St. Clair (Table 9). This separation appears to be the result of smaller proportions of emergent marsh-nesting obligates and area-sensitive emergent marsh-nesting obligates in the Detroit River wetlands (Table 10). The mean bird-IBI of St. Clair NWA: Bear Creek Unit – OPG Marsh in the St. Clair River AOC is approaching the condition of the non-AOC Lake St. Clair wetlands; however, Lake St. Clair coastal wetlands support some of the highest quality marsh bird communities in the Lower Great Lakes.

Bird IBI values from 2013 generally appeared to be comparable to or surpassing the condition of the same sites in 2012. Several wetlands the St. Clair River and Lake St. Clair experienced a sharp decline in bird-IBIs in 2012, which generally appears to have remained stable in 2013. The decline suggests that natural variation occurred throughout the region, across both non-AOC and AOC areas, and that fluctuations may occur in future years. Canard River Marsh experienced the strongest increase from 27.32 in 2012 to 49.49 in 2013; previous years were comparable to the 2012 values. The St. Clair River AOC wetlands varied with respect to increases or decreases of bird-IBIs from 2012 to 2013, while the Detroit River AOC wetlands generally remained stable or increased between 2012 and 2013. The most significant driver of the bird-IBI values appears to be the richness of area-sensitive emergent marsh nesting obligates.

Table 9. Marsh breeding bird community IBI (Bird-IBI) score and descriptor for selected coastal wetlands in the Detroit River and St. Clair River Areas of Concern (AOC) and non-AOC sites in Lake St. Clair.

Wetland by AOC	2007	2008	Bird IBI			Mean	Descriptor*
			2011	2012	2013		
St. Clair River AOC							
Stag Island Marsh	-	-	32.47	15.80	18.43	22.23	Fair
Roberta Stewart Marsh	70.00	-	-	-	-	70.00	Very good
Snye River Marsh	69.58	-	52.21	59.84	70.09	62.93	Very good
St. Clair NWA: Bear Creek Unit – OPG Marsh	83.51	-	96.21	75.85	70.18	81.44	Excellent
St. Clair NWA: Bear Creek Unit – Lozon Marsh	38.63	-	-	-	-	38.63	Fair
St. Clair NWA: Bear Creek Unit – Maxwell Marsh	25.54	-	48.12	46.22	59.74	44.91	Good
St. Clair NWA: Bear Creek Unit – Snye Marsh	57.71	-	-	-	-	57.71	Good
Mitchell's Bay – Mudcreek Marsh and Syne River Marsh	81.54	-	85.44	47.92	64.67	69.89	Very good
Moon Cove / Tic Tac Point Marsh	80.84	-	84.41	32.41	34.82	58.12	Good
Lake St. Clair (Non-AOC)							
Lake St. Clair Marshes	86.20	-	80.75	38.71	33.90	59.89	Good
St. Clair NWA – East Marsh	84.97	-	79.57	75.01	80.76	80.08	Very good
St. Clair NWA – West Marsh	82.12	-	-	-	-	82.12	Excellent
Detroit River AOC							
Peche Island Marsh	-	13.17	7.90	15.80	15.80	13.17	Poor
Turkey Creek Marsh	-	20.04	18.11	20.07	27.15	21.34	Fair
Fighting Island Diked Marsh	-	13.59	-	-	-	13.59	Poor
Detroit River Marshes	-	22.31	17.46	33.04	49.18	30.50	Fair
Turkey Island Marsh	-	10.53	-	-	-	10.53	Poor
Canard River Mouth Marsh	-	61.99	-	-	-	61.99	Very good
Canard River Marsh	-	21.07	28.31	27.32	49.49	31.55	Fair

* based upon mean IBI value for years sampled

Table 10. Breeding bird community IBIs (out of 100) and standardized metrics (out of 10) for coastal wetlands sampled in 2013.

Wetland by AOC	PEMNO	RMN	RAEMNO	2013 IBI
<i>St. Clair River AOC</i>				
Stag Island Marsh	0.00	5.53	0.00	18.43
Snye River Marsh	2.60	8.43	10.00	70.09
St. Clair NWA: Bear Creek Unit – OPG Marsh	4.39	10.00	6.67	70.18
St. Clair NWA: Bear Creek Unit – Maxwell Marsh	2.30	8.95	6.67	59.74
Mitchell's Bay – Mudcreek Marsh and Syne River Marsh	3.01	8.89	7.50	64.67
Moon Cove / Tic Tac Point Marsh	2.11	5.00	3.33	34.82
<i>Lake St. Clair (Non-AOC)</i>				
Lake St. Clair Marshes	1.22	6.09	2.86	33.90
St. Clair NWA – East Marsh	4.23	10.00	10.00	80.76
<i>Detroit River AOC</i>				
Peche Island Marsh	0.00	4.74	0.00	15.80
Turkey Creek Marsh	0.51	5.14	2.50	27.15
Detroit River Marshes	1.46	8.30	5.00	49.18
Canard River Marsh	1.60	6.58	6.67	49.49

PEMNO Percent emergent marsh nesting obligates
RMN Richness of marsh nesters
RAEMNO Richness of area-sensitive marsh nesting obligates

Discussion

There is a major difference in the condition of breeding marsh bird communities between the Detroit River AOC and St. Clair River AOC. The Detroit River wetlands exhibit communities indicative of disturbed conditions whereas marsh bird communities in the St. Clair River AOC (with the exception of Stag Island Marsh) score good or better and Lake St. Clair (with the exception of Lake St. Clair Marshes in recent years) communities score near or at the top of the IBI scale. These differences cannot be attributed to a single factor; however, habitat encroachment from urban development and habitat loss from shoreline hardening are of significant importance. As a result of encroachment and loss, the remaining coastal wetlands are reduced to small fringing units, which are unable to support many area-sensitive and marsh obligate species. Larger wetlands that remain, such as Canard River, are heavily impacted by watershed inputs and do not support the quality of habitat necessary for these species.

The wetlands remaining in the St. Clair River AOC exist as small units in the river, but together comprise a network of wetlands along the Snye River and the large marshes of the St. Clair River Delta, which are known to support many target guilds and species. Lake St. Clair wetlands act as a contiguous swath of wetland along a portion of the shoreline and scored high bird IBI values, thereby emphasizing the importance of the St. Clair National Wildlife Areas in providing high quality habitat for marsh birds.

6.0 Aquatic Macroinvertebrate Community

Methodology

For each wetland, three replicate sub-samples of approximately 150 nektonic and epiphytic aquatic macroinvertebrates ($\geq 500 \mu\text{m}$) were taken by sweep-netting through the water column in the cattail-dominated or flooded common reed emergent communities. Macroinvertebrates were identified to the lowest taxonomic group possible.

Burton et al. (2008) include recommendations for an aquatic macroinvertebrate community IBI through the Great Lakes Coastal Wetland Consortium (www.glc.org/wetlands). Five metrics were used that have shown a significant association with disturbance (Table 9). Most metrics (e.g., number of Odonata genera [NODO]) have been shown to decrease with disturbance while others (e.g., percent Diptera [PDIP]) have been shown to increase with disturbance (Merritt and Cummins 1996, EC and CLOCA 2004).

Results

The IBIs for the Detroit River AOC wetlands scored from good to very good but are typically good. The non-AOC Lake St. Clair wetlands scored from very good to excellent. The St. Clair River AOC wetlands scored from good to very good but are typically very good. There is considerable variation in IBI scores over time with no consistent pattern observed among wetlands. Regionally, the Detroit River AOC wetlands scored lower than both the non-AOC and St. Clair River AOC wetlands (Table 11). The variation in IBI scores does not appear to be driven by specific metric values, as variation exists among sites as well as regions (Table 12).

Table 11. Index of Biotic Integrity (IBI) for the condition of the aquatic macroinvertebrate community for selected coastal wetlands in the Detroit River and St. Clair River Areas of Concern (AOC) and non-AOC sites in Lake St. Clair.

Wetland by AOC	Aquatic Macroinvertebrate IBI							Descriptor*
	2006	2007	2008	2011	2012	2013	Mean	
St. Clair River AOC								
Stag Island Marsh	-	-	-	54.13	41.60	35.94	43.89	Good
Roberta Stewart Marsh	85.83	61.52	64.19	-	-	-	70.51	Very good
Snye River Marsh	84.97	90.77	63.61	39.91	60.11	40.45	63.31	Very good
St. Clair NWA: Bear Creek Unit – OPG Marsh	72.70	93.00	83.01	68.01	75.86	74.50	77.85	Very good
St. Clair NWA: Bear Creek Unit – Lozon Marsh	45.68	52.75	-	-	-	-	49.21	Good
St. Clair NWA: Bear Creek Unit – Maxwell Marsh	-	92.32	-	54.31	45.67	58.27	62.64	Very good
St. Clair NWA: Bear Creek Unit – Snye Marsh	60.79	58.16	67.89	-	-	-	62.28	Very good
Mitchell’s Bay – Mudcreek Marsh and Syne River Marsh	69.18	85.92	78.70	71.17	66.55	48.66	70.03	Very good
Moon Cove / Tic Tac Point Marsh	85.63	80.57	87.60	83.73	79.05	67.15	80.62	Very good
Lake St. Clair (Non-AOC)								
Lake St. Clair Marshes	-	71.66	72.44	70.18	74.96	84.38	74.72	Very good
St. Clair NWA – East Marsh	-	94.26	-	51.53	69.82	75.09	72.67	Very good
St. Clair NWA – West Marsh	-	96.32	-	-	-	-	96.32	Excellent
Detroit River AOC								
Peche Island Marsh	-	-	77.13	33.31	53.70	54.58	54.68	Good
Turkey Creek Marsh	58.46	-	40.75	26.24	46.99	40.51	42.59	Good
Fighting Island Diked Marsh	-	-	65.43	-	-	-	65.43	Very good
Fighting Island Undiked Marsh	-	-	44.87	-	-	-	44.87	Good
Detroit River Marshes (North)	-	-	-	-	45.98	45.61	45.79	Good
Detroit River Marshes	89.52	-	68.32	55.18	51.11	62.44	65.32	Very good
Turkey Island Marsh	77.76	-	43.14	-	-	-	60.45	Good
Canard River Mouth Marsh	76.98	-	68.63	-	-	-	72.81	Very good
Canard River Marsh	-	-	61.79	46.46	67.98	51.00	56.81	Good

* based upon mean IBI value for years sampled

Table 12. Aquatic Macroinvertebrate community IBIs (out of 100) and standardized metrics (out of 10) for coastal wetlands sampled in 2013.

Wetland by AOC	PDIP	PCRU	PAMP	NODO	NFAM	2013 IBI
<i>St. Clair River AOC</i>						
Stag Island Marsh	3.58	0.00	0.00	5.72	8.67	35.94
Snye River Marsh	0.00	0.83	0.82	8.58	10.00	40.46
St. Clair NWA: Bear Creek Unit – OPG Marsh	6.60	6.19	6.45	10.00	8.00	74.50
St. Clair NWA: Bear Creek Unit – Maxwell Marsh	0.00	5.42	3.72	10.00	10.00	58.27
Mitchell's Bay – Mudcreek Marsh and Snye River Marsh	0.00	3.96	4.13	8.58	7.67	48.66
Moon Cove / Tic Tac Point Marsh	3.72	10.00	10.00	2.86	7.00	67.15
<i>Lake St. Clair (Non-AOC)</i>						
Lake St. Clair Marshes	8.64	10.00	10.00	5.72	7.83	84.38
St. Clair NWA – East Marsh	0.04	10.00	10.00	7.51	10.00	75.09
<i>Detroit River AOC</i>						
Peche Island Marsh	0.00	3.57	3.71	10.00	10.00	54.58
Turkey Creek Marsh	0.00	2.00	2.09	10.00	6.17	40.51
Detroit River Marshes (North)	0.00	1.47	1.34	10.00	10.00	45.61
Detroit River Marshes	1.79	4.66	4.77	10.00	10.00	62.44
Canard River Marsh	0.00	3.89	3.99	7.72	9.90	51.00
	PDIP	Proportion of Diptera				
	PCRU	Proportion of Crustacea				
	PAMP	Proportion of Amphipoda				
	NODO	Number of Odonata				
	NFAM	Total number of families				

Discussion

The results from the aquatic macroinvertebrate IBI highlight the importance of using a multimetric approach in IBI development, as no single metric appeared to drive IBI scores. This also illustrates that despite wetlands being characterized as being in good or very good condition, certain metrics are still negatively impacted, and disturbance remains.

The utility of using aquatic macroinvertebrates to assess coastal wetland condition cannot be understated, as these organisms spend a large proportion of their life cycle in water and act as indicators of conditions on a longer time scale than discrete water quality sampling. In addition, the GLCWC methodology utilized here is standardized for the Great Lakes and can be used in regional comparisons across the basin. This is important in the development of specific delisting criteria and for comparisons with non-AOC conditions. It is recommended that aquatic macroinvertebrate community monitoring continue to support the reporting on coastal wetland habitat condition in this region to better understand variability at multiple time scales.

7.0 Using indicators to report on delisting criteria

CWS-ON's coastal monitoring framework is used to monitor the condition of coastal wetlands across the Great Lakes. It is used regionally (e.g., Durham Region's Coastal Wetland Monitoring Program) and in other Areas of Concern (e.g., Bay of Quinte, Wheatley Harbour, Thunder Bay and St. Marys River), as well as in lake-wide basin assessments (e.g., Coastal Habitat Assessment and Monitoring Project; CHAMP). CWS-ON uses the framework to develop indices to report on the condition of wildlife communities and habitat, which supports long-term monitoring efforts and the development of specific and quantifiable delisting criteria for AOCs.

The IJC's delisting guideline for BUI #3 – *“when environmental conditions support healthy, self-sustaining communities of desired fish and wildlife at predetermined levels of abundance that would be expected from the amount and quality of suitable physical, chemical and biological habitat present”* – is more conceptual than quantifiable. The delisting criteria for BUI #3 for Detroit River AOC – *“when environmental conditions support self-sustaining and healthy communities of [...] wildlife (e.g., black-crowned night heron, northern leopard frog) species”* – suggests the use of indicator species but does not specify the mechanisms by which success will be measured. It is therefore important to determine a paradigm for designing more attainable and measurable criteria. This will better utilize the indicators currently included in reporting, and in turn advance the achievability of delisting the AOCs.

One of the current delisting criteria for BUI #14 for St. Clair River AOC is *“Wetland habitat quality achieves an integrated ranking of Good or better based on the IBI scores for water quality, submerged aquatic vegetation, aquatic invertebrates, fish and birds or, when the quality of the wetlands in the AOC are shown to be comparable to reference wetlands outside the AOC”* (CRIC, 2013). Although this criterion takes a positive step in developing an achievable and measurable delisting end-point because it accounts for the natural geophysical and biological variations in the Huron-Erie Corridor, the criterion lacks information regarding the origin of the 'Good' descriptor. If this descriptor is based on the qualitative scale in this document and is based on CHAMP data, then this should be recognized in the delisting criterion.

The importance of comparing AOC wetlands to reference conditions outside the AOC is demonstrated in the marsh bird data presented in this report. The mean bird-IBI in 2012 in St. Clair River AOC displayed a strong decline compared to 2011 and 2007 results (Figure 3). If taken solely within the St. Clair River AOC, results suggest the bird populations were undergoing decline in the AOC. However, when compared to the non-AOC reference sites, this decline can be seen throughout the region, suggesting that stressors affecting the bird community go beyond the confines of the AOC and are not necessarily AOC-specific. Comparisons to non-AOC reference wetlands present a more complete picture of coastal wetland wildlife, demonstrating that these BUIs may be no longer impaired even if they remain below the pre-determined target IBI.

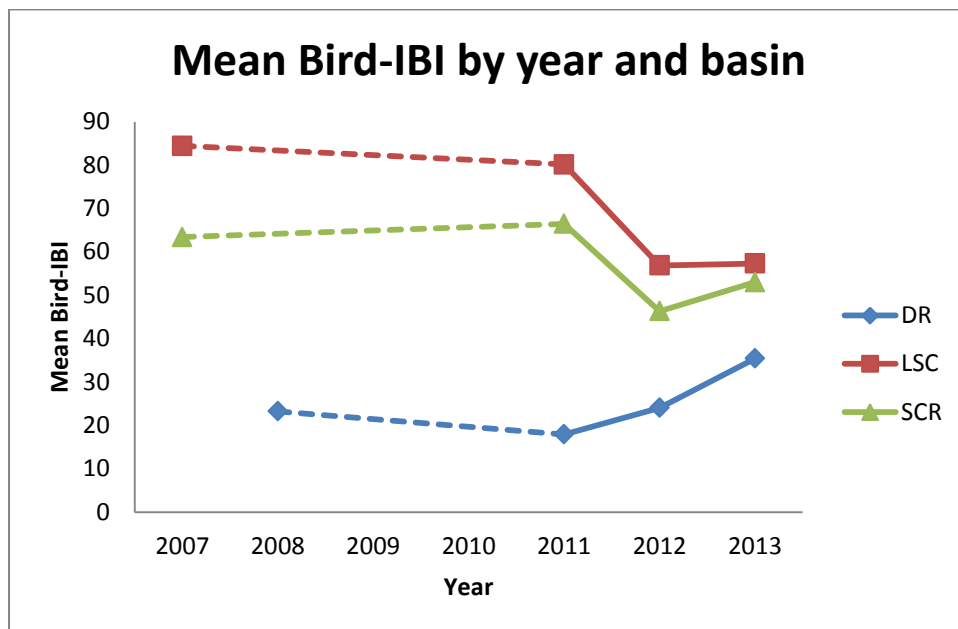


Figure 3. Mean bird-IBIs for Detroit River (DR), Lake St. Clair (LSC), and St. Clair River (SCR) for the years 2007-2013, demonstrating AOC and non-AOC decline. Dashed lines indicate years not sampled.

The use of non-AOC reference wetlands to incorporate variation as well as the move away from a fixed IBI target has been supported in the Bay of Quinte. There, the criteria are such that amphibian and bird “community IBIs at representative Bay of Quinte coastal wetlands shall not be more than two standard deviations below the recent representative site mean that has been corrected for varying conditions in Lake Ontario outside of the AOC from 2006-2010” (GKR Consulting and French Planning Services Inc., 2013). The Bay of Quinte has subsequently seen success in meeting its targets and is moving toward redesignation of this BUI to “not impaired”, and the St. Clair River supports a similar allowance for variation as noted above. Therefore, using non-AOC reference wetlands or other methods to incorporate variation in the Detroit River AOC would greatly strengthen the utility of the delisting criteria.

It is therefore recommended to use a paradigm that will incorporate quantifiable delisting criteria and better represent natural variation in this area. In addition, clarification is needed on how existing indicators can best be utilized to report on delisting criteria. Because of the intrinsic variation of wetlands in the Huron-Erie Corridor, it may prove problematic to target IBIs of good or better. Instead, using a paradigm that incorporates the geophysical and biological components in the Huron-Erie Corridor that will be tempered with the IBIs to create realistic and attainable criteria will advance the achievability of eventually delisting the Detroit River and St. Clair River AOCs. Further, a set list of coastal wetlands should be used for the assessment so as to ensure consistency in reporting so that a wetland sampled once will not influence the outcomes of wetland regularly sampled within the Huron-Erie Corridor. A recommended list of sites based on sites surveyed for the past three years can be found in Appendix 4.

8.0 Summary

This report describes the condition of coastal wetlands in the Huron-Erie Corridor (Detroit River AOC, Lake St. Clair, and St. Clair River AOC) using values of water chemistry and three separate IBIs for SAV, aquatic macroinvertebrates, and breeding bird communities. Overall, wetland condition ranged widely from highly degraded to excellent, with a large proportion of sites exhibiting evidence of being in good condition (Table 13).

Table 13. Summary of index scores and descriptors for water quality (from -3 to +3), submerged aquatic vegetation (SAV), aquatic macroinvertebrates (Invert), and breeding marsh bird communities (Bird) (from 0 to 100) of selected coastal wetlands in the Detroit River and St. Clair River Areas of Concern (AOC) and non-AOC sites in Lake St. Clair.

Wetland by AOC		WQI	Mean Index Score ¹			
			SAV-IBI	Bird-IBI	Invert-IBI	
St. Clair River AOC						
Stag Island Marsh		0.63	59.06	22.23	43.89	
Roberta Stewart Marsh		-0.94	26.69	70.00	70.51	
Snye River Marsh		0.26	58.40	62.93	63.31	
St. Clair NWA: Bear Creek Unit – Corsini Marsh		-2.16	-	-	-	
St. Clair NWA: Bear Creek Unit – OPG Marsh		-0.09	39.34	81.44	77.85	
St. Clair NWA: Bear Creek Unit – Lozon Marsh		-0.57	46.16	38.63	49.21	
St. Clair NWA: Bear Creek Unit – Maxwell Marsh		0.26	60.18	44.91	62.64	
St. Clair NWA: Bear Creek Unit – Snye Marsh		-0.74	64.18	57.71	62.28	
Snye River South Marsh		-0.94	-	-	-	
Mitchell's Bay – Mudcreek Marsh and Syne River Marsh		-0.22	51.46	69.89	70.03	
Moon Cove / Tic Tac Point Marsh		-0.34	64.08	58.12	80.62	
Lake St. Clair (Non-AOC)						
Lake St. Clair Marshes		-0.38	61.18	59.89	74.71	
St. Clair NWA – East Marsh		0.08	62.99	80.08	72.67	
St. Clair NWA – West Marsh		0.08	34.79	82.12	96.32	
Detroit River AOC						
Peche Island Marsh		0.13	47.72	13.17	54.68	
Turkey Creek Marsh		-1.09	58.95	21.34	42.59	
Fighting Island Diked Marsh		-0.09	44.13	13.59	65.43	
Fighting Island Undiked Marsh		-0.47	63.54	-	44.87	
Detroit River Marshes (North)		-0.69	48.44	-	45.79	
Detroit River Marshes		-0.27	68.14	30.50	65.32	
Turkey Island Marsh		-0.56	63.59	10.53	60.45	
Canard River Mouth Marsh		-0.43	72.35	61.99	72.81	
Canard River Marsh		-1.89	52.66	31.55	56.81	
Crystal Bay		0.20	-	-	-	
IBI Key:	Poor	Fair	Good	Very Good	Excellent	
WQI Key	Highly Degraded	Very Degraded	Moderately Degraded	Good	Very Good	Excellent

¹ based upon mean index value for years sampled

Water quality was similar among AOCs and non-AOCs. In general, index scores have indicated moderate levels of degradation in the Huron-Erie Corridor. Similarly, submerged aquatic vegetation condition exhibits some variability but is consistent among waterbodies. Few wetlands show signs of high levels of disturbance in the submerged aquatic vegetation community, with the majority of sites in very good condition. Breeding marsh bird community

condition exhibits a difference between AOCs, with the Detroit River AOC wetlands exhibiting poorer marsh bird community condition than both the non-AOC and St. Clair River AOC wetlands. The St. Clair River bird communities are generally in good or very good condition, and highlight the importance of this area for bird populations. Similarly, aquatic macroinvertebrate community condition is slightly poorer in the Detroit River AOC than either the non-AOC or St. Clair River AOC, and provides insight into the long-term water quality conditions of the region. This report outlines the conditions in the Huron-Erie Corridor coastal wetlands and provides key baseline monitoring data for the region.

Acknowledgements

Environment Canada – Canadian Wildlife Service acknowledges and thanks Detroit River, Lake St. Clair, and St. Clair River shoreline property owners and stewards for granting land access in support of this project. In particular the following provided important access: City of Windsor, Stag Island Environmental Committee, and the Balmoral, Bay Lodge, Big Point, Mud Creek, and St. Luke's Hunt Clubs.

Funds for this project were provided by the Government of Canada's Great Lakes Action Plan.

Cover Photos: Environment Canada – Canadian Wildlife Service.

Literature Cited

- Burton, T.M., J.C. Brazner, J.J.H. Ciborowski, G.P. Grabas, J. Hummer, J. Schneider, and D.G. Uzarski (Eds.). 2008. Great Lakes Coastal Wetlands Consortium Monitoring Plan. Great Lakes Coastal Wetlands Consortium. United States Environmental Protection Agency – Great Lakes National Program Office. <http://www.glc.org/wetlands/final-report.html>
- Chow-Fraser, P. 2006. Development of the Wetland 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.
- Crewe, Tara L. 2013. Development of Bird, Invertebrate and Submerged Aquatic Vegetation Community Indices of Biotic Integrity for the St. Clair and Detroit River Region.
- Ducks Unlimited Canada. 2010. Southern Ontario Wetland Conversion Analysis – Final Report. Barrie, ON: Ducks Unlimited Canada. October 2010.
- Environment Canada – Canadian Wildlife Service. 2008. St. Clair River Area of Concern: Coastal Wetland Habitat Assessments. Technical Report. May 2008. Downsview, ON: CWS-ON.
- Environment Canada – Canadian Wildlife Service. 2009a. Addendum to St. Clair River Area of Concern: Coastal Wetland Habitat Assessments. Technical Report. May 2009. Downsview, ON: CWS-ON.
- Environment Canada – Canadian Wildlife Service. 2009b. Detroit River Area of Concern: Coastal Wetland Habitat Assessment. Technical Report. June 2009. Downsview, ON: CWS-ON.
- Environment Canada – Canadian Wildlife Service. 2012a. Detroit River and St. Clair River Areas of Concern: Coastal Wetland Habitat Assessment Report. Technical Report. June 2012. Downsview, ON: CWS-ON.
- Environment Canada – Canadian Wildlife Service. 2012b. Coastal Habitat Assessment and Monitoring Project: Year 3 Technical Review. Environment Canada, Canadian Wildlife Service (Ontario).
- Environment Canada and Central Lake Ontario Conservation Authority. 2004. Durham Region Coastal Wetland Monitoring Project: Year 2 Technical Report. Downsview, ON: ECB-OR.
- Environmental Systems Research Institute (ESRI). 2010. ArcGIS 10.0. Redlands, California.
- GKR Consulting and French Planning Services Inc. 2013. BQRAP Science Forum Proceedings Report: “Assessing Delisting Requirements”. Belleville, Ontario. 29 January. http://www.bqrap.ca/cms_lib/BQRAP%202012%20Forum%20Proceedings_final.1.pdf

- Grabas G.P., E.A. Blukacz-Richards, S. Pernanen. 2012. Development of a submerged aquatic vegetation community index of biotic integrity for use in Lake Ontario coastal wetlands. *Journal of Great Lakes Research*. 30(2):243-250.
- Grabas, G.P., T.L. Crewe and S.T.A. Timmermans. 2008. Bird Community Indicators. Chapter 7 *In Great Lakes Coastal Wetlands Monitoring Plan*, pp.116-142. Great Lakes Wetlands Consortium, March 2008. www.glc.org/wetlands/documents/finalreport/ch7.pdf
- Green N.D., L. Cargnelli, T. Briggs, R. Drouin, M. Child J. Esbjerg, M. Valiante, T. Henderson, D. McGregor, and D. Munro (eds.). 2010. Detroit River Canadian Remedial Action Plan: Stage 2 Report. Detroit River Canadian Cleanup, Publication No. 1, Essex, Ontario, Canada.
- Maynard, L., and D.A. Wilcox. 1997. Coastal wetlands. State of the Lakes Ecosystem Conference 1996 Background Paper. Environmental Protection Agency 905-R-97-015b. 99 pp.
- Meyer, S.W., J.W. Ingram and G.P. Grabas. 2006. The Marsh Monitoring Program: evaluating marsh bird survey protocol modifications to assess Lake Ontario coastal wetlands at a site-level. Technical Report Series 465. Canadian Wildlife Service, Ontario Region, Ontario.
- Oldham, M. J., W. D. Bakowsky and D. A. Sutherland. 1995. Floristic Quality Assessment System for Southern Ontario. Ontario Ministry of Natural Resources, Natural Heritage Information Centre: Peterborough. 69 pp.
- Snell, E. 1987. Wetland distribution and conservation in Southern Ontario. Working Paper No. 48. Inland Waters and Land Directorate, Environment Canada, Ottawa, ON
- St. Clair River Canadian Remedial Action Plan Implementation Committee (CRIC). 2013. St. Clair River Area of Concern 2012-2017 Work Plan. St. Clair Region Conservation Authority, Strathroy, Ontario, Canada.
- St. Clair River RAP Team, St. Clair River BPAC, Ontario Ministry of Environment and Energy, Michigan Department of Natural Resources. 1995. St. Clair River Water Use Goals, Remedial Measures and Implementation Strategy (Stage 2).

Appendix 1

List of species observed during 2013 submerged aquatic vegetation (SAV) surveys.

Common Name	Genus/Species	Native	Turbidity -Tolerant	Coefficient of Conservatism	Nutrient Responsive
American lotus	Nelumbo lutea	√		10	
Brittlewort	Nitella sp.	√			
Broadleaf Cattail	Typha latifolia	√		3	
Broad-leaved Arrowhead	Sagittaria latifolia	√		4	
Canada Waterweed	Elodea canadensis	√	Tolerant	4	√
Common Bladderwort	Utricularia vulgaris	√		4	
Common burreed	Sparganium eurycarpum	√		3	
Common Reed (Invasive)	Phragmites australis	×			
Common Three-square	Schoenoplectus pungens	√		6	
Coontail, Hornwort	Ceratophyllum demersum	√	Tolerant	4	√
Curly Pondweed	Potamogeton crispus	×	Tolerant		√
Curly White Water Crowfoot	Ranunculus longirostris	√	Tolerant	5	
dead Typha	dead Typha	√			
Eurasian Water Milfoil	Myriophyllum spicatum	×	Tolerant		√
European Frog-bit	Hydrocharis morsus-ranae	×			
Filamentous algae surface	Algae sp. (fil. surface)	√			√
Filamentous algae underwater	Algae sp. (fil. underwater)	√			√
Flat-stemmed Pondweed	Potamogeton zosteriformis	√	Intolerant	5	
Floating Arrowhead	Sagittaria cuneata	√		7	
Floating Slender Liverwort	Riccia fluitans	√			
Floating-leaved Pondweed	Potamogeton natans	√		5	
grass-leaved arrowhead	Sagittaria graminea	√		8	
Greater Duckweed	Spirodela polyrhiza	√		4	
Hardstem Bulrush	Schoenoplectus acutus	√		6	
knotweed, smartweed	Polygonum sp.	√			
Leafy Pondweed	Potamogeton foliosus	√	Tolerant	4	
lesser bladderwort	Utricularia minor	√		8	
Lesser Duckweed	Lemna minor	√		2	√
little floatingheart	Nymphoides cordata	√		10	
Narrow-leaved Cattail	Typha angustifolia	√		3	
Needle Spikerush	Eleocharis acicularis	√			
Northern Water Milfoil	Myriophyllum sibiricum	√	Intolerant	6	
Pickeralweed	Pontederia cordata	√		7	
Pondweed sp.	Potamogeton sp.	√			
Richardson's, Clasping Leaved Pondweed	Potamogeton richardsonii	√		5	
Sago Pondweed	Potamogeton pectinatus	√	Tolerant	4	√
Slender Naiad	Najas flexilis	√	Intolerant	5	
Slender Pondweed	Potamogeton pusillus	√	Tolerant	5	
Softstem Bulrush	Schoenoplectus tabernaemontani	√		5	
Spiny Naiad	Najas minor	×			
Star Duckweed	Lemna trisulca	√		4	
Stiff Arrowhead	Sagittaria rigida	√		6	
Stonewort, Muskgrass	Chara sp.	√			
Tape Grass, Wild Celery, Water Celery	Vallisneria americana	√	Intolerant	6	
Variable-leaved Pondweed	Potamogeton gramineus	√		4	

Common Name	Genus/Species	Native	Turbidity -Tolerant	Coefficient of Conservatism	Nutrient Responsive
Water Star-grass	Heteranthera dubia	√	Tolerant	7	
White Water Lily, Fragrant Water Lily	Nymphaea odorata	√		5	
Wild Rice	Zizania palustris	√		9	
Yellow Pond Lily, Bullhead Lily, Spatterdock	Nuphar lutea ssp. variegata	√		4	

Appendix 2

Bird species observed during 2013 surveys, grouped into metrics that were included for calculating the IBI: a) emergent marsh nesting obligates, b) marsh nesters, and c) area-sensitive marsh nesting obligates.

a) Emergent marsh nesting obligates

Code	Common Name	Species
COMO	common moorhen	<i>Gallinula chloropus</i>
MAWR	marsh wren	<i>Cistothorus palustris</i>
PBGR	pied-billed grebe	<i>Podilymbus podiceps</i>
SORA	sora	<i>Porzana carolina</i>
VIRA	Virginia rail	<i>Rallus limicola</i>
YHBL	yellow-headed blackbird	<i>Xanthocephalus xanthocephalus</i>

b) Marsh nesters

Code	Common Name	Species
AMBI	American bittern	<i>Botaurus lentiginosus</i>
AMCO	American coot	<i>Fulica americana</i>
BLTE	black tern	<i>Chlidonias niger</i>
CAGO	Canada Goose	<i>Branta canadensis</i>
COMO	common moorhen	<i>Gallinula chloropus</i>
COYE	Common Yellowthroat	<i>Geothlypis trichas</i>
FOTE	Forster's tern	<i>Sterna forsteri</i>
LEBI	least bittern	<i>Ixobrychus exilis</i>
MAWR	marsh wren	<i>Cistothorus palustris</i>
NOHA	Northern Harrier	<i>Circus cyaneus</i>
PBGR	pied-billed grebe	<i>Podilymbus podiceps</i>
RWBL	Red-winged Blackbird	<i>Agelaius phoeniceus</i>
SORA	sora	<i>Porzana carolina</i>
SWSP	swamp sparrow	<i>Melospiza georgiana</i>
VIRA	Virginia rail	<i>Rallus limicola</i>
YHBL	yellow-headed blackbird	<i>Xanthocephalus xanthocephalus</i>

c) Area-sensitive marsh-nesting obligate bird species

Code	Common Name	Species
AMBI	American bittern	<i>Botaurus lentiginosus</i>
AMCO	American Coot	<i>Fulica americana</i>
BLTE	black tern	<i>Chlidonias niger</i>
FOTE	Forster's tern	<i>Sterna forsteri</i>
LEBI	least bittern	<i>Ixobrychus exilis</i>

Appendix 3

List of Aquatic Macroinvertebrate species identified to the lowest taxonomic unit possible from 2013 samples.

Phylum	Class	Order	Family	Genus/Species
Annelida	Clitellata	Arhynchobdellida	Erpobdellidae	
Annelida	Clitellata	Arhynchobdellida	Erpobdellidae	Erpobdella punctata
Annelida	Clitellata	Rhynchobdellida	Glossiphoniidae	
Annelida	Clitellata	Rhynchobdellida	Glossiphoniidae	Alboglossiphonia heteroclita
Annelida	Clitellata	Rhynchobdellida	Glossiphoniidae	Desserobdella phalera
Annelida	Clitellata	Rhynchobdellida	Glossiphoniidae	Glossiphonia complanata
Annelida	Clitellata	Rhynchobdellida	Glossiphoniidae	Helobdella fusca
Annelida	Clitellata	Rhynchobdellida	Glossiphoniidae	Helobdella papillata
Annelida	Clitellata	Rhynchobdellida	Glossiphoniidae	Helobdella sp.
Annelida	Clitellata	Rhynchobdellida	Glossiphoniidae	Helobdella stagnalis
Annelida	Clitellata	Rhynchobdellida	Glossiphoniidae	Helobdella triserialis
Annelida	Clitellata	Rhynchobdellida	Glossiphoniidae	Placobdella ornata
Annelida	Clitellata	Rhynchobdellida	Glossiphoniidae	Placobdella sp.
Annelida	Oligochaeta			
Arthropoda	Arachnida	Acarina		
Arthropoda	Crustacea	Amphipoda		
Arthropoda	Crustacea	Amphipoda	Crangonyctidae	Crangonyx sp.
Arthropoda	Crustacea	Amphipoda	Gammaridae	
Arthropoda	Crustacea	Amphipoda	Gammaridae	Echinogammarus ischnus
Arthropoda	Crustacea	Amphipoda	Gammaridae	Gammarus fasciatus
Arthropoda	Crustacea	Amphipoda	Gammaridae	Gammarus sp.
Arthropoda	Crustacea	Amphipoda	Gammaridae	Gammarus tigrinus
Arthropoda	Crustacea	Amphipoda	Hyalellidae	Hyalella azteca
Arthropoda	Crustacea	Decapoda	Cambaridae	
Arthropoda	Crustacea	Isopoda	Asellidae	Caecidotea sp.
Arthropoda	Insecta	Coleoptera	Chrysomelidae	
Arthropoda	Insecta	Coleoptera	Curculionidae	
Arthropoda	Insecta	Coleoptera	Dytiscidae	
Arthropoda	Insecta	Coleoptera	Dytiscidae	Celina sp.
Arthropoda	Insecta	Coleoptera	Dytiscidae	Hydroporinae sp.
Arthropoda	Insecta	Coleoptera	Dytiscidae	Hygrotus sp.
Arthropoda	Insecta	Coleoptera	Dytiscidae	Laccophilus sp.
Arthropoda	Insecta	Coleoptera	Dytiscidae	Liodessus sp.
Arthropoda	Insecta	Coleoptera	Dytiscidae	Matus sp.
Arthropoda	Insecta	Coleoptera	Dytiscidae	Neoporus sp.
Arthropoda	Insecta	Coleoptera	Elmidae	Dubiraphia sp.
Arthropoda	Insecta	Coleoptera	Gyrinidae	Dineutus sp.
Arthropoda	Insecta	Coleoptera	Gyrinidae	Gyrinus sp.
Arthropoda	Insecta	Coleoptera	Halipidae	Halipus sp.
Arthropoda	Insecta	Coleoptera	Halipidae	Pelodytes sp.
Arthropoda	Insecta	Coleoptera	Hydrophilidae	
Arthropoda	Insecta	Coleoptera	Hydrophilidae	Berosus sp.
Arthropoda	Insecta	Coleoptera	Hydrophilidae	Enochrus sp.
Arthropoda	Insecta	Coleoptera	Hydrophilidae	Tropisternus sp.
Arthropoda	Insecta	Coleoptera	Noteridae	
Arthropoda	Insecta	Coleoptera	Noteridae	Hydrocanthus sp.
Arthropoda	Insecta	Coleoptera	Noteridae	Suphisellus sp.
Arthropoda	Insecta	Collembola		

Phylum	Class	Order	Family	Genus/Species
Arthropoda	Insecta	Diptera	Ceratopogonidae	
Arthropoda	Insecta	Diptera	Ceratopogonidae	Bezzia/Palpomyia
Arthropoda	Insecta	Diptera	Ceratopogonidae	Culicoides sp.
Arthropoda	Insecta	Diptera	Chironomidae	
Arthropoda	Insecta	Diptera	Chironomidae	Tanypodinae sp.
Arthropoda	Insecta	Diptera	Culicidae	Anopheles sp.
Arthropoda	Insecta	Diptera	Sciomyzidae	
Arthropoda	Insecta	Diptera	Stratiomyidae	Odontomyia/Hedriodiscus
Arthropoda	Insecta	Diptera	Tabanidae	
Arthropoda	Insecta	Diptera	Tipulidae	Helius sp.
Arthropoda	Insecta	Ephemeroptera		
Arthropoda	Insecta	Ephemeroptera	Baetidae	
Arthropoda	Insecta	Ephemeroptera	Baetidae	Callibaetis sp.
Arthropoda	Insecta	Ephemeroptera	Baetidae	Procloeon/Centroptilum
Arthropoda	Insecta	Ephemeroptera	Caenidae	Caenis sp.
Arthropoda	Insecta	Hemiptera	Belostomatidae	Belostoma sp.
Arthropoda	Insecta	Hemiptera	Corixidae	
Arthropoda	Insecta	Hemiptera	Corixidae	Hesperocorixa sp.
Arthropoda	Insecta	Hemiptera	Corixidae	Palmacorixa sp.
Arthropoda	Insecta	Hemiptera	Corixidae	Trichocorixa sp.
Arthropoda	Insecta	Hemiptera	Gerridae	
Arthropoda	Insecta	Hemiptera	Gerridae	Rheumatobates sp.
Arthropoda	Insecta	Hemiptera	Gerridae	Trepobates sp.
Arthropoda	Insecta	Hemiptera	Hebridae	Merragata sp.
Arthropoda	Insecta	Hemiptera	Mesoveliidae	Mesovelvia sp.
Arthropoda	Insecta	Hemiptera	Naucoridae	Pelocoris sp.
Arthropoda	Insecta	Hemiptera	Nepidae	Ranatra sp.
Arthropoda	Insecta	Hemiptera	Notonectidae	Buenoa sp.
Arthropoda	Insecta	Hemiptera	Notonectidae	Notonecta sp.
Arthropoda	Insecta	Hemiptera	Pleidae	Neoplea sp.
Arthropoda	Insecta	Hemiptera	Veliidae	Microvelia sp.
Arthropoda	Insecta	Lepidoptera		
Arthropoda	Insecta	Lepidoptera	Crambidae	Acentria sp.
Arthropoda	Insecta	Lepidoptera	Crambidae	Parapoynx sp.
Arthropoda	Insecta	Lepidoptera	Crambidae	Synclita sp.
Arthropoda	Insecta	Megaloptera	Corydalidae	Chauliodes sp.
Arthropoda	Insecta	Odonata	Aeshnidae	
Arthropoda	Insecta	Odonata	Aeshnidae	Anax sp.
Arthropoda	Insecta	Odonata	Coenagrionidae	
Arthropoda	Insecta	Odonata	Coenagrionidae	Enallagma sp.
Arthropoda	Insecta	Odonata	Coenagrionidae	Enallagma/Coenagrion sp.
Arthropoda	Insecta	Odonata	Coenagrionidae	Ischnura sp.
Arthropoda	Insecta	Odonata	Corduliidae	Epitheca (Tetragoneuria)
Arthropoda	Insecta	Odonata	Libellulidae	
Arthropoda	Insecta	Odonata	Libellulidae	Leucorrhinia/Sympetrum
Arthropoda	Insecta	Odonata	Libellulidae	Pachydiplax sp.
Arthropoda	Insecta	Odonata	Libellulidae	Tamea sp.
Arthropoda	Insecta	Odonata	Libellulidae/Corduliidae	
Arthropoda	Insecta	Trichoptera	Hydroptilidae	
Arthropoda	Insecta	Trichoptera	Hydroptilidae	Hydroptila sp.
Arthropoda	Insecta	Trichoptera	Hydroptilidae	Oxyethira sp.
Arthropoda	Insecta	Trichoptera	Leptoceridae	
Arthropoda	Insecta	Trichoptera	Leptoceridae	Leptocerus sp.
Arthropoda	Insecta	Trichoptera	Leptoceridae	Oecetis sp.
Arthropoda	Insecta	Trichoptera	Leptoceridae	Triaenodes sp.

Phylum	Class	Order	Family	Genus/Species
Arthropoda	Insecta	Trichoptera	Phryganeidae	Banksiola sp.
Arthropoda	Insecta	Trichoptera	Phryganeidae	Fabria sp.
Arthropoda	Insecta	Trichoptera	Polycentropodidae	
Cnidaria	Hydrozoa	Hydroida	Hydridae	Hydra sp.
Mollusca	Bivalvia	Veneroida	Pisidiidae	
Mollusca	Bivalvia	Veneroida	Pisidiidae	Musculium sp.
Mollusca	Gastropoda			
Mollusca	Gastropoda	Basommatophora	Ancylidae	
Mollusca	Gastropoda	Basommatophora	Ancylidae	Ferrissia sp.
Mollusca	Gastropoda	Basommatophora	Ancylidae	Laevapex sp.
Mollusca	Gastropoda	Basommatophora	Lymnaeidae	
Mollusca	Gastropoda	Basommatophora	Lymnaeidae	Fossaria sp.
Mollusca	Gastropoda	Basommatophora	Lymnaeidae	Pseudosuccinea sp.
Mollusca	Gastropoda	Basommatophora	Lymnaeidae	Stagnicola sp.
Mollusca	Gastropoda	Basommatophora	Physidae	Physa/Physella
Mollusca	Gastropoda	Basommatophora	Planorbidae	
Mollusca	Gastropoda	Basommatophora	Planorbidae	Gyraulus sp.
Mollusca	Gastropoda	Basommatophora	Planorbidae	Helisoma/Planorbella
Mollusca	Gastropoda	Basommatophora	Planorbidae	Planorbula sp.
Mollusca	Gastropoda	Basommatophora	Planorbidae	Promenetus sp.
Mollusca	Gastropoda	Mesogastropoda	Bithyniidae	Bithynia tentaculata
Mollusca	Gastropoda	Mesogastropoda	Valvatidae	Valvata sp.
Mollusca	Gastropoda	Mesogastropoda	Valvatidae	Valvata tricarinata
Mollusca	Gastropoda	Neotaenioglossa	Hydrobiidae	
Mollusca	Gastropoda	Stylommatophora	Succineidae	Succinea sp.
Nematoda				
Platyhelminthes	Turbellaria	Tricladida		

Appendix 4

A recommended list of sampling sites, based on sites surveyed for the past three years (2011-2013).

St. Clair River AOC

- Stag Island Marsh
- Snye River Marsh
- St. Clair NWA: Bear Creek Unit – OPG Marsh
- St. Clair NWA: Bear Creek Unit – Maxwell Marsh
- Mitchell's Bay – Mudcreek Marsh and Syne River Marsh
- Moon Cove / Tic Tac Point Marsh

Lake St. Clair (Non-AOC)

- Lake St. Clair Marshes
- St. Clair NWA – East Marsh

Detroit River AOC

- Peche Island Marsh
- Turkey Creek Marsh
- Detroit River Marshes
- Canard River Marsh