Status of Coastal Wetland Habitat in the Canadian Huron-Erie Corridor

March 2014

Environment Canada
Canadian Wildlife Service

Environnement Canada
Service canadien de la faune

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Executive Summary

Degradation and loss of habitat are major causes of species decline in North America including within Areas of Concern (AOCs) in the Great Lakes basin. Great Lakes AOCs are areas that have experienced significant environmental degradation, exhibiting local symptoms known as Beneficial Use Impairments (BUI). The St. Clair River is a Great Lakes AOC that currently has ten BUIs listed as impaired or requiring further assessment, including the loss of fish and wildlife habitat. The Detroit River is also a Great Lakes AOC and it has 11 BUIs listed as impaired or requiring further assessment, including the loss of fish and wildlife habitat. To restore BUIs, Remedial Action Plans (RAPs) were created for each AOC and contain criteria for delisting each BUI.

Fish and wildlife habitat includes coastal wetlands, which provide habitat for many species including many species at risk. They also affect the quality of water entering the Great Lakes where the effects of upland land use and lake processes intermingle. In addition, these are important transitional ecosystems within the Great Lakes basin. Recognizing their importance, many coastal wetlands are protected to varying degrees through various municipal and provincial policies. Yet few studies have assessed whether the quantity of coastal wetland habitat has changed within AOCs since designation (i.e., 1985). The purpose of this project is to provide information on the status of the *Loss of Fish and Wildlife Habitat* BUI by assessing the extent of coastal wetlands within the Canadian portion of the St. Clair River and Detroit River AOC since listing (i.e., 1985). Where available, information is also provided for Lake St. Clair so as to provide the status of the coastal wetland habitat throughout the Huron-Erie Corridor.

To assess wetland changes since AOC designation, historical wetland data from 1978 were compared to wetland data from 2010 in the Huron-Erie Corridor. Using aerial photographic interpretation, the community classes for wetland and aquatic system were classified according to the Ecological Land Classification for Southern Ontario (ELC) framework. Data were summarized at the community class and system scales. In the St. Clair River AOC, the combined wetland and aquatic system showed a 2.5% increase from 1978 to 2010 and the Detroit River AOC showed a 3.3% increase for the same time period.

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Introduction

Background

In the Great Lakes basin, coastal wetlands are important transitional zones where the effects of upland land use and lake processes intermingle. These diverse ecotones provide the critical transitional habitat many species depend upon. A high number of wildlife species inhabit wetlands during all or part of their life cycle, including many species at risk. However, coastal wetlands are the receiving body for numerous human-related activities that cause various disturbances. Fill operations, altered hydrology, watershed deforestation, increased surface imperviousness, contaminant and nutrient inputs, exotic species introductions and the construction of retaining walls and port infrastructure are some of the human-related activities affecting coastal wetlands and natural shoreline habitats.

In an effort to quantify, track and remediate human effects on the Great Lakes basin ecosystem, the Remedial Action Plan Program was created in 1987 and formalized under the Great Lakes Water Quality Agreement between Canada and the United States. The Program outlines a commitment of both countries to restore and protect areas in the Great Lakes basin that have experienced significant environmental degradation and have been identified as Areas of Concern (AOCs). A common set of criteria known as Beneficial Use Impairments (BUIs) were created to guide Remedial Action Plan (RAP) targets in all Great Lakes AOCs.

The St. Clair River was designated as a Great Lakes Area of Concern (AOC) in 1985 due to problems with its chemical, physical and biological integrity. Nine of 14 possible Beneficial Uses (BUIs) were initially identified as "*Impaired*" including: BUI 3: *Degradation of Fish and Wildlife Populations* and BUI 14: *Loss of Fish and Wildlife Habitat.* An additional three BUIs were designated as "*Requires Further Assessment*". Currently, seven BUIs are still listed as "*Impaired*", three are listed as "*Requires Further Assessment*" and four are listed as "*Not Impaired*" (Table 1; Environment Canada (EC) 2014).

The Detroit River was designated as a Great Lakes AOC in 1985 due to problems including pollution, such as contaminated sediment (which was a major reason for impairment), point source discharges from municipal and industrial sources, and non-point source discharges. Currently nine BUIs are still listed as "Impaired", two listed as "Required Further Assessment" and three listed as "Not Impaired" (Table 1; EC 2014).

Since 1985, much effort has been spent on improving and restoring the aquatic ecosystem of the St. Clair River and Detroit River AOCs to address the BUIs. Through the RAP program, various strategies and on the ground actions have been undertaken to enable BUIs to be assessed as unimpaired and ultimately delist the AOC. Delisting of the *loss of fish and wildlife habitat* BUI requires protecting the quantity, function and diversity of significant natural features to the greatest extent possible.

Table 1. Beneficial Use Impairments identified in the St. Clair River and Detroit River Areas of Concern.

Beneficial Use Impairment #	Description	St. Clair River AOC Designation	Detroit River AOC Designation
1	Restrictions on fish and wildlife consumption	*Impaired*	*Impaired for fish*
2	Tainting of fish and wildlife flavour	*Not Impaired*	*Requires Further Assessment*
3	Degradation of fish and wildlife populations	*Requires Further Assessment*	*Impaired*
4	Fish tumours and other deformities	*Requires Further Assessment*	*Impaired*
5	Bird or animal deformities or reproduction problems	*Requires Further Assessment*	*Impaired*
6	Degradation of benthos	*Impaired*	*Impaired*
7	Restrictions on dredging activities	*Impaired*	*Impaired*
8	Eutrophication or undesirable algae	*Not Impaired*	*Not Impaired*
9	Restrictions on drinking water or taste and odour problems	*Impaired*	*Not impaired*
10	Beach closures	*Impaired*	*Impaired*
11	Degradation of aesthetics	*Impaired*	*Impaired*
12	Added costs to agriculture or industry	*Not impaired*	*Not impaired*
13	Degradation of phytoplankton and zooplankton populations	*Not Impaired*	*Requires Further Assessment*
14	Loss of fish and wildlife habitat	*Impaired*	*Impaired*

Project Objective

The objective of this project is to provide information on the status of the *Loss of Fish and Wildlife Habitat* BUI by assessing the extent of coastal wetlands within the Canadian portion of the St. Clair River and Detroit River AOC since listing (i.e., 1985). Where available, information is also provided for Lake St. Clair so as to provide the status of the coastal wetland habitat throughout the Huron-Erie Corridor.

Site Description

St. Clair River AOC: The St. Clair River AOC extends approximately 64 kilometres from Lake Huron to Lake St. Clair. It includes the entire St. Clair River from the Blue Water Bridge to the southern tip of Seaway Island, west to St. John's Marsh and east to include the north shore of Mitchell's Bay on Lake St. Clair. Prior to entering Lake St. Clair, the river divides into many channels creating the St. Clair delta including Walpole Island First Nation. This area encompasses aquatic, coastal wetland, riverine and littoral habitats that are either hydrologically connected or separated from the main channel. This area is commonly referred to as "Area 1A" and continues to be a priority for the St. Clair River Binational Public Advisory Council (SCR BPAC) (Figure 1). In the Stage 2 Report, the St. Clair River AOC was expanded to include the immediate drainage basin of the St. Clair River as well as the watersheds of many tributary creeks. This area is referred to as "Area 1B" and was included to improve the biological connectivity between the Sydenham and St. Clair rivers.

Detroit River AOC: The Detroit River AOC extends 51 km from Lake St. Clair to Lake Erie (Figure 2). Its width varies from 600 m at the Ambassador Bridge to over 6 km where it empties into Lake Erie.

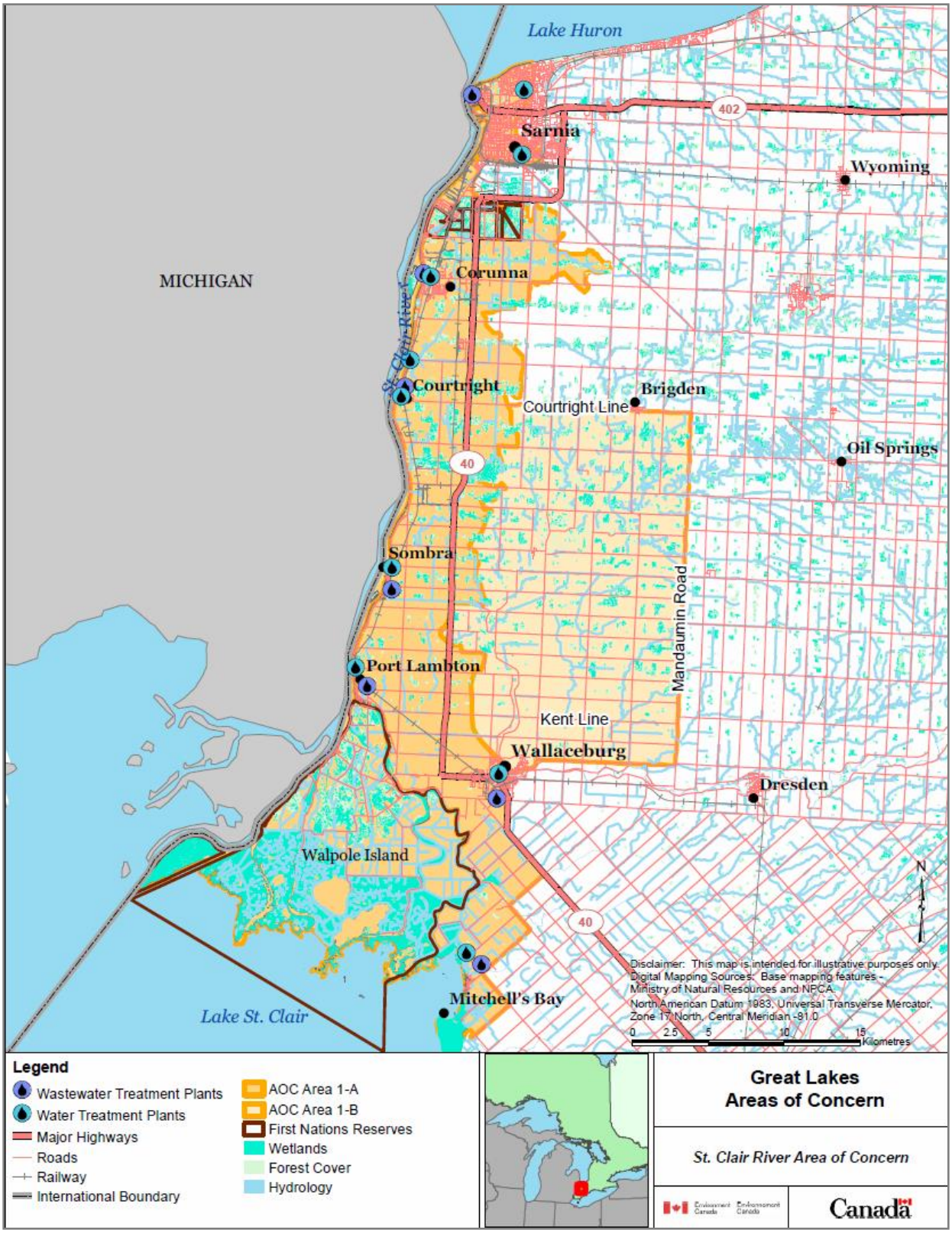

Figure 1. Location of St. Clair River Area of Concern (Canadian side) with priority areas – Area 1A and Area 1B.

Figure 2. Location of Detroit River Area of Concern (Canadian side).

Methodology

Background

The purpose of this study was to investigate the change in aerial extent of coastal wetland habitat since the St. Clair River and Detroit River were listed as AOCs in 1985. To achieve this, a standard vegetation classification scheme was used to identify all wetland and aquatic vegetation communities. The Ecological Land Classification for Southern Ontario (ELC) framework categorizes vegetation into a hierarchy of systems (including wetland and aquatic), classes and series, thereby allowing scalable mapping and analyses (Lee et al. 1998).

The St. Clair River and Detroit River AOCs are within Southern Ontario, an area with abundant aerial photography coverage over several vintages. Both AOCs are covered by 1978 spring/summer black and white photo coverage, representing the pre-listing period (historic) and 2010 spring/summer colour aerial photographs representing the current status. A commonly accepted and well documented method for capturing these changes is air photo interpretation, a relatively inexpensive method to create detailed, site-level information in an efficient and effective manner (Owens and Hop 1995).

Data Processing

The wetland extents in the Huron-Erie Corridor (composed of St. Clair River, Lake St. Clair and Detroit River) were extracted from the Great Lakes Coastal Wetland Inventory (Environment Canada and Ontario Ministry of Natural Resources 2004). A variety of geoprocessing functions were used throughout the data creation and analysis stage, which were based on the Environmental Research Systems Institute (ESRI) ArcGIS 10.1 Platform (ESRI 2012). Extracted wetlands were dissolved (simplified to remove internal boundaries) and buffered (1,000 m) creating an assessment area which included additional wetland area adjacent to the identified coastal wetlands. The area was restricted to the Canadian side of the Huron-Erie Corridor. Additionally, as aerial photographs were missing for 1978 for portions of Point Edward Marsh, Stag Island (St. Clair River) and Lake St. Clair Marshes, only areas completely covered in both years were included in the analysis.

All wetland and aquatic systems within this 1,000 metre buffer were delineated, ensuring both coastal wetlands and wetlands without a permanent connection to the lake or otherwise altered, were captured (Figure 3). Wetland and aquatic boundaries were interpreted and digitized on screen. Neither wetland dataset was ground truthed, however wildlife habitat surveys were completed at most of the study sites (excluding Walpole Island First Nation) between 2006 and 2013 so some on the ground knowledge was available for the analysis. This established some confidence in the wetland delineations. However, exact amount of error associated with the datasets remains unknown. Habitat was classified at the community class level – swamp, fen, bog, marsh (wetland system), open water and shallow water (aquatic system) (Appendix 1) and stored within a geodatabase model. All other areas within the area of analysis were noted as “other” and assumed part of the terrestrial system (these areas were not delineated to any finer resolution for this project). The result was two topologically correct datasets, 1978 and 2010. The minimum mapping unit was set to 0.25 ha, well below the 0.5 ha threshold typically used for ELC mapping (Lee et al. 1998). The imagery and georeferencing standards (0.5 m cell size) allowed distinct features to be identified at a much finer scale, enabling subtle changes to be captured.

During the air photo interpretation process, challenges were noted in the identification of swamp habitat in the 1978 imagery which may result in an underrepresentation of this classification in the dataset. Additionally, as the 1978 images were contact prints that were scanned and mosaicked in the mid-2000s, there were some issues of alignment both within the 1978 dataset and between the 1978 and 2010 datasets. This may result in increased error, especially when comparing locations of wetland habitat between 1978 and 2010.

Due to the continuous nature of wetland habitat extending from the St. Clair River AOC into Lake St. Clair, an artificial cut-off between the two areas was applied. Based on the boundary of the AOC, the closest feature beyond the southern AOC boundary is the Boyle Drain. As such, the boundary between AOC and Lake St. Clair was applied at this location (Figure 3). As the areas of analysis for three distinct areas (St. Clair River AOC, Detroit River AOC and Lake St. Clair) were created based on the wetlands within each area, there is an area of overlap between St. Clair River and Lake St. Clair. As such, values presented in this report cannot simply be added together for a representation of the coastal wetland habitat in the Huron-Erie Corridor.

Statistical Analysis

There are dozens of landscape metrics which can be used to quantify landscape patterns. Many of these metrics, however are correlated with one another as they are based upon a small number of parameters (i.e., patch area, perimeter and nearest neighbour distance). Many landscape metrics are highly sensitive to scale and may change at different resolutions and map extents (Hargis et al. 1998). The area and resolution assessed did not change between the years, thus the behaviour of the landscape metrics with respect to scale was not a concern for the comparison.

Riitters et al. (1995) conducted a factor analysis on several landscape metrics to determine common dimensions of landscape pattern and structure while identifying appropriate metrics to quantify the changes. Some of recommended landscape metrics include average patch perimeter to area ratio, contagion, relative patch area and fractal dimension (O'Neill et al. 1999).

Landscape and patch pattern metrics (Table 2) were calculated for both the 1978 and 2010 datasets at the system level layers using Patch Analyst (Rempel et al. 2012). Prior to calculating the statistics, polygons were dissolved (simplified to remove internal boundaries) at the system level. The selected metrics include mean patch size, area weighted mean shape index, and mean perimeter to area ratio. Area weighted mean shape index measures patch shape complexity and weights larger patches more than smaller patches. Perimeter to area ratio measures shape complexity and is often used to estimate fragmentation (Aurambout et al. 2005).

Note that due to the analysis extent for the project, artificial boundaries were created, especially on the aquatic portion of the area of analysis. As such, any statistics using the edge (e.g., perimeter to area ratio) may not accurately portray the on the ground condition. However, comparison of edge-based statistics between years may be acceptable as similar artificial edges (e.g., lake or river cut-off) exist in both datasets.

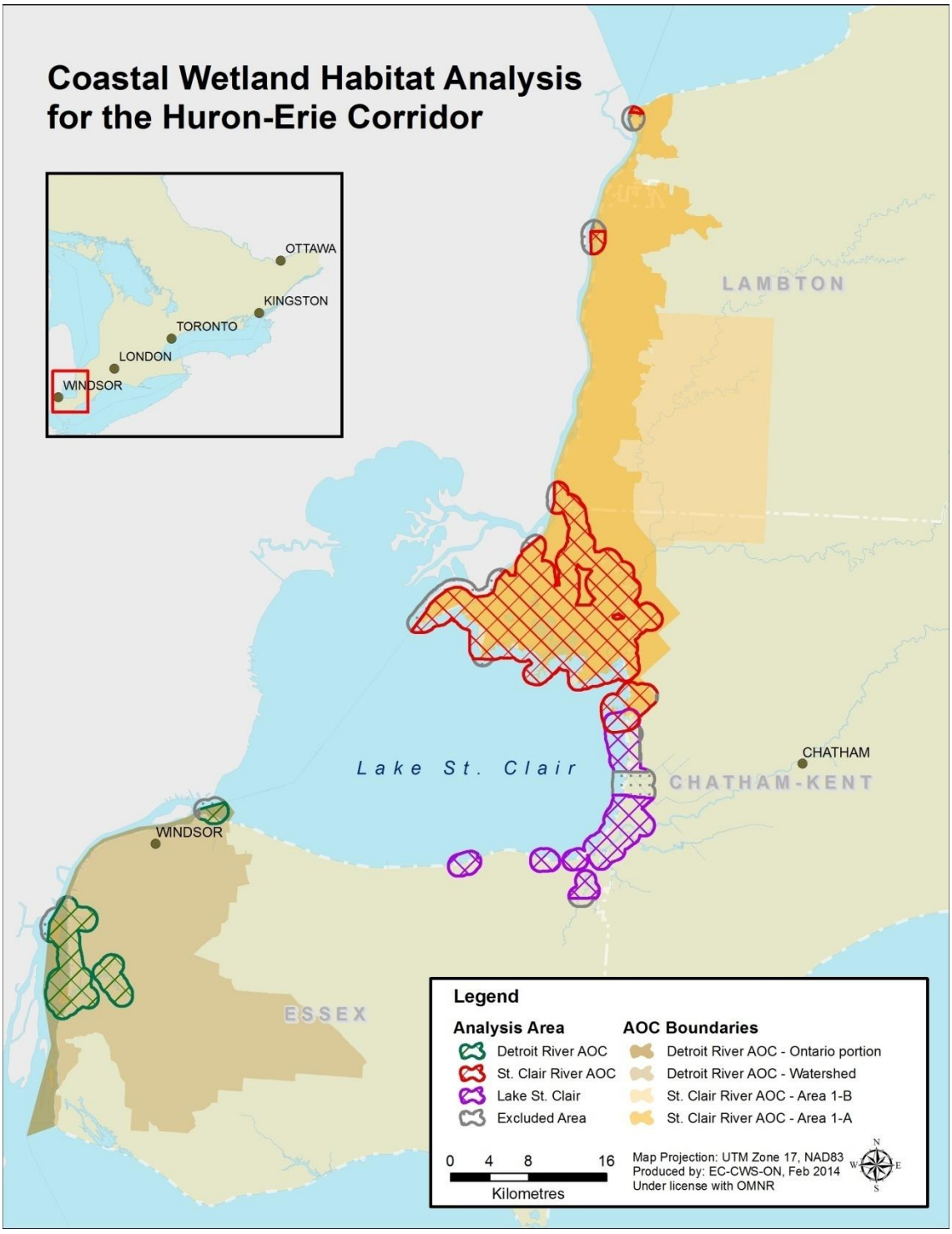

Figure 3. Analysis extent developed based on a 1,000 metre buffer of the Great Lakes Coastal Wetland Inventory wetlands in the St. Clair River, Detroit River, and Lake St. Clair. Note there is an area of overlap between St. Clair River AOC and Lake St. Clair as the buffer was applied to wetlands in each area. Some areas were excluded from the analysis due to missing imagery in one or both time periods. Additionally, area in the United States was also excluded from the analysis.

Table 2. Description of landscape metrics used in the analysis.

Acronym	Index Name	Description	Units/Range
TLA	Total landscape area	Sum of the areas of all patches in the landscape.	hectares (ha)
NumP	No. of patches	The number of patches in the landscape.	---
MPS	Mean patch size	The average patch size of all patches in the landscape.	hectares (ha)
PSSD	Patch size standard deviation	Standard deviation of patch areas.	hectares (ha)
PSCov	Patch size coefficient of variation	Coefficient of variation for patch size.	percent (%)
ED	Edge density	Amount of edge relative to the landscape area.	metres per hectare (m/ha)
AWMSI	Area weighted mean shape index	A measure of shape complexity, the shape index is calculated from the edge length of a patch divided by the square root of the patch area and is adjusted by a circular standard. AWMSI weights larger patches more than small ones. AWMSI = 1 when all patches are circular and increases with increasing patch shape complexity	AWMSI ≥ 1, without limit
MPAR	Mean perimeter-area ratio	A measure of patch shape complexity. The mean perimeter-area ratio is the average perimeter-area ratio of the patches within the landscape.	metres per hectare (m/ha)

Source: McGarigal and Marks, 1995.

Results

St. Clair River AOC

The St. Clair River AOC area of analysis has an area of 25,608.8 hectares which, in 1978 was composed of 28.6 % marsh, 0.4% swamp, 27.9% shallow water, 4.6% open water and 38.5% terrestrial habitat (Table 3a). In 2010, the area was composed of 29.9% marsh, 1.1% swamp, 27.2% shallow water, 4.8% open water and 37.0% terrestrial habitat. In both 1978 and 2010, the majority of the wetland habitat was classified as marsh while the majority of the aquatic habitat was shallow water (Figure 4 and Figure 5).

The ELC composition transition matrix identifies the amount of habitat for each community class that has remained the same or changed between 1978 and 2010. Marsh, shallow water, open water and terrestrial classes had 85% or greater of their respective classes remaining as originally classified (Table 4). For swamp, only 51% remained as swamp while 22% was converted to marsh and 22% to terrestrial. Conversion of marsh habitat was highest to shallow water (676.5 ha) followed by terrestrial (352.2 ha). Conversion of shallow water habitat was highest to marsh (836.5 ha) and conversion of terrestrial habitat was highest to marsh (573.4 ha).

Results were also summarized at the ELC system scale – wetland (composed of marsh, swamp, bog, and fen) and aquatic (composed of shallow water and open water; see Appendix 1 for description). At the system scale, aquatic habitat decreased by 129.5 ha while wetland habitat increased by 515.9 ha (Table 5; Figure 8). The number of patches for aquatic system decreased from 882 to 624 with a corresponding increase in the mean patch size from 9.4 to 13.1 ha. The majority of patches in both years were less than

1 ha (Figure 10d). The number of wetland patches increased from 327 to 921 with a corresponding decrease in the mean patch size from 22.7 to 8.6 ha. In 2010, the majority of patches were less than 1 ha in size (Figure 10a). In both years, the majority of wetland habitat is contained in patches greater than 50 ha (86% [6,346 ha] in 1978 and 78% [6,194 ha] in 2010).

Lake St. Clair

The Lake St. Clair area of analysis has an area of 7,530 ha, which, in 1978 was composed of 8.2% marsh, 1.1% swamp, 36.6% shallow water and 54.1% terrestrial habitat (Table 3b). In 2010, the area was composed of 7.1% marsh, 1.3% swamp, 36.8% shallow water, 0.4% open water and 54.4% terrestrial habitat. In both 1978 and 2010, the majority of the wetland habitat was classified as marsh while the majority of the aquatic habitat was shallow water (Figure 4 and Figure 5).

The ELC composition transition matrix identifies that 92% or greater of the terrestrial and shallow water habitat extent remained constant between time periods whereas marsh and swamp saw a higher degree of conversion (Table 4). 49% of marsh habitat remains as marsh while 21% was converted to shallow water and 29% to terrestrial habitat. 30% of swamp habitat remains as swamp while 52% was converted to terrestrial habitat.

At the system scale, aquatic habitat increased by 42.3 ha while wetland habitat decreased by 68.9 ha (Table 5; Figure 8). The number of patches for aquatic system increase from 104 to 235 and the mean patch size decreased from 26.5 to 11.9 ha. The number of wetland patches increase from 100 to 453 with a decrease in mean patch size from 145.4 ha to 75.9 ha. In 1978, the majority of patches were between 1 and 10 ha while in 2010, the majority were less than 1 ha (Figure 10b). The majority of wetland habitat is contained in patches greater than 50 ha (32% [227 ha]) whereas in 2010, the majority of wetland habitat is in patches between 1 and 10 ha in size (39% [243 ha]).

Detroit River AOC

The Detroit River AOC area of analysis has an area of 6,202.6 ha which, in 1978 was composed of 7.1% marsh, 0.7% swamp, 31.6% shallow water, 2.2% open water and 58.4% terrestrial (Table 3c). In 2010, the area was composed of 9.8% marsh, 1.7% swamp, 29.3% shallow water, 2.2% open water and 57.0% terrestrial. In both 1978 and 2010, the majority of wetland habitat was classified as marsh while the majority of the aquatic habitat was shallow water (Figure 4 and Figure 5).

The ELC composition transition matrix identifies that greater than 87% of the shallow water, open water and terrestrial habitat remained constant between time periods whereas marsh and swamp saw higher degrees of conversion (Table 4). 65% of marsh habitat remains as marsh while 14% becomes shallow water and 18.0% becomes terrestrial habitat

At the system scale, aquatic habitat decreased by 144.8 ha while wetland habitat increased by 229.6 ha (Table 5; Figure 9). The number of patches for aquatic system increased from 36 to 89 with a decrease in mean patch size from 58.3 to 22.0. The number of wetland patches increased from 131 to 441 with a decrease in mean patch size from 3.7 to 1.6 ha. In 1978, there were about equal number of patches in both the less than 1 ha and 1–10 ha bins (n=62 and n=61) whereas in 2010, the majority of patches were less than 1 ha (n=330; Figure 10c). The majority of the wetland habitat is found in the 1–10 ha patches (44% [214 ha] in 1978 and 44% [311 ha] in 2010.

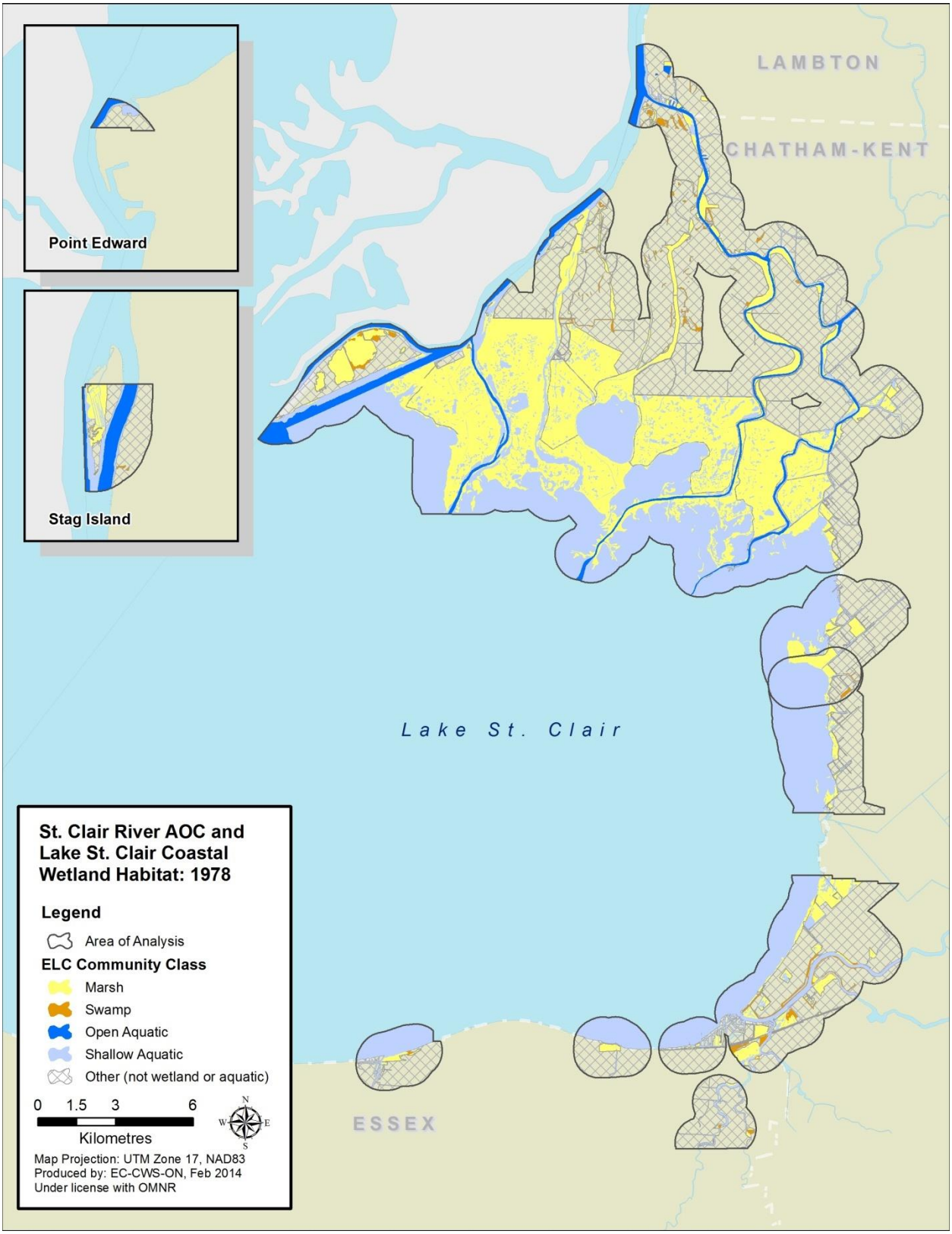

Figure 4. Wetland and aquatic habitat in St. Clair River AOC and Lake St. Clair in 1978 within the area of analysis. Habitat was classified using Ecological Land Classification for Southern Ontario at the community class level (wetland and aquatic systems).

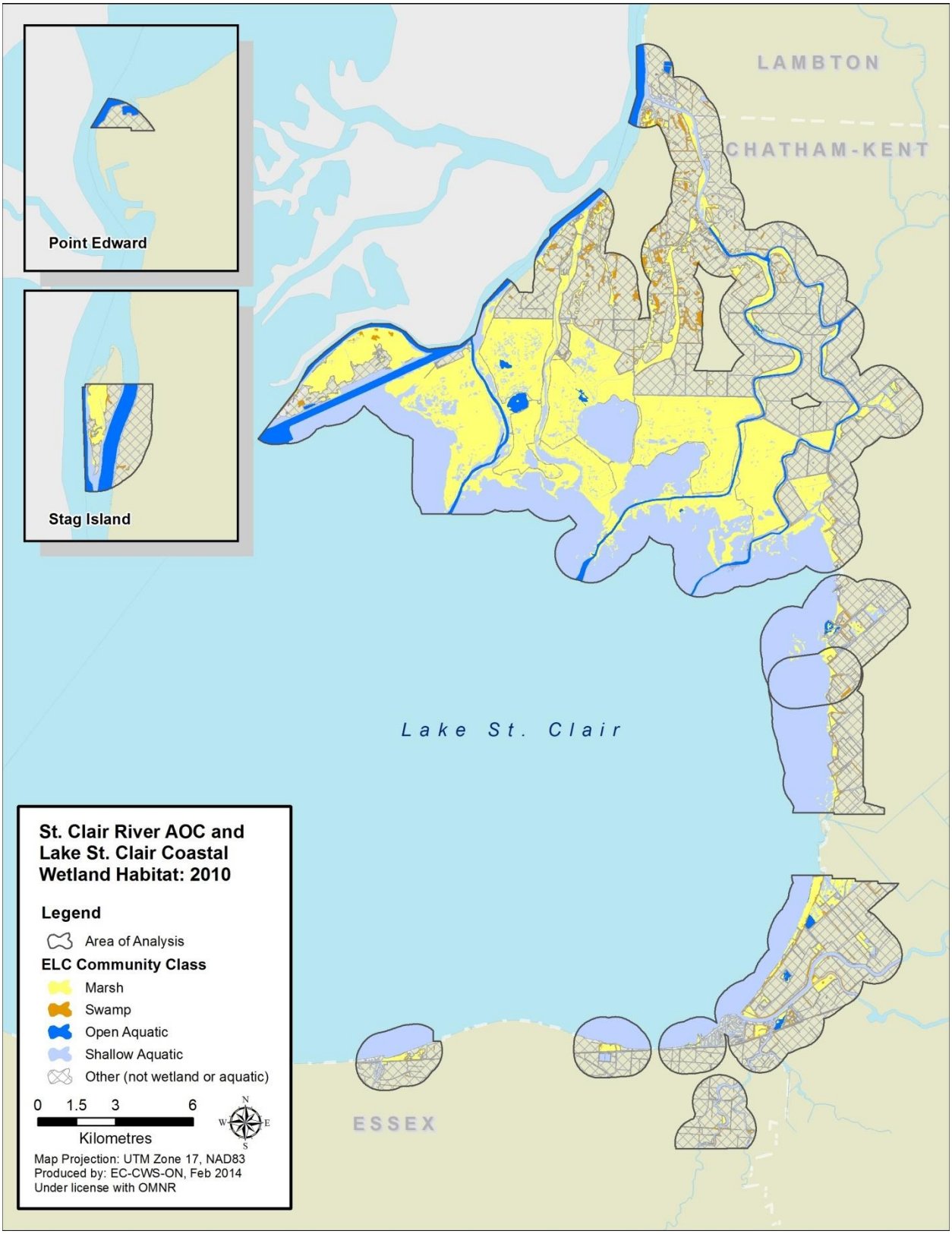

Figure 5. Wetland and aquatic habitat in St. Clair River AOC and Lake St. Clair in 2010 within the area of analysis. Habitat was classified using Ecological Land Classification for Southern Ontario at the community class level (wetland and aquatic systems).

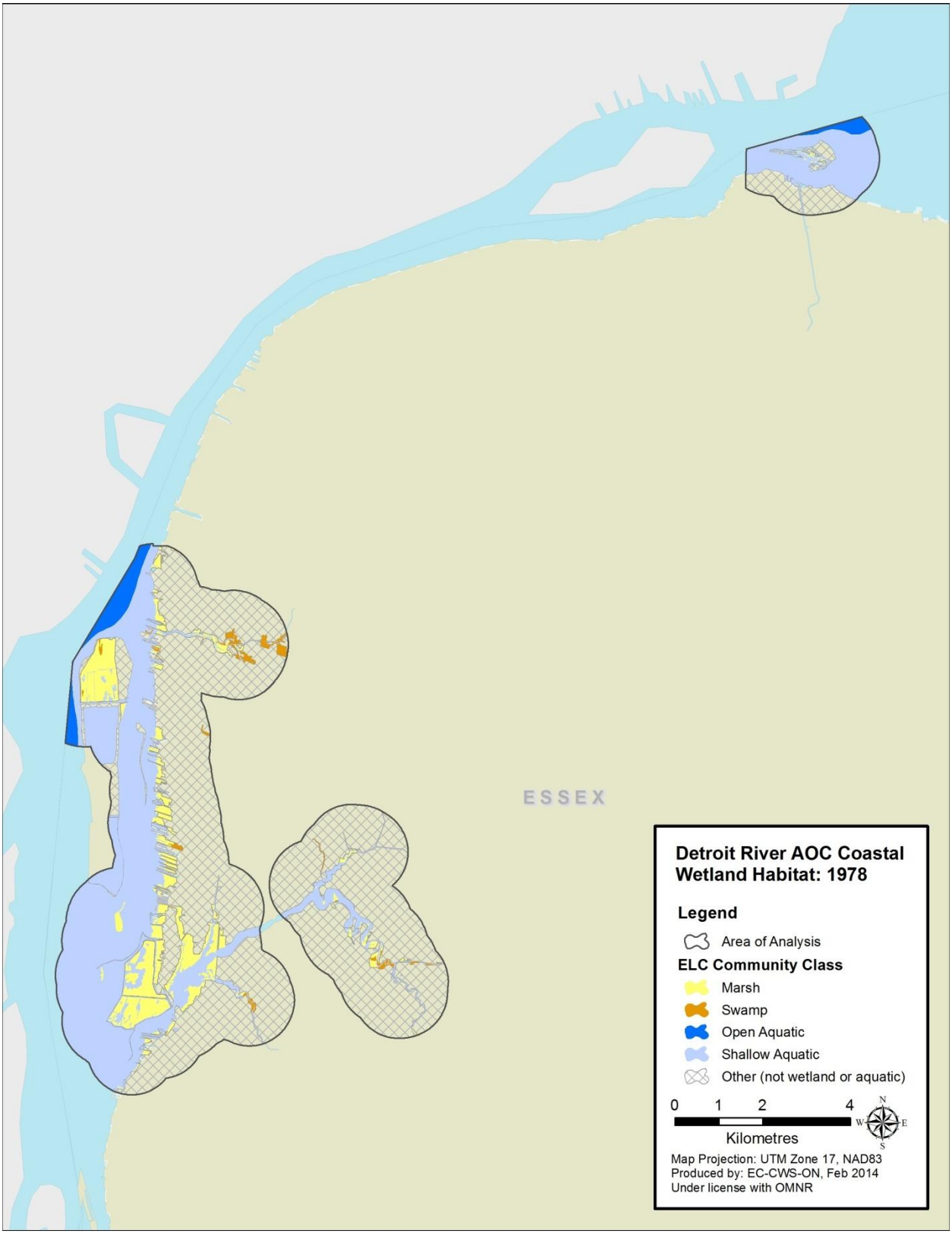

Figure 6. Wetland and aquatic habitat in Detroit River AOC in 1978 within the area of analysis. Habitat was classified using Ecological Land Classification for Southern Ontario at the community class level (wetland and aquatic systems).

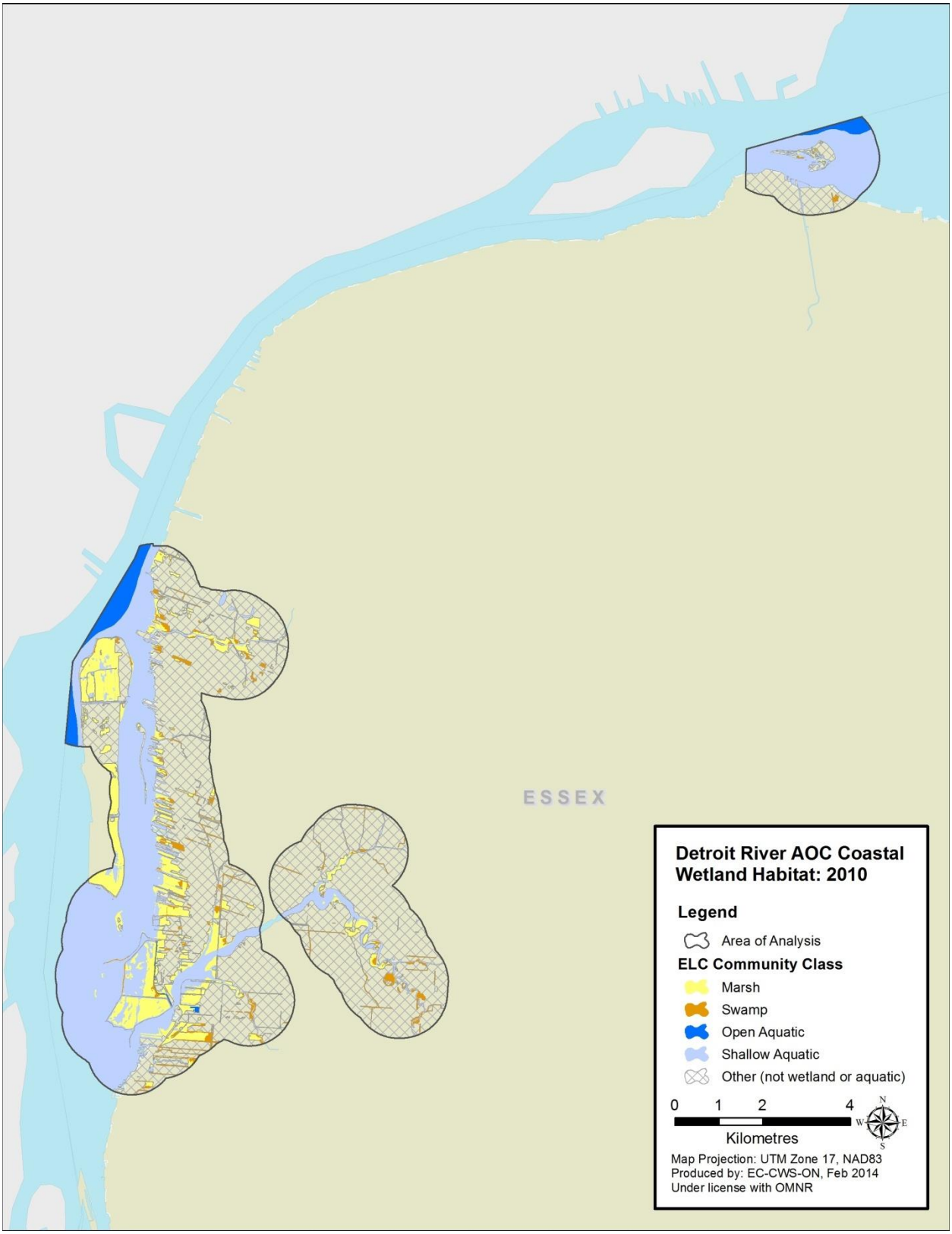

Figure 7. Wetland and aquatic habitat in Detroit River AOC in 2010 within the area of analysis. Habitat was classified using Ecological Land Classification for Southern Ontario at the community class level (wetland and aquatic systems).

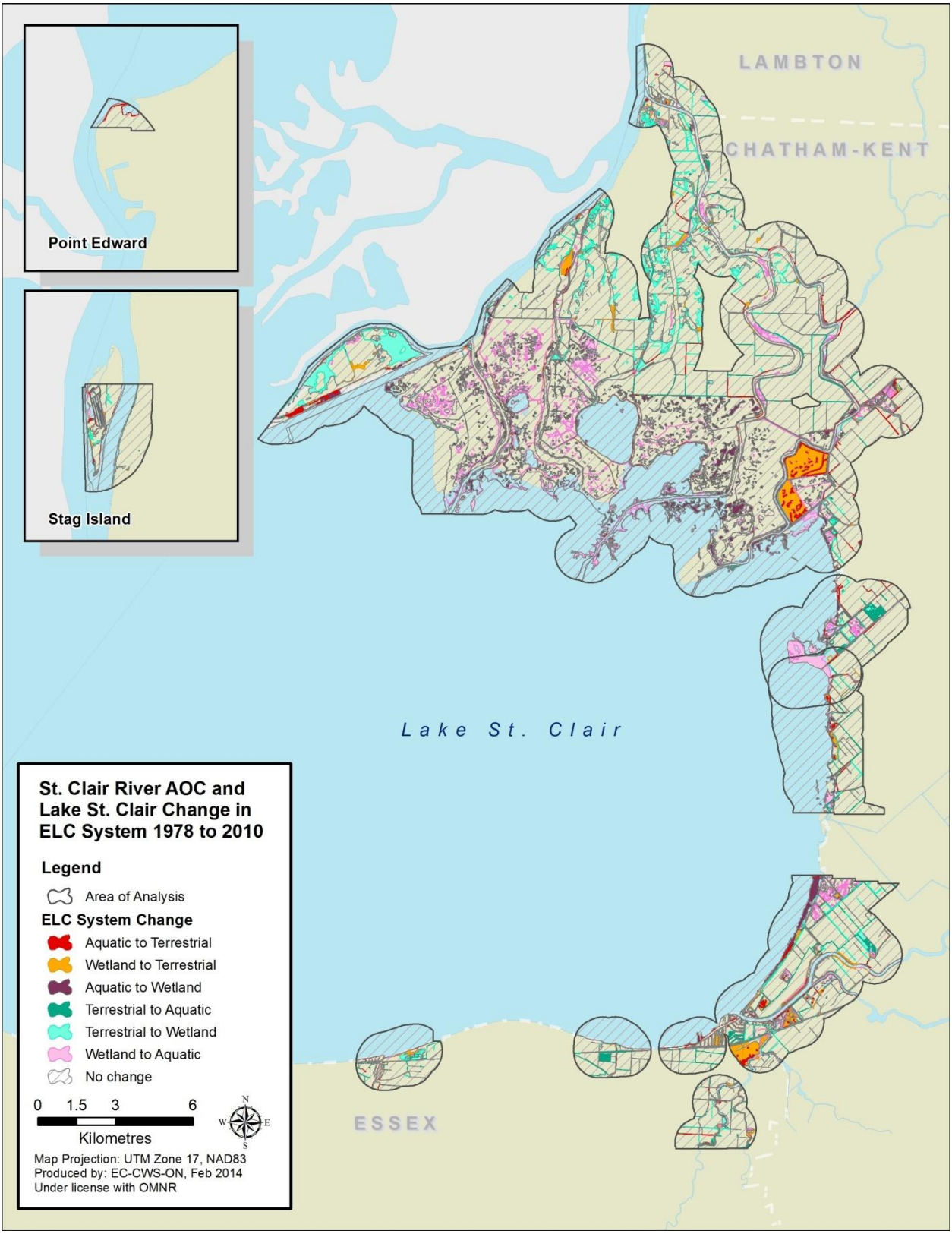

Figure 8. Change in ELC system from 1978 to 2010 in the St. Clair River AOC and Lake St. Clair.

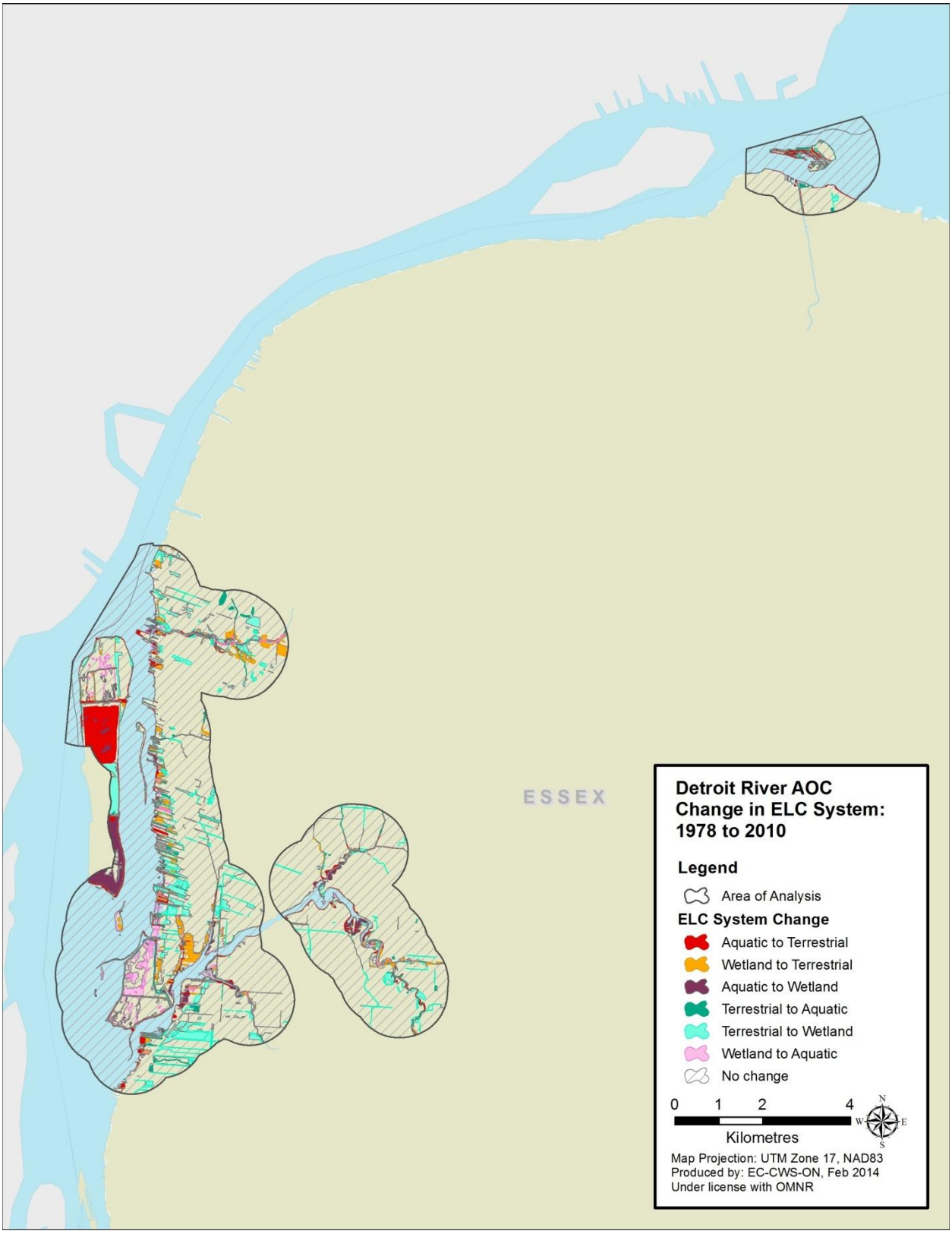

Figure 9. Change in ELC system from 1978 to 2010 in the Detroit River AOC.

Table 3. Area (ha) and percentages of habitat types (based on ELC classification) within the area of analysis for (a) St. Clair River AOC, (b) Lake St. Clair and (c) Detroit River AOC. Note only wetland and aquatic habitat types were classified. All terrestrial habitats were grouped and noted as "Other".

(a) St. Clair River AOC

		1978		2010		Change
ELC Classification		**Area**	**%**	**Area**	**%**	**in Area**
Wetland	Marsh	7 316.3	28.6	7 665.0	29.9	348.7
	Swamp	99.8	0.4	267.0	1.1	167.2
Aquatic	Shallow Water	7 151.8	27.9	6 971.0	27.2	-180.8
	Open Water	1 172.6	4.6	1 223.9	4.8	51.3
Terrestrial	Other	9 868.3	38.5	9 481.9	37.0	-386.4
Total		**25 608.8**	**100.0**	**25 608.8**	**100.0**	

(b) Lake St. Clair

		1978		2010		Change
ELC Classification		**Area**	**%**	**Area**	**%**	**in Area**
Wetland	Marsh	618.5	8.2	534.9	7.1	-83.6
	Swamp	80.8	1.1	95.6	1.3	14.7
Aquatic	Shallow Water	2 759.0	36.6	2 769.5	36.8	10.6
	Open Water	0.0	0.0	31.7	0.4	31.7
Terrestrial	Other	4 071.7	54.1	4 098.3	54.4	26.6
Total		**7 530.0**	**100.0**	**7 530.0**	**100.0**	

(c) Detroit River AOC

		1978		2010		Change
ELC Classification		**Area**	**%**	**Area**	**%**	**in Area**
Wetland	Marsh	443.5	7.1	607.5	9.8	164.0
	Swamp	40.9	0.7	106.4	1.7	65.5
Aquatic	Shallow Water	1 964.7	31.6	1 815.0	29.3	-149.7
	Open Water	133.7	2.2	138.6	2.2	4.9
Terrestrial	Other	3 619.8	58.4	3 535.1	57.0	-84.7
Total		**6 202.6**	**100.0**	**6 202.6**	**100.0**	

Table 4. Ecological Land Classification composition transition matrix at the community class for (a) St. Clair River AOC, (b) Lake St. Clair, (c) Detroit River AOC.

(a) St. Clair River AOC

Year		2010				
	Community Class	Marsh	Swamp	Shallow Water	Open Water	Terrestrial
1978	Marsh	6 228.4	21.7	676.5	37.5	352.2
	Swamp	22.1	50.6	5.3		21.8
	Shallow Water	836.5	9.0	6 101.3	118.3	86.7
	Open Water	4.8	0.0	100.8	1 063.1	4.0
	Terrestrial	573.4	185.7	87.1	4.9	9 017.3

(b) Lake St. Clair

Year		2010				
	Community Class	Marsh	Swamp	Shallow Water	Open Water	Terrestrial
1978	Marsh	302.6	28.4	131.6	8.8	147.1
	Swamp	8.7	24.4	6.1		41.7
	Shallow Water	109.0	7.8	2 554.9	22.7	64.5
	Open Water				0.0	
	Terrestrial	114.6	35.0	77.0	0.1	3 845.0

(c) Detroit River AOC

Year		2010				
	Community Class	Marsh	Swamp	Shallow Water	Open Water	Terrestrial
1978	Marsh	286.7	15.1	61.1	0.9	79.6
	Swamp	8.4	8.4	2.2		21.9
	Shallow Water	122.6	5.1	1 710.5	2.0	124.5
	Open Water			0.1	133.6	
	Terrestrial	189.8	77.7	41.1	2.2	3 309.0

Table 5. Statistics presented at the wetland and aquatic systems level for St. Clair River AOC, Lake St. Clair and Detroit River AOC.

	1978	2010	change	% change
St. Clair River AOC – aquatic system				
Area (ha)	8 324.4	8 194.9	-129.5	-1.6
Number of Patches	882	624	-258	
Mean Patch Size (ha)	9.4	13.1	3.7	
Area weighted mean shape index	14.5	12.2	-2.3	
Mean Perimeter to Area Ratio (m/ha)	1 110.4	1 501.6	391.1	
St. Clair River AOC – wetland system				
Area (ha)	7 416.1	7 932.0	515.9	7.0
Number of Patches	327	921	594	
Mean Patch Size (ha)	22.7	8.6	-14.1	
Area weighted mean shape index	7.4	5.2	-2.2	
Mean Perimeter to Area Ratio (m/ha)	1 285.7	2 016.6	730.9	
Lake St. Clair – aquatic system				
Area (ha)	2 759.0	2 801.2	42.3	1.5
Number of Patches	104	235	131	
Mean Patch Size (ha)	26.5	11.9	-14.6	
Area weighted mean shape index	4.2	4.3	0.1	
Mean Perimeter to Area Ratio (m/ha)	1 058.4	4 858.6	3800.2	
Lake St. Clair – wetland system				
Area (ha)	699.3	630.5	-68.9	-9.8
Number of Patches	100	453	353	
Mean Patch Size (ha)	145.4	75.9	-69.5	
Area weighted mean shape index	3.3	4.1	0.8	
Mean Perimeter to Area Ratio (m/ha)	987.7	3 280.1	2292.4	
Detroit River AOC – aquatic system				
Area (ha)	2 098.4	1 953.6	-144.8	-6.9
Number of Patches	36	89	53	
Mean Patch Size (ha)	58.3	22.0	-36.3	
Area weighted mean shape index	7.5	7.0	-0.5	
Mean Perimeter to Area Ratio (m/ha)	988.2	1 581.6	593.4	
Detroit River AOC – wetland system				
Area (ha)	484.4	713.9	229.6	47.4
Number of Patches	131	441	310	
Mean Patch Size (ha)	3.7	1.6	-2.1	
Area weighted mean shape index	2.8	3.0	0.2	
Mean Perimeter to Area Ratio (m/ha)	979.8	2 024.6	1044.8	

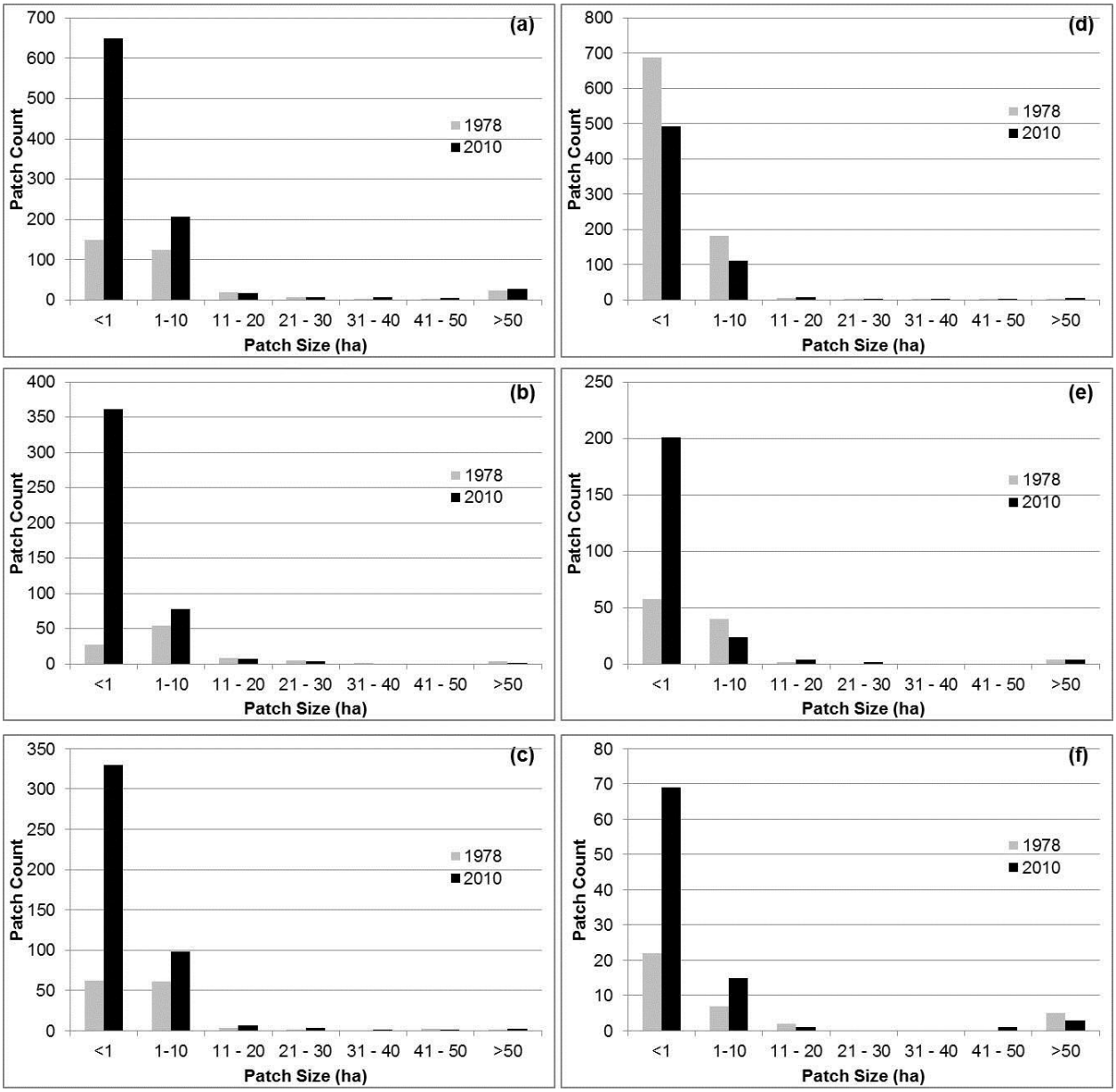

Figure 10. Patch frequency distribution for wetland system in St. Clair River AOC (a), Lake St. Clair (b), and Detroit River AOC (c) and for aquatic system in St. Clair River AOC (d), Lake St. Clair (e), and Detroit River AOC (f).

Discussion

Wetland Habitat

Various reports have provided different information on the status of wetland habitat in the St. Clair River AOC. The Stage 1 Report indicates within the Canadian portion, wetland area dropped from 3,754 ha in 1965 to 2,510 ha in 1984 (SCR BPAC 1991). The Stage 2 Report presents a figure of wetland loss/gain for various time periods (SCR BPAC 1995) showing the majority of wetland loss within the Canadian portion of the AOC occurred prior to 1967. Mayne (2006) indicates the aerial extent of wetland habitat within Area 1A is 6,879 ha. In the Detroit River AOC, based on information provided in the *Detroit River Canadian Remedial Action Plan Stage 2 Report*, the amount of wetland habitat was estimated to be 1,136 ha in 1991 and 1,150.52 ha in 2009 (Green et al. 2010). This includes marsh and swamp as well as open water habitat. Using a similar layer (wetland unit; source Ontario Ministry of Natural Resources), the amount of wetland habitat (marsh and swamp) in the area of analysis is 783 ha which is comparable to the amount of wetland habitat identified in 2010 in this analysis (713.9 ha). The wetland and open water total is 1,163 ha. If wetland and aquatic systems are combined from this analysis, the area is more than double what was presented in the Stage 2 report (Table 6). This is a result of the inclusion of the entire portion of open water habitat within the area of analysis rather than only portions associated with the wetlands. The value presented in the Stage 2 report also suggests this project greatly underestimates the amount of wetland habitat present in 1978. Depending on the scale, methods used, and the water levels at the time of mapping, the wetland extent may vary. As such, comparing wetland extent values from this analysis to previous analyses may not be appropriate. Additionally, this analysis only includes coastal wetlands, which are the largest class of wetlands within the AOC.

Another component is the extent to which wetland habitat includes adjacent shallow waters. Given the objective of the report is to assess the status of fish and wildlife habitat, is in important to include the shallow water component of the area of analysis. Given the challenges distinguishing between shallow water (less than 2 m in depth) and open water (greater than 2 m in depth) and the limited amount of open water, the aquatic and wetland systems were combined (Table 6). Using this approach, wetland habitat (being the combination of wetland and aquatic systems in this case) appears to be stable or have increased slightly from 1978 to 2010. However, as noted above, not all the aquatic systems habitat should be considered as part of the coastal wetlands.

Table 6. Change in area (ha) of the combined wetland and aquatic systems for each of the three areas of analysis.

	1978		2010		Change	%
Area of Analysis	Area	%	Area	%	in Area	Change
St. Clair River AOC	15 740.5	61.5	16 126.9	63.0	386.4	2.5
Lake St. Clair	3 458.3	45.9	3 431.7	45.6	-26.6	-0.8
Detroit River AOC	2 582.8	41.6	2 667.5	43.0	84.7	3.3

Areas of Wetland Loss or Gain

St. Clair River AOC: While the net wetland + aquatic systems gain within the St. Clair River AOC analysis area is 2.5 % (386.4 ha), it is composed of a loss of 464.6 ha and a gain of 851 ha of wetland + aquatic habitat. Figure 8 prominently shows a large area of wetland loss in the St. Clair River AOC in the area, between Chenal Ecarte and Mitchell's Bay in the Lake St. Clair Marshes (north and west of Mud Creek

Line). This area has experienced a loss of 239 ha of wetland + aquatic habitat which is nearly half of the wetland + aquatic area lost within the area of analysis. In this example, aerial photos show that the wetland + aquatic loss is attributable to the conversion of wetland habitat to agricultural land (Figure 11). The Stage 1 Report (SCR BPAC 1991) noted that 92% of the wetland loss was as a result of drainage for agriculture and the issue is clearly demonstrated in this example. The largest area of wetland gain appears to be on Seaway Island in the St. Clair River Delta, showing a gain of 185 ha (Figure 8).

Detroit River AOC: While the net wetland + aquatic habitat gain within the Detroit River AOC analysis area is 3.3% (84.7 ha), it is composed of a loss of 226 ha and a gain of 310.7 ha. Habitat changes on Fighting Island appear to play an important role in the changes in wetland habitat in the area (Figure 12). In 1978, the island was used as dumping grounds for industrial waste. Over many years, the island has been transformed with tree plantings and wetland restoration activities. It's unclear whether the apparent loss of coastal wetland habitat on the island is in fact a loss (i.e., if settling beds appeared as habitat which have now been vegetated). Other areas of increase appear here and there, in particular along the Detroit River shoreline (Figure 13). Some of wetland areas in 2010 appear to have been agricultural land in 1978. While some of the other changes may be alignment issues between the imagery, others are change in the shoreline from 1978 to 2010.

Wetland Patch Sizes and Abundance

Different sizes of wetland patches benefit different species. Large wetlands (e.g., more than 30 ha) are important for area-sensitive species such as Marsh Wren (*Cistothorus palustris*) and Black Tern (*Chlidonias niger*) where interior marsh is required whereas species such as Eastern Kingbird (*Tyrannus tyrannus*), Song Sparrow (*Melospiza melodia*) and Alder Flycatcher (*Empidonax alnorum*) prefer small (1 to 25 ha) marshes. The presence of smaller wetlands is also important as they may provide habitat for wetland-dependent amphibians and reptiles. Compared to the other areas, St. Clair River AOC has a high number of wetland patches greater than 30 ha (n=27 in 1978 and n=40 in 2010; Figure 10a). This is contrasted with three (1978) or four (2010) in Detroit River AOC and five (1978) or two (2010) in Lake St. Clair. The large patches of wetland habitat in the St. Clair River are predominantly located in the St. Clair River Delta.

In all three areas, the number of wetland patches less than 1 ha increased substantially from 1978 to 2010 (Figure 10a, b, c). This apparent increase may be, at least in part, as a result of clearer imagery in 2010 allowing differentiation of some of these areas that were not distinguishable in 1978 air photo series.

Figure 11. Example of wetland loss in the St. Clair River AOC. View in 1978 (a), 2010 (b) and the change in ELC system from 1978 to 2010 (c).

Figure 12. Fighting Island in 1978 (a) and 2010 (b). The change in habitat at the ELC system level is shown on the 2010 imagery in (c).

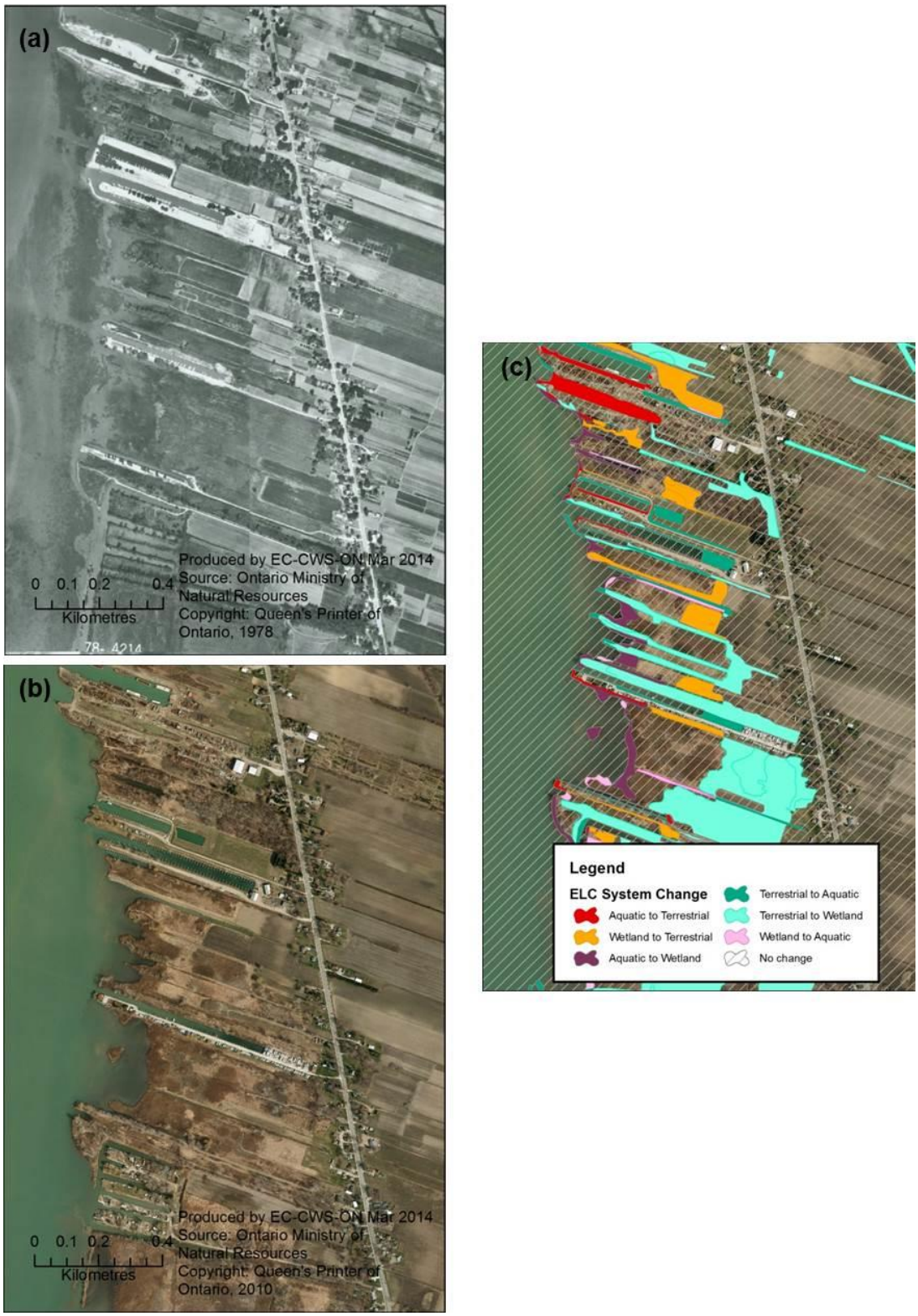

Figure 13. Detroit River shoreline (Front Rd and Malden Rd area) in 1978 (a) and 2010 (b). The change in habitat at the ELC system level is shown on the 2010 imagery in (c).

Summary

Both St. Clair River and Detroit River AOCs showed an overall increase in wetland + aquatic systems from 1978 to 2010. They may have been some limitations in the delineation of wetland habitat in 1978 which may result in an underrepresentation of the wetland habitat. As such, the numbers presented in this report should be used with caution. Throughout the corridor, wetland habitat has been both lost and gained. Wetland habitat has been converted to terrestrial habitat such as was seen in the Lake St. Clair marshes example but has also been converted to aquatic habitat.

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Appendices

Appendix 1. Ecological Land Classification (ELC) Wetland and Aquatic Systems and Community Classes (adapted from Lee et al. 1998).

ELC Community Units	ELC Code	Vegetation Characteristics	Landscape Characteristics
Wetland Systems		- open, shrub and treed communities; average wetness index typically > 0; plant communities consist mainly of facultative, facultative upland, and upland plant species; consult the Ontario Wetland Evaluation System (OWES) for up to date wetland plant species indicators	- water table seasonally or permanently at, near, or above substrate surface; flooded bedrock or hydric mineral or organic (organic > 40cm) substrates; standing water, pools or vernal pooling > 20% of ground coverage; wetland plant indicator species (OWES) cover > 50%; mean wetness score of a site for native species => 0; moisture regime typically < 5;
Swamp	SW	- tree or shrub cover > 25% - dominated by hydrophytic shrub and tree species	- variable flooding regimes - water depth < 2 m - standing water or vernal pooling > 20% of ground coverage
Fen	FE	- tree cover (trees > 2m high) ≤ 25% - sedges, grasses and low (< 2 m) shrubs dominate	- substrate organic; > 40 cm of brown moss or sedge peat - rarely flooded, always saturated - pH is slightly alkaline to mildly non-calcareous - minerotrophic peatland
Bog	BO	- tree cover (trees > 2m high) ≤ 25%	- substrate organic; > 40 cm of Sphagnum peat; rarely flooded; always saturated - pH is moderate to highly non-calcareous (< 4.2) - ombrotrophic peatland
Marsh	MA	- tree and shrub cover ≤ 25% - dominated by emergent hydrophytic macrophytes	- variable flooding regimes; - water depth < 2 m
Aquatic Systems			
Open Water	OA	- dominated (<25%) by submerged macrophytes, no tree or shrub cover - plankton dominated	- water depth > 2 m - lake trophic status
Shallow Water	SA	- submerged or floating-leaved macrophytes - emergent vegetation may be present but never dominant - no tree or shrub cover	- water up to 2 m depth - standing water always present - shoreline energy; substrate; nutrients