Extent of Non-Native *Phragmites australis* in Coastal Wetlands 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

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. Invasive species such as *Phragmites australis* are impacting these coastal wetlands.

The objective of this project was to identify the current (2010) aerial extent of *Phragmites* in coastal wetlands in the Canadian Huron-Erie Corridor and surrounding land and to identify the change in amount of *Phragmites* from 2006 to 2010. Results are presented for three areas – St. Clair River Area of Concern, Lake St. Clair, and Detroit River Area of Concern. While the invasion of *Phragmites* is not an AOC-specific issue, questions are often raised on the impact of *Phragmites* on the status of fish and wildlife habitat and populations.

Phragmites in the Huron-Erie Corridor is a real concern given its vast extent. While it would appear to be spreading, due to the confounding effects of management techniques such as burning and cutting, the rate of spread and any other analysis as to the true extent of *Phragmites* need to be verified on the ground. The air photo interpretation provides a starting point for such analysis and may be useful to track areas of expansion in the future.

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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.

Phragmites australis (herein *Phragmites*) is a perennial wetland plant that grows in wet areas such as marshes, drainage ditches, roadside and shallow lake edges and the non-native variety is considered an invasive species (Mal and Narina 2004). It often forms extensive monocultures and as a result, habitat quality and species diversity decline (Chambers et al. 1999; Wilcox et al. 2003). *Phragmites* may be managed through herbicide applications, cutting, burning or draining of habitat.

Many projects and programs are underway, especially in the Great Lakes basin to map, monitor or control the spread of *Phragmites* (see http://greatlakesphragmites.net for some examples) including in the Huron-Erie Corridor. This corridor is composed of the St. Clair River, Lake St. Clair and the Detroit River. Both the St. Clair River and Detroit River were designated as Great Lakes Area of Concern (AOCs) in 1985 due to problems with its chemical, physical and biological integrity. While the invasion of *Phragmites* is not an AOC-specific issue, questions are often raised on the impact of *Phragmites* on the status of fish and wildlife habitat and populations.

Project Objective

The objective of this project is to identify the current (2010) aerial extent of *Phragmites* in coastal wetlands in the Canadian Huron-Erie Corridor and surrounding land and to identify the change in extent of *Phragmites* from 2006 to 2010.

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 1). Its width varies from 600 m at the Ambassador Bridge to over 6 km where it empties into Lake Erie.

Methodology

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, air photos for a small area in the Lake St. Clair Marshes were missing and this area was excluded for the analysis (Figure 1).

A commonly accepted and well documented method for capturing changes in landscape features is air photo interpretation, a relatively inexpensive method to create detailed, site-level information in an efficient and effective manner (Owens and Hop 1995). Using 2006 spring/summer colour aerial photos and 2010 spring/summer colour aerial photographs, all *Phragmites* and burned habitat boundaries were digitized on screen within the area of analysis for each time period (Table 1). Burned habitat was included as burning may be used as a management technique for *Phragmites*. The native and the non-native cannot be distinguished from one another through air photo interpretation and both are referred to as *Phragmites* in this document (see JWRL 2014 for more details on the interpretation). 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 allowed distinct features to be identified at a much finer scale, enabling subtle changes to be captured.

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 1). 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.

Table 1. Vegetation classification and associated descriptions used for this project. Notes on challenges for photo interpretation of the habitat are also included.

Vegetation Classification	Habitat Description and Aerial Photo Interpretation Notes
Phragmites	– Species less tolerant of prolonged flooding, grass cover dominant. – dominates with scattered herbaceous species – Flooding seasonal – soils flooded in spring, moist to dry by summer. – typically mineral soil based – Overall, readily distinguished but areas in the St. Clair River Delta was a challenge. Most individual wetlands were readily interpreted but those in the St Clair River Delta were difficult due to the abundance of yearly burns and the abundance and composition of shallow marshes. – The *Phragmites* polygons interpreted were reeds that were alive and thriving. Any *Phragmites* sites that were destroyed due to weather, cutting, partial burns and any other disturbance were classified into the Not Classified class.
Burn	– recently burned areas with a focus on areas originally marsh or prairie habitat (rather than result of forest fire) – new burns were generally easy to identify (charred black with long plumes or fingers caused by the wind or abruptly stopped by a man made disturbance), older burns (early spring of that year or late fall of the previous year) were more difficult - grass regeneration had often started and a greener color is imaged.
Not classified	– All other area within the area of analysis was not classified.

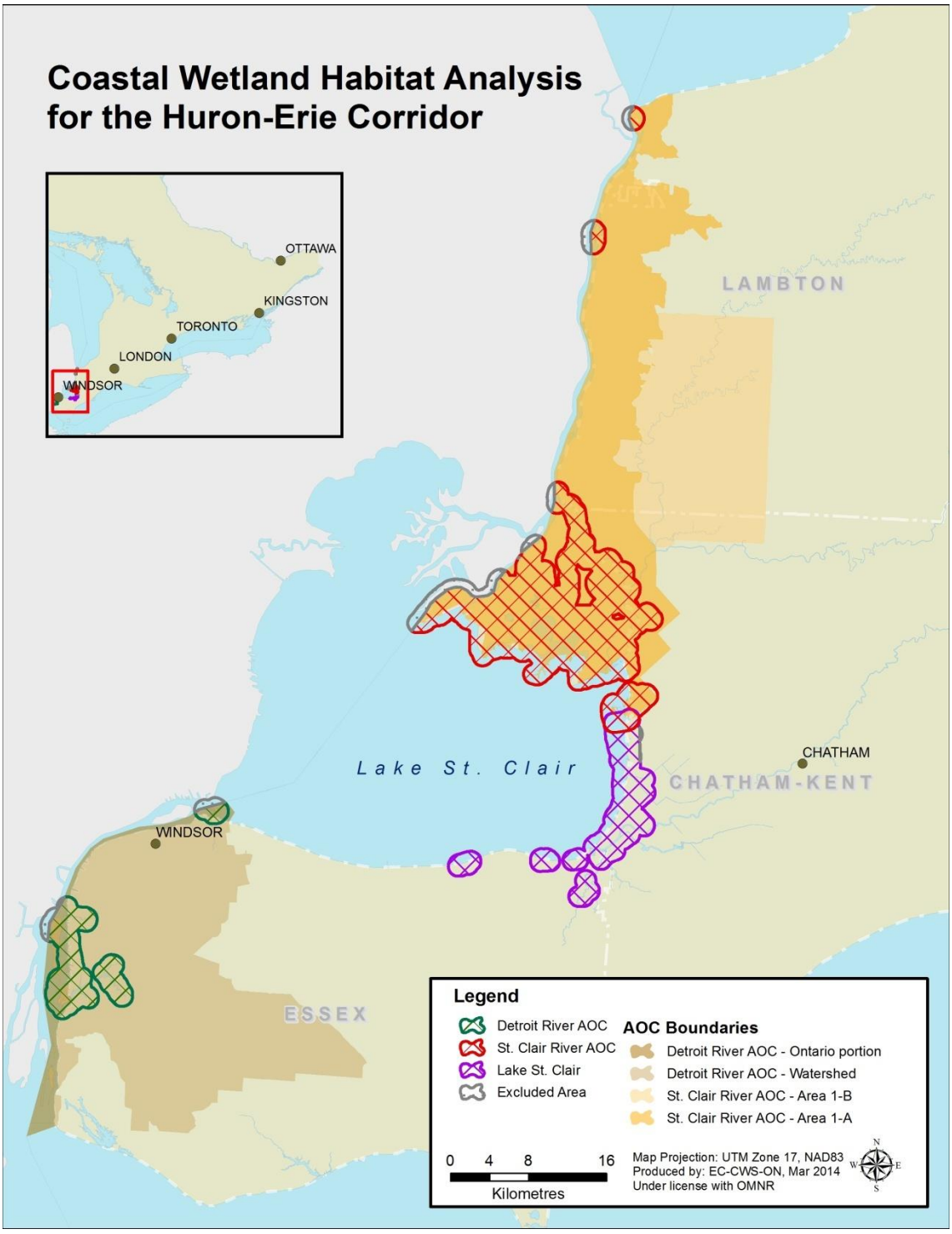

Figure 1. Analysis extent developed based on a 1,000 metre buffer of the Great Lakes Coastal Wetland Inventory wetlands in the St. Clair River, Detroit River, and Lake St. Clair. Note there is an area of overlap between St. Clair River AOC and Lake St. Clair as the buffer was applied to wetlands in each 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.

Results

St. Clair River AOC

The areal extent of *Phragmites* in the St. Clair River AOC remained fairly consistent between 2006 and 2010 with an area of 1,095.2 and 1,105.3 ha respectively (Table 2). The amount of habitat identified as burn increased substantially from 1,781.6 ha in 2006 to 2,958.8 ha in 2010. In both years, the majority of *Phragmites* patches were less than 0.25 ha although there was nearly double the number of patches of this size in 2006 compared with 2010 (n=667 vs. 358; Figure 2). For the remaining patch size bins, the number of patches per bin between years was fairly similar.

The habitat composition transition matrix identifies the amount of habitat that has remained the same or changed between 2006 and 2010. While 41 % (446.1 ha) of the *Phragmites* habitat was in the same location in 2010, 39 % (429.8 ha) was instead identified as burn and 20% (219.3 ha) not classified (Table 3). Burn habitat remained the same in both years for 57% (1016.5 ha) of the habitat while 13% (237.6 ha) was instead identified as *Phragmites* and 30% (527.5 ha) not classified. Newly burned areas not previously identified as *Phragmites* were found in particular within the St. Clair River Delta, in particular on St. Anne Island (Figure 3).

Lake St. Clair

The areal extent of *Phragmites* in Lake St. Clair increased from 183.5 ha to 227.0 ha (Table 2). The amount of burn habitat decreased from 22.1 ha to 0.2 ha. In both years, the majority of *Phragmites* patches were less than 0.25 ha and the number of patches in each frequency bin was similar between 2006 and 2010 (Figure 2). The largest *Phragmites* patches in 2010 were found at Tremblay Beach Marsh and in the Lake St. Clair Marshes (Figure 4).

The habitat transition matrix show the majority of *Phragmites* habitat remained as *Phragmites* although 32 % (59.5 ha) of it was identified as not classified in 2012.

Detroit River AOC

The areal extent of *Phragmites* in the Detroit River AOC increased from 196.1 ha in 2006 to 252.8 ha in 2010 (Table 2). The amount of burn habitat is relatively small and is similar in both years. In both years, the majority of *Phragmites* patches were less than 0.25 ha and the number of patches in each frequency bin was similar between 2006 and 2010 (Figure 2). The largest *Phragmites* patches in 2010 were located on Fighting Island (Figure 5).

The habitat transition matrix shows the majority (78%; 153.1 ha) of *Phragmites* habitat remained as *Phragmites* with the remaining portion identified in 2010 as not classified (Table 3).

Table 2. Amount of habitat identified as *Phragmites* and burn in 2006 and 2010 in St. Clair River AOC, Lake St. Clair and Detroit River AOC areas of analysis.

		Analysis Area		
Habitat	**Year/Change**	**St. Clair River AOC**	**Lake St. Clair**	**Detroit River AOC**
Phragmites	2006 (ha)	1 095.2	183.5	196.1
	2010 (ha)	1 105.3	227.0	252.8
	Change (ha)	***10.0***	***43.5***	***56.7***
	Change (%)	0.9	23.7	28.9
Burn	2006 (ha)	1 781.6	22.1	6.0
	2010 (ha)	2 958.8	0.2	7.1
	Change (ha)	***1 177.2***	***-21.9***	***1.1***
	Change (%)	66.1	-99.2	18.0
Phragmites + Burn	2006 (ha)	2 876.9	205.6	202.1
	2010 (ha)	4 064.1	227.2	259.9
	Change (ha)	***1 187.2***	***21.6***	***57.7***
	Change (%)	41.3	10.5	28.6

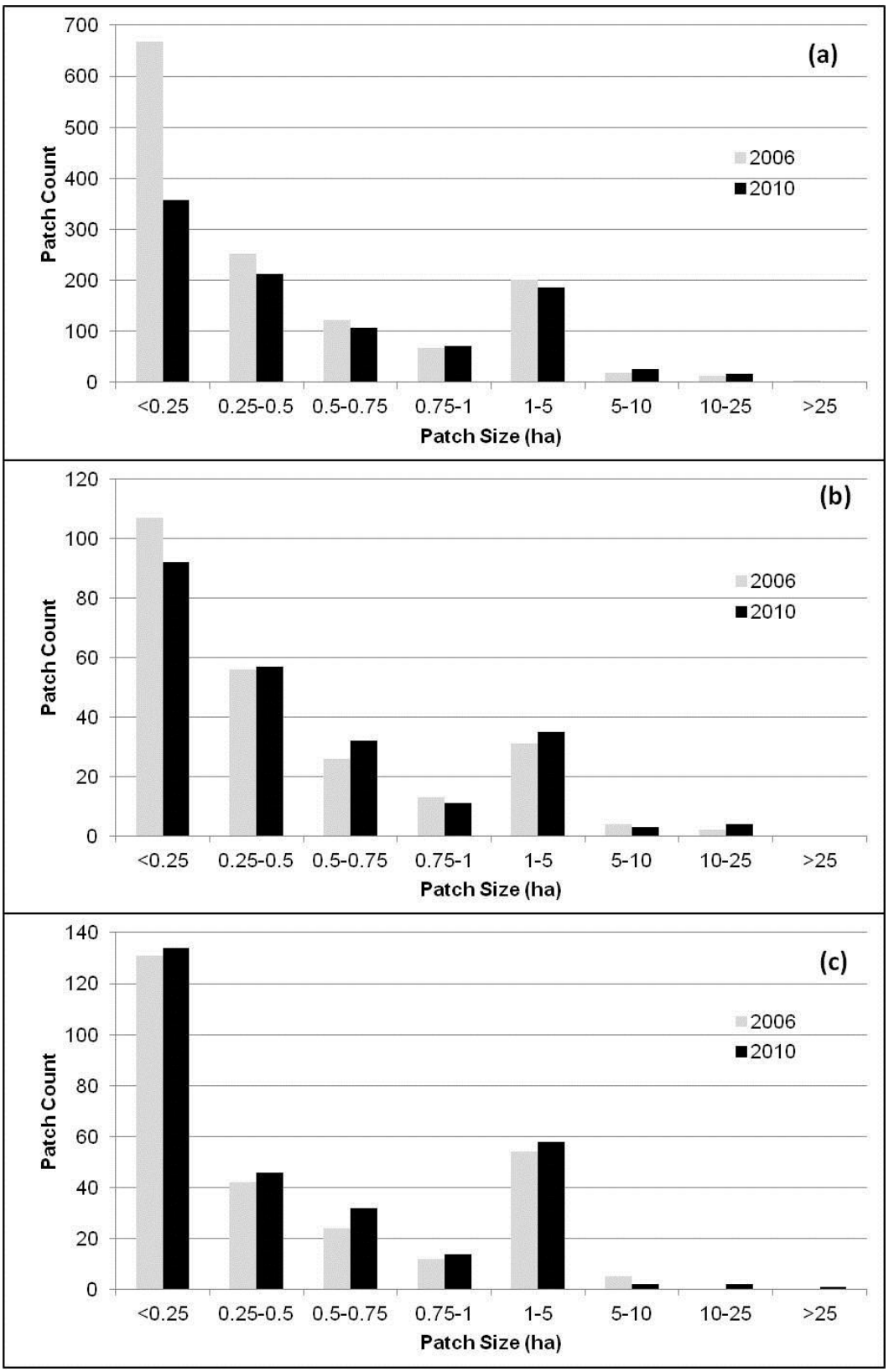

Figure 2. Patch frequency of *Phragmites* in 2006 and 2010 in St. Clair River AOC (a), Lake St. Clair (b), and Detroit River AOC (c). Note y-axis range is different among graphs.

Table 3. Habitat composition transition matrix from 2006 to 2010 for St. Clair River AOC (a), Lake St. Clair (b), and Detroit River AOC (c).

(a) St. Clair River AOC

Year		2010		
	Habitat	***Phragmites***	**Burn**	**Not classified**
2006	***Phragmites***	446.1	429.8	219.3
	Burn	237.6	1016.5	527.5
	Not classified	421.5	1512.5	21243.2

(b) Lake St. Clair

Year		2010		
	Habitat	***Phragmites***	**Burn**	**Not classified**
2006	***Phragmites***	123.8	0.1	59.5
	Burn	13.4	0.0	8.7
	Not classified	89.8	0.0	8486.8

(c) Detroit River AOC

Year		2010		
	Habitat	***Phragmites***	**Burn**	**Not classified**
2006	***Phragmites***	153.1	0.2	42.9
	Burn	6.0	0.0	0.0
	Not classified	93.7	6.9	5922.7

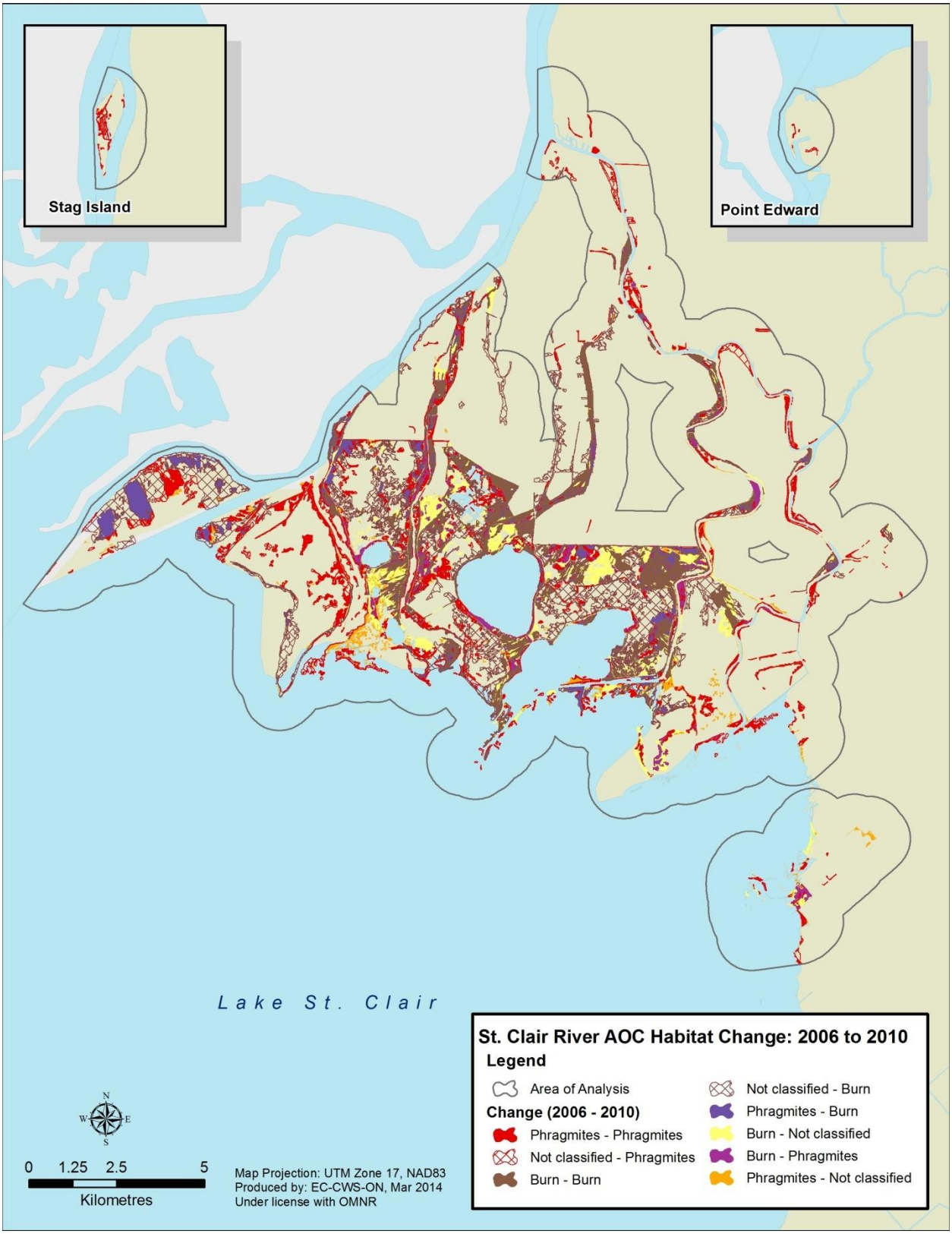

Figure 3. The change in *Phragmites* and Burn habitat in the St. Clair River AOC from 2006 to 2010.

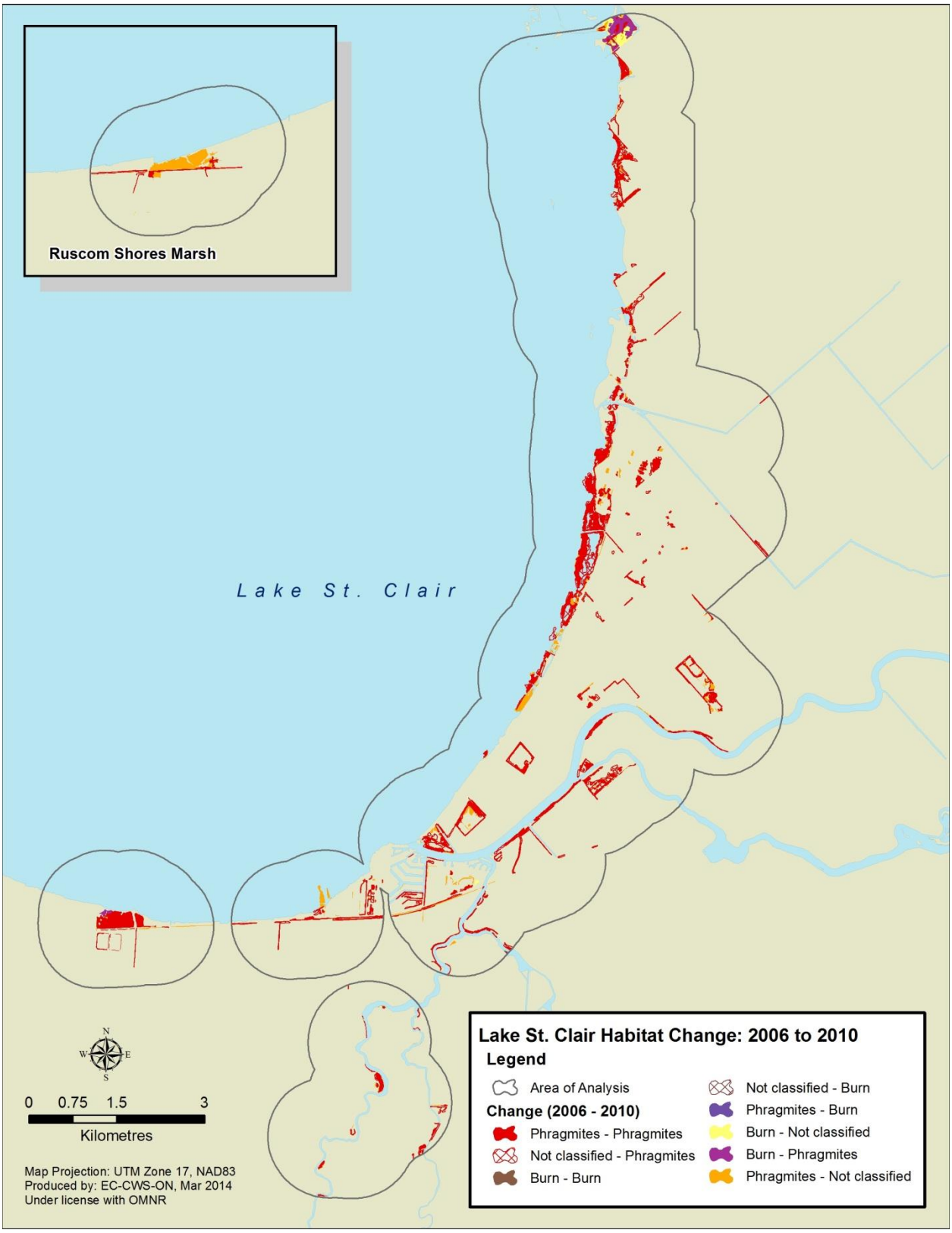

Figure 4. The change in *Phragmites* and Burn habitat in Lake St. Clair River from 2006 to 2010.

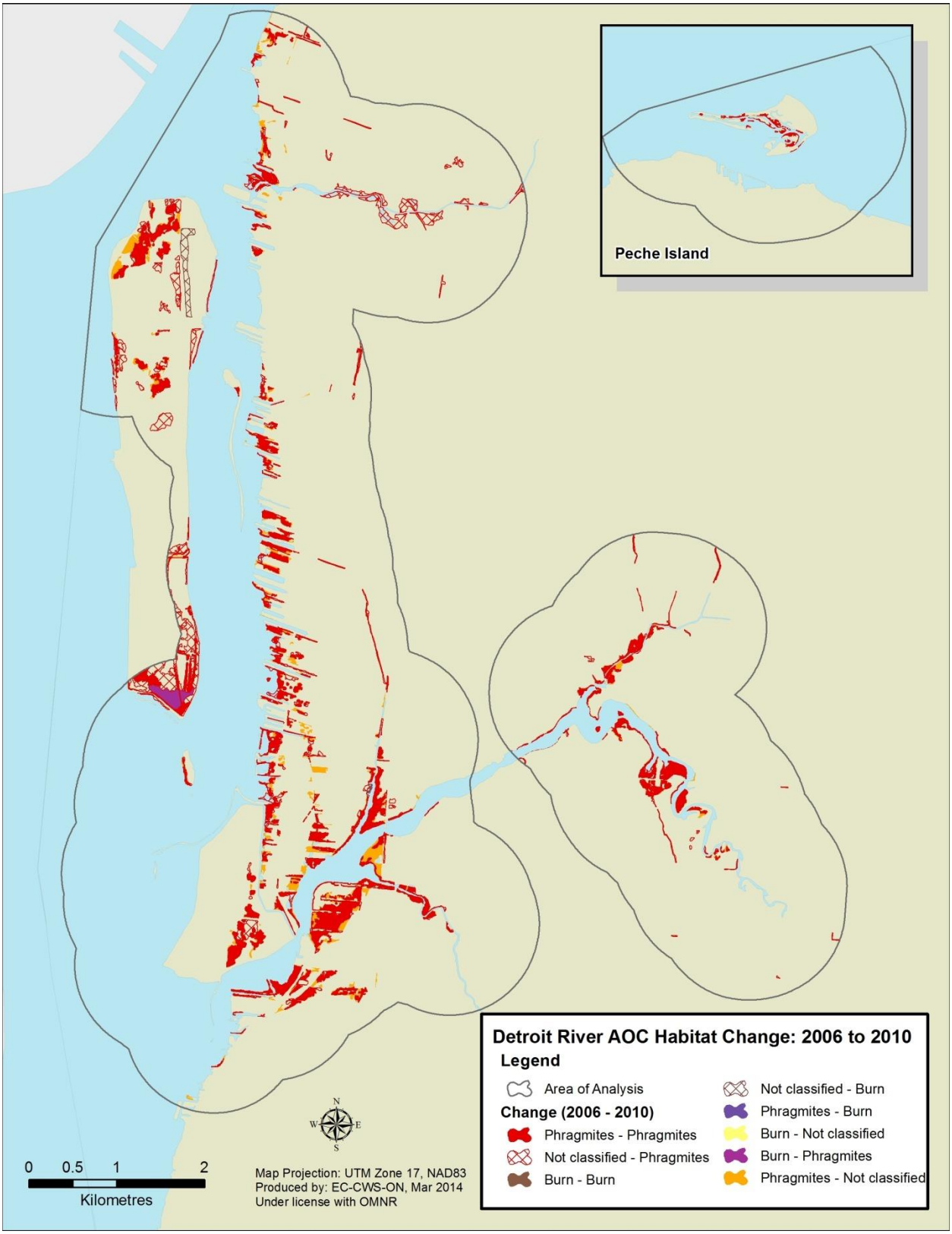

Figure 5. The change in *Phragmites* and Burn habitat in the Detroit River AOC from 2006 to 2010.

Discussion

All three areas saw an increase in the amount of *Phragmites* present from 2006 to 2010. While a relatively small (10 ha) increase in *Phragmites* was observed in the St. Clair River AOC, there was an increase of 1,177.2 ha of burn habitat (Table 2). While the burn habitat cannot be conclusively identified as *Phragmites*, a portion of that habitat is likely *Phragmites*. The habitat composition transition matrix provides some support to this idea given 237.6 ha of habitat identified as burn in 2006 in the St. Clair River AOC was identified as *Phragmites* in 2010. Figure 6 provides an example of a case where habitat identified as burn in 2006 is to a large extent identified as *Phragmites* in 2010 while Figure 7 shows and area of *Phragmites* in 2006 that is primarily burned habitat in 2010.

Prescribed burns are used to manage *Phragmites* but are also used for creating or restoring tallgrass prairie. Burns for both purposes are likely taking place in the area of analysis, in particular in the St. Clair River Delta thus creating a challenge when attempting to identify the amount of *Phragmites* in the Huron-Erie Corridor. The Southern Ontario Resource Information System (SOLRIS) provides a landscape-level inventory of natural, rural and urban areas and uses the Ecological Land Classification (ELC) for southern Ontario which includes classes such as marsh and open tallgrass prairie. Based on SOLRIS, the majority of Burn habitat in 2010 was identified as marsh (89%). Only a small portion (1.5%) was tallgrass (prairie or other tallgrass habitat) suggesting that considering the majority of the burn habitat as marsh with the potential of being or having been *Phragmites* is an acceptable approach.

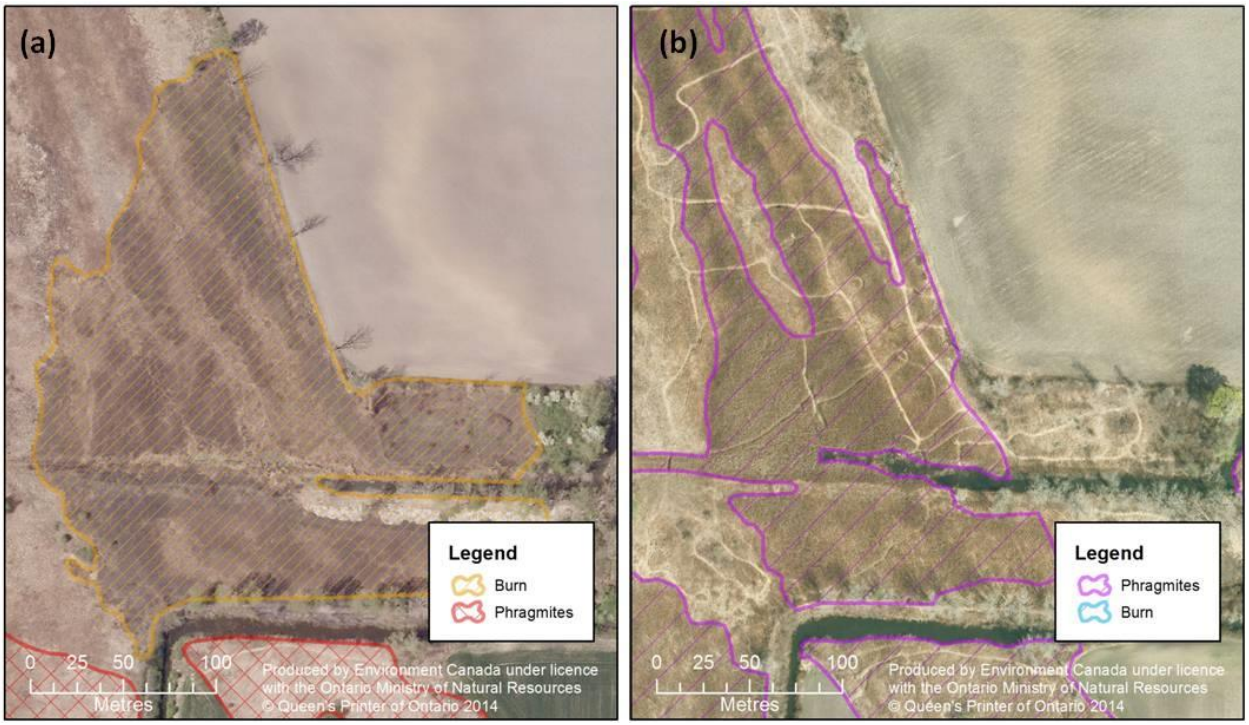

Figure 6. Example of burn habitat in 2006 (a) which is identified as *Phragmites* in 2010 (b).

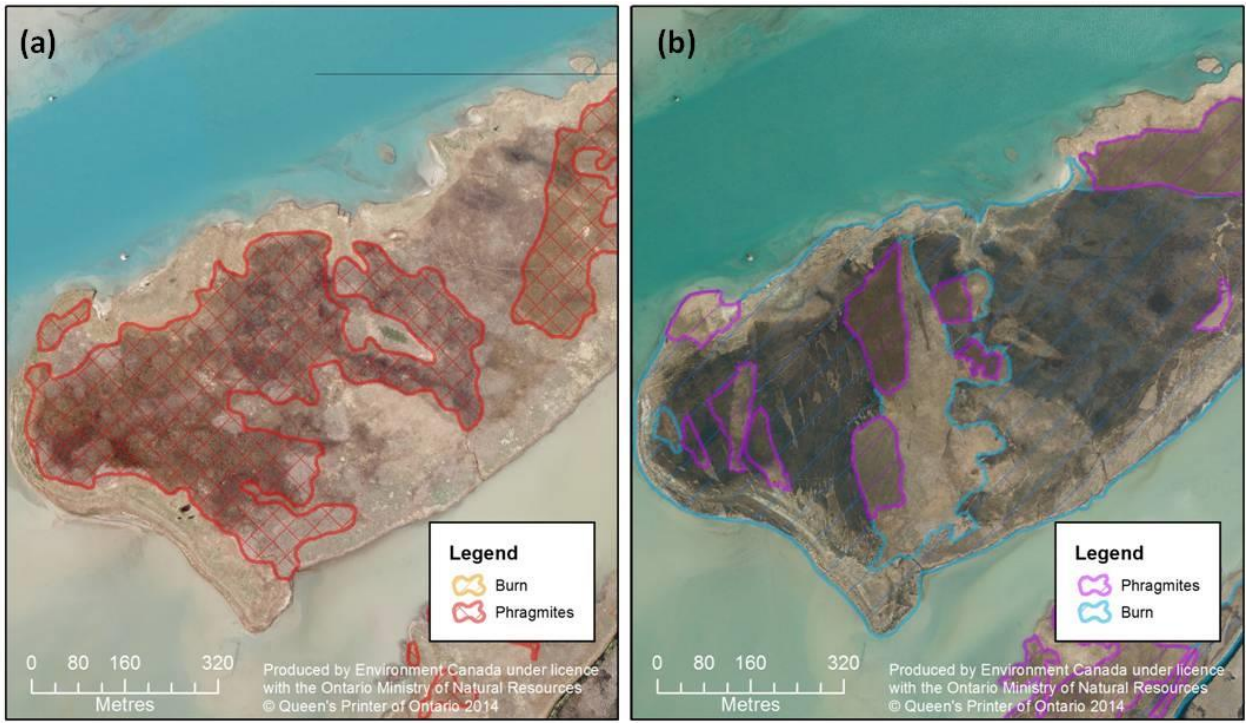

Figure 7. Example of the extent of Burn and *Phragmites* habitat in 2006 (a) and 2010 (b) in the St. Clair River. Note large area that appears to have been burned for control of *Phragmites*.

The habitat composition matrix presents a somewhat puzzling result on first glance with respect to the 219.3 ha of habitat in St. Clair River AOC identified as *Phragmites* in 2006 now identified as not classified (i.e., not *Phragmites* or Burn). The answer may in part rest in the air photo interpretation notes which indicated sites destroyed due to weather, cutting, partial burns or other disturbance were identified as not classified (see Table 1). Figure 9 provides an example where two relatively large patches of *Phragmites* were located in 2006 and no *Phragmites* or burn habitat was identified in the same area in 2010. This particular area appears to have been cut. A similar case can be seen on Fighting Island in the Detroit River (Figure 8).

Without ground verification of the air photo interpretation, the confidence of the outcomes of the analysis is reduced. While many areas are clearly identifiable as *Phragmites*, even to someone with limited air photo interpretation skills, the unexpected transformation of *Phragmites* habitat to not classified creates challenges in the overall interpretation of the outcomes of this project. Other sources of information can be used to assist in the validation of the data set. Once such case is the availability of ground surveys for *Phragmites* at St. Clair National Wildlife Area in 2012 (see Appendix 1 for description of project and results). As outlined in Appendix 1, this limited comparison shows that air photo interpretation correctly identified *Phragmites* the majority of the time. However, more than half the *Phragmites* identified on the ground was identified as something other than *Phragmites* or Burn. While there is nearly a two year gap between the imagery used in the air photo interpretation and the ground surveys, it is unlikely to be responsible for more than a small portion of the difference. As discussed in the case study, there are patches which do not readily appear on the imagery while others appear to have been missed in the air photo interpretation.

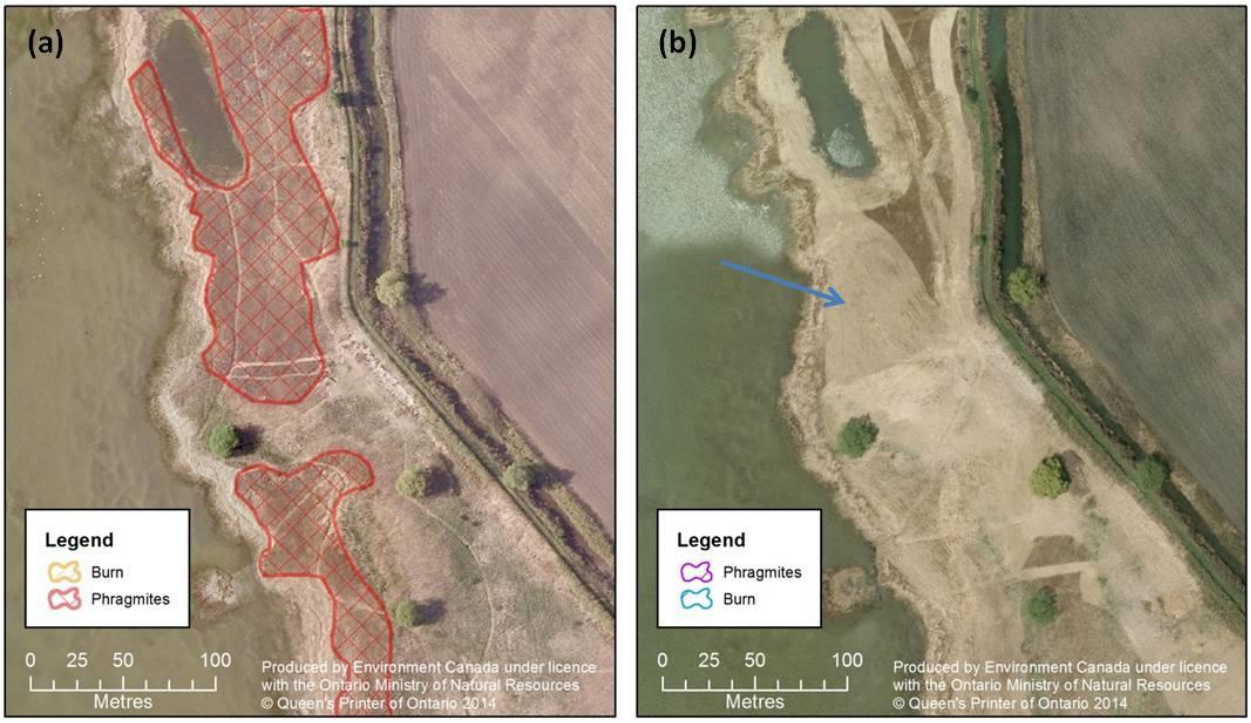

Figure 9. Extent of *Phragmites* habitat in 2006 (a) and 2010 (b). Area appears to have been cut. St. Clair River AOC.

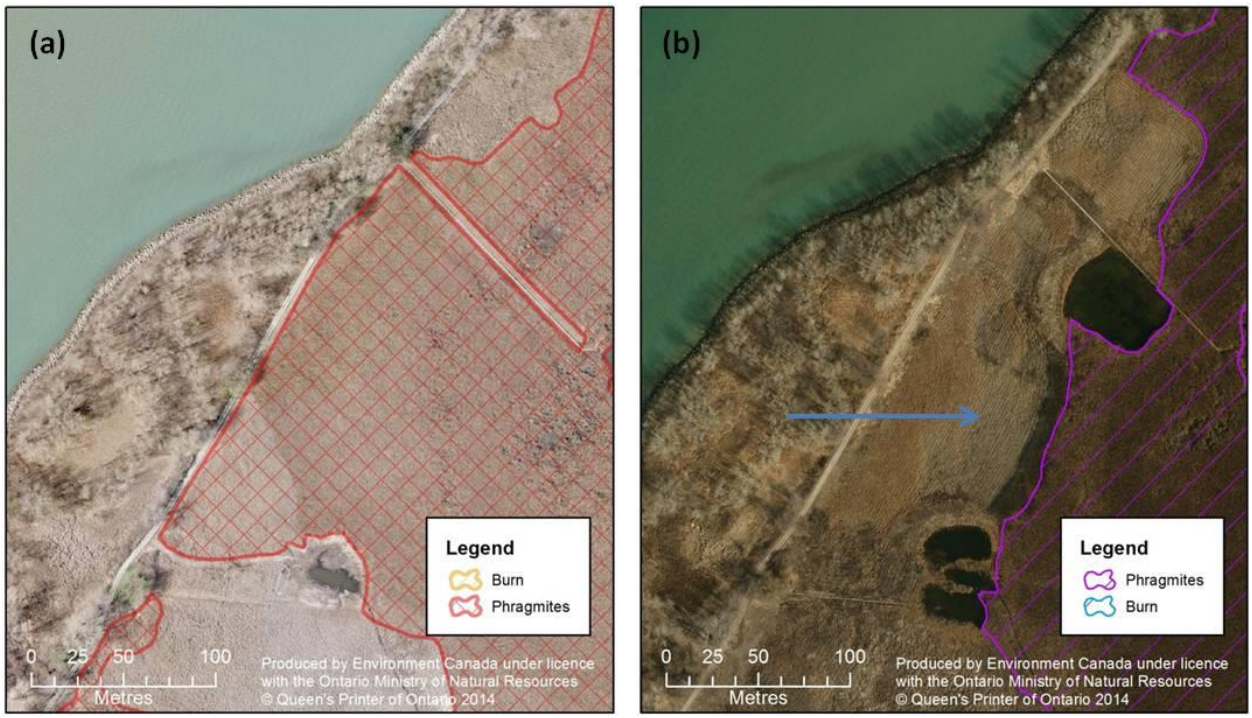

Figure 8. Extent of *Phragmites* habitat in 2006 (a) and 2010 (b). Area appears to have been cut. Fighting Island, Detroit River.

A second comparison was undertaken based on available remote sensing identification of *Phragmites* in the area of analysis (see Appendix 2 for details). Based on it and the comparison to ground data, the remote sensing product greatly overestimates the amount of *Phragmites* present, especially in situations where the patches are small or narrow. In part, this is a result of a 0.81 ha minimum mapping unit for the product thus smaller patches are either missed or end up being represented by a much larger area.

Summary

Phragmites in the Huron-Erie Corridor is a real concern given its vast extent. While it would appear to be spreading, due to the confounding effects of management techniques such as burning and cutting, the rate of spread and any other analysis as to the true extent of *Phragmites* need to be verified on the ground. The air photo interpretation provides a starting point for such analysis and may be useful to track areas of expansion in the future.

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Appendices

Appendix 1. Case Study – *Phragmites australis* at St. Clair National Wildlife Area

Background

In February 2012, the St. Clair and Bear Creek units of the St. Clair National Wildlife Area (NWA) were surveyed for *Phragmites*. Due to a warm winter, it was not possible to access all stands of *Phragmites* as ice was not thick enough to walk on. Where stands could not be reached, they were assessed from the dykes or shore and using field notes and air photos (spring/summer 2010 imagery), the areas were digitized. Points were collected for patches less than 25 m^2; line features are used to capture long linear stretches that are <1 m to 2-3 m wide; and polygons are used to capture stands larger than 25 m^2. Additional details of the project can be found in the report: *Mapping the Distribution of Invasive* Phragmites australis *for the St. Clair National Wildlife Area* (Natural Resource Solutions Inc., 2012).

Air photo interpretation was previously undertaken at the same area using 2010 spring/summer aerial photos but without any ground verification. As such, it was possible to undertake a small accuracy assessment of identification of *Phragmites* through air photo interpretation alone. Air photo interpretation is done through heads up (on screen) digitizing and targets polygons greater than 0.25 ha although smaller patches are delineated.

Results

Using the polygon data only, the 2012 ground mapping identified 19.37 ha of *Phragmites* at St. Clair NWA (n=180; mean =0.11 ha). The majority (91%) of the patches fell below the specified minimum mapping unit of 0.25 ha for the Ecological Land Classification (ELC). However, it is recognized that polygons below 0.25 ha are commonly found in ELC mapping. For example, for available ELC mapping in the Huron-Erie Corridor, 39% of *Phragmites* patches fell below the 0.25 ha mapping standard. This suggests at least some of the smaller patches could be delineated through air photo interpretation.

With the exception of the *Phragmites* and Burn classes, the available ELC data was summarized to the community class level for the area delineated as *Phragmites* in 2012 (Table A1). Within this area, 27.2% of the area was correctly identified as *Phragmites* through air photo interpretation while an additional 20.2% was identified as “Burn”.

Conversely, St. Clair NWA had 5.8 ha identified as *Phragmites* and 7.4 ha identified as Burn through 2010 air photo interpretation (Table A2). The confusion matrix shows of the 5.8 ha, 4.9 ha (85%) of the area was identified as *Phragmites* in 2012. Of the 7.4 ha of Burn habitat, 3.9 ha (53%) was identified as *Phragmites* in 2012.

Table A1. Breakdown of ELC mapping by community class for areas identified as *Phragmites* in 2012 through ground verification as opposed to air photo interpretation for 2010 imagery.

ELC	Area	% of total
Burn	3.91	20.2
Phragmites	5.26	27.2
Marsh	6.38	33.0
Constructed	0.22	1.1
Cultivated	0.04	0.2
Forest	0.21	1.1
Meadow	1.44	7.4
Open water	0.22	1.1
Shallow water	0.55	2.8
Savannah	0.13	0.7
Swamp	0.77	4.0
Thicket	0.24	1.2
Total	**19.37**	**100.0**

Table A2. Confusion matrix between the amount (ha) of the ELC classes *Phragmites* and Burn from 2010 air photo interpretation and 2012 *Phragmites* mapping.

		2012		
	Class	***Phragmites***	**Other**	**Total**
2010	*Phragmites*	4.9	0.9	5.8
	Burn	3.9	3.5	7.4
	Total	**8.9**	**3.5**	**13.2**

At the patch scale, 33 of the 180 *Phragmites* patches delineated in 2012 had some *Phragmites* detected through air photo interpretation – ranging from 0.2% to 100% of the total area (mean=65%). An additional 29 patches had Burn habitat present – ranging from 2 to 100% of the total area (mean=73%). Together, 62 patches – ranging in coverage from 0.2 to 100% (mean=69%) – identified at least a portion of the patch containing *Phragmites* or Burn habitat. Of the 118 patches where neither was identified, only four of the patches had an area greater than 0.25 ha. Of these four patches, two are long and narrow (width 2-3 m) while the other two are larger "blobs" of *Phragmites*. Of these two *Phragmites* patches identified in 2012, one does not appear to be readily distinguishable on the air photo (Figure A1) while the other appears to have been missed during the air photo interpretation as patches of *Phragmites* are visible (Figure A2).

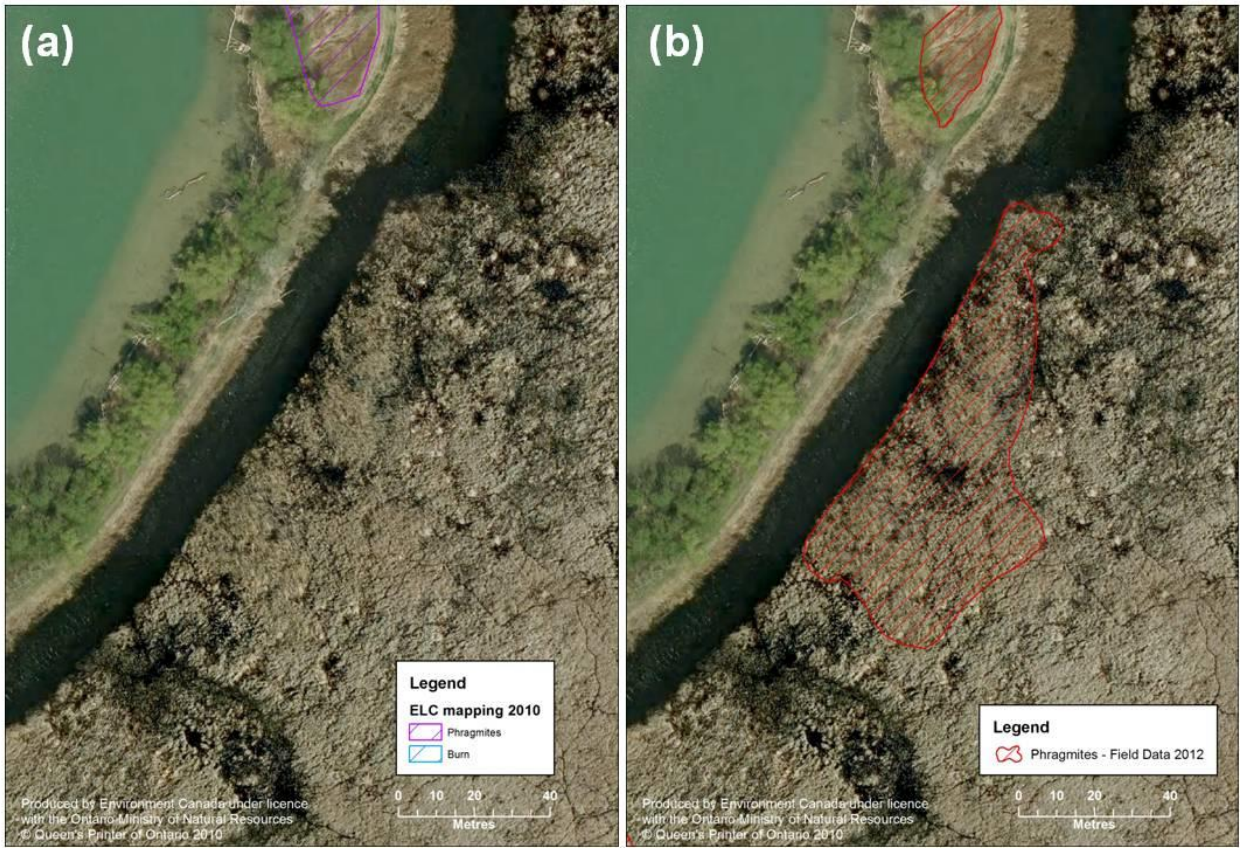

Figure A1. Comparison of *Phragmites* mapping from air photo interpretation (a) and on the ground verification (b) at the St. Clair NWA – Bear Creek Unit. Air photo interpretation missed a 0.36 ha patch which appears difficult to pick out from air photos alone.

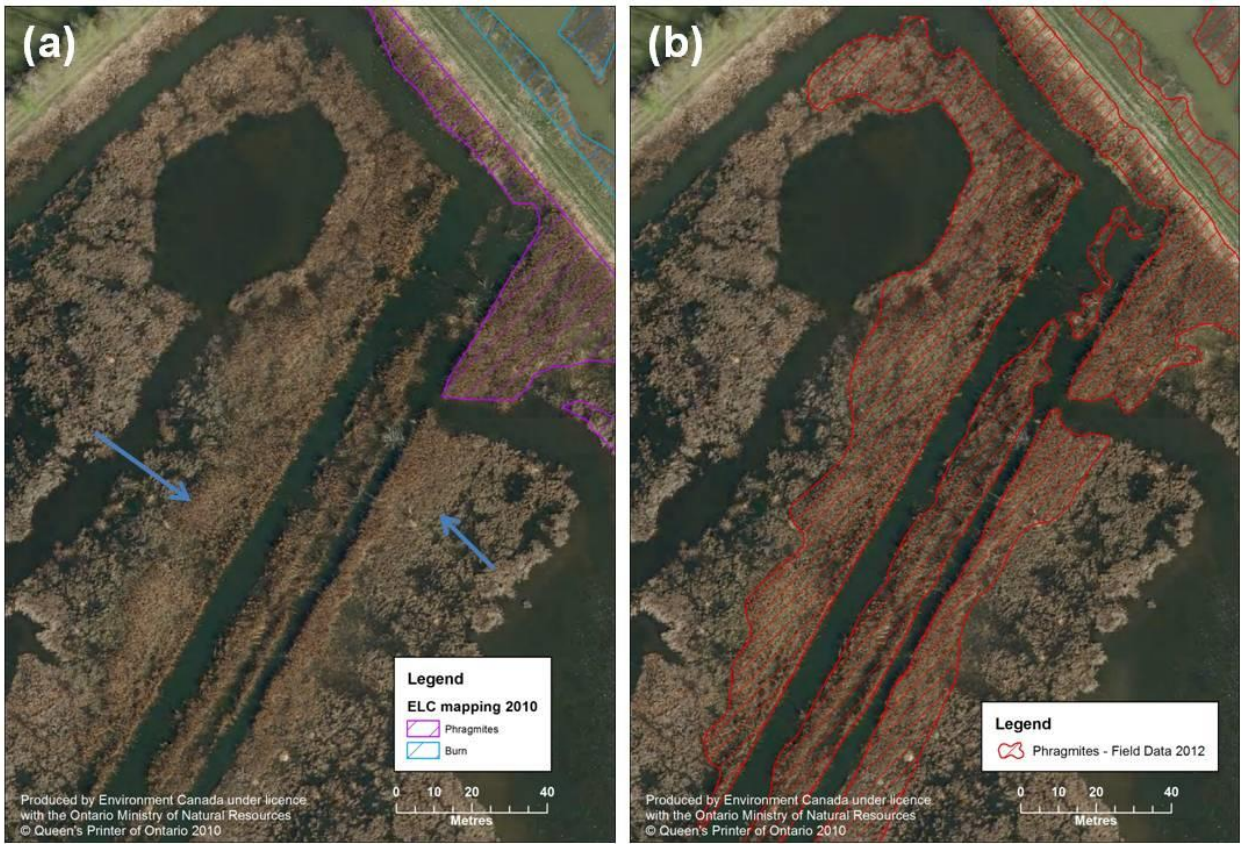

Figure A2. Comparison of *Phragmites* mapping from air photo interpretation (a) and on the ground verification (b) at the St. Clair NWA – Bear Creek Unit. Air photo interpretation missed several patches on *Phragmites* which are fairly clearly visible on the air photos (arrows).

Discussion

Less than half of the *Phragmites* identified in 2012 ground surveys was delineated through air photo interpretation of 2010 imagery in the class of either *Phragmites* or Burn. Given the average size of *Phragmites* patches, some of these were likely not identified due to size. Just over a third of the patches identified in 2012 had at least a portion of the patch identified as Burn or *Phragmites*. Many of the missed patches were small or long and narrow. However, cases such as Figure A2 do show some evident areas that were missed in the interpretation.

Conversely, looking at the confusion matrix between ELC mapping of *Phragmites* or Burn classes, 84% of the land classified as *Phragmites* was identified as such in 2012 while 53% of the ELC mapping of Burn was identified as *Phragmites*. This suggested that areas delineated as *Phragmites* through ELC air photo interpretation are fairly accurate. However, more than half the *Phragmites* present in an area may be missed through inaccurate interpretations or the inability to clearly identify smaller patches. With respect to burn habitat, in this case study, just over half was identified as *Phragmites*. However, upon closer inspection of one of the large patches (2.1 ha) of Burn habitat, there are some small patches (points) of *Phragmites*. These were not factored into the analysis (nor were the lines) as it is less likely that such small features would be discernible through air photo interpretation.

Appendix 2. Comparison of Air Photo Interpretation and Satellite Imagery Derived *Phragmites* Mapping

Background

In 2011, the Ontario Ministry of Natural Resources (OMNR) completed a project using LANDSAT TM NDVI to identify *Phragmites* in Southern Ontario coastal wetlands. A portion of the study area overlaps the area of analysis for this project. As such, a short review of the similarities and differences of the output of both methods can be undertaken. The OMNR's project had a raster cell size of 30 m and a minimum mapping unit of 0.81 ha and used the Southern Ontario Land Resource Information System (SOLRIS) layer to identify possible areas of *Phragmites* based on the need for a damp substrate and disturbed area (i.e., selecting shoreline, wetlands, and open water areas). Very little field data was available to validate the output so the dataset is considered a draft. Full details are available in the project report (OMNR 2011).

Recognizing the different approaches, there is an interest as to the agreement between approaches. As such, this brief analysis will explore the differences in identification of *Phragmites* in Huron-Erie Corridor coastal wetlands between 2010 air photo interpretation and 2010 satellite imagery derived layers.

Methods

Processing and analysis of layers was conducted using ArcGIS 10.1. A common analysis area was developed for both layers for two reasons. First, Stag Island and Point Edward wetlands were not included in the OMNR layer and were dropped. Second, given that the OMNR layer used SOLRIS as a mask (see Table 1 in OMNR 2011), a similar mask needs to be applied here. Thus, for the analysis two modified layers were used:

(a) OMNR *Phragmites* layer restricted to the CWS area of interest (excluding Point Edward and Stag Island), and
(b) CWS *Phragmites* layer restricted to the revised area of interest and identifying the SOLRIS grid code so that those areas with acceptable SOLRIS classes could be identified.

The two layers were intersected and the following areas selected for analysis: OMNR *Phragmites* classes *Phragmites* (all) and Other Vegetation OR from the CWS *Phragmites* layer suitable SOLRIS codes. Thus only those areas from the CWS *Phragmites* layer that had the potential to be included in the OMNR *Phragmites* layer are considered (note – some non-suitable coded polygons are retained as they are in the OMNR *Phragmites* layer likely as a result of the different resolution of the layers).

Results

In the St. Clair River AOC, the MNR remote sensing layer identified 2945.6 ha of *Phragmites* whereas the air photo interpretation layer identified 1064.0 ha although an additional 2782.6 ha of burn habitat was identified which is at least in part, *Phragmites* (Table A3). 36% of the area identified through remote sensing as *Phragmites* was not classified in the air photo interpretation layer.

There is poor agreement between results for Lake St. Clair and Detroit River AOC with the majority of *Phragmites* habitat from the remote sensing layer identified as not classified.

Table A3. Confusion matrix between remote sensing derived *Phragmites* layer and air photo interpretation for St. Clair River AOC (a), Lake St. Clair (b), and Detroit River AOC (c). Area is presented in hectares. Note much of the (blank) habitat in the remote sensing layer is water thus not included in the other two classes.

(a) St. Clair River AOC

		Air Photo Interpretation			
	Habitat	***Phragmites***	**Burn**	**Not classified**	**Total**
Remote Sensing	*Phragmites*	473.8	1407.5	1064.3	2945.6
	Other Vegetation	393.3	1146.6	3135.9	4675.8
	(blank)	196.9	228.5	7888.2	8313.6
	Total	**1064.0**	**2782.6**	**12088.4**	**15935.0**

(b) Lake St. Clair

		Air Photo Interpretation			
	Habitat	***Phragmites***	**Burn**	**Not classified**	**Total**
Remote Sensing	*Phragmites*	98.3		405.9	504.2
	Other Vegetation	42.2		335.2	377.4
	(blank)	46.9	0.2	3051.2	3098.3
	Total	**187.5**	**0.2**	**3792.3**	**3979.9**

(c) Detroit River AOC

		Air Photo Interpretation			
	Habitat	***Phragmites***	**Burn**	**Not classified**	**Total**
Remote Sensing	*Phragmites*	95.4	0.7	228.1	324.1
	Other Vegetation	32.3	1.4	167.8	201.5
	(blank)	41.4	1.5	1880.8	1923.7
	Total	**169.0**	**3.6**	**2276.7**	**2449.3**

Discussion

Generally, there is poor agreement between the remote sensing and air photo interpretation derived *Phragmites* layers. Even in places where the added confusion of burn habitat is not present, the amount of habitat identified as *Phragmites* through remote sensing was double that of air photo interpretation. Neither data source has been ground verified so caution is needed in both instances.

The OMNR *Phragmites* layer is a raster based layer with a 30 m resolution with a minimum mapping unit of 0.81 ha as compared with the polygon based ELC layer with a minimum mapping unit of 0.25 ha (although smaller is also mapped). As a comparison, the ELC layer was converted to a 30 m resolution raster (although no minimum mapping unit applied) but the results were similar to the analysis shown above. Given that many *Phragmites* patches are long and narrow or small, it is not surprising that the remote sensing based product would end up overestimating the size of these polygons. However, for patches that are larger and more rounded, it would be expected that these areas should be comparable. Once such example is at the Tremblay Beach Marsh on Lake St. Clair where remote sensing identifies

20.2 ha of *Phragmites* and air photo interpretation identifies 19.5 ha of *Phragmites* covering a very similar area (Figure A3).

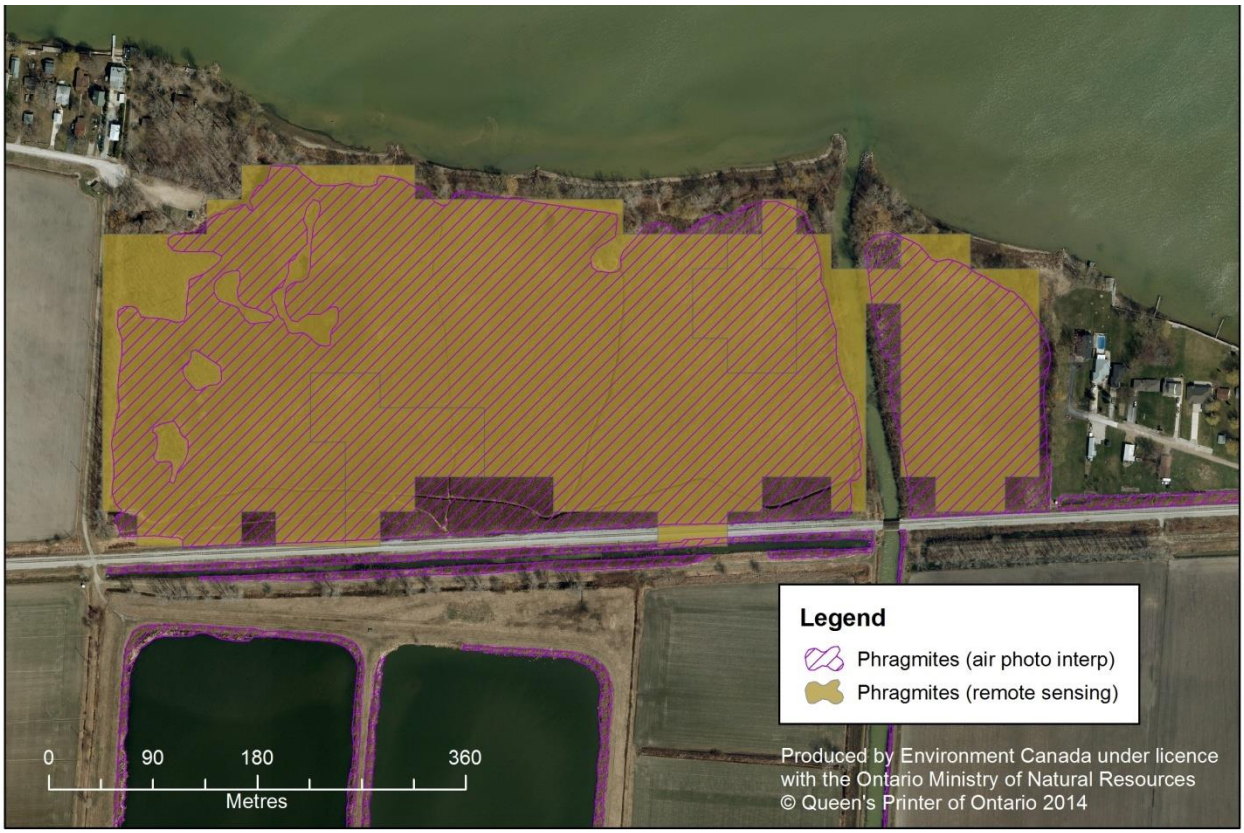

Figure A3. Tremblay Beach Marsh, Lake St. Clair. An example of good agreement between remote sensing and air photo interpretation identification of *Phragmites*.

Limited field data is available for validation of the remote sensing product and much of the area with field data contains *Phragmites* in relatively smaller patches, many of which are smaller than the minimum mapping unit. Figure A5 shows a portion of the St. Clair National Wildlife Area where ground identification of *Phragmites* was undertaken in 2012. In this area, the OMNR *Phragmites* layer identified 7.6 ha of *Phragmites* in whereas field work identified 2.4 ha of *Phragmites*. In this example, many of the *Phragmites* areas are long and narrow which are likely harder to detect in coarse (30 m) resolution remote sensing efforts. However the blockier area on the west side is fairly accurately represented in the remote sensing layer with 1.0 ha of field and 1.2 ha in the remote sensing layer.

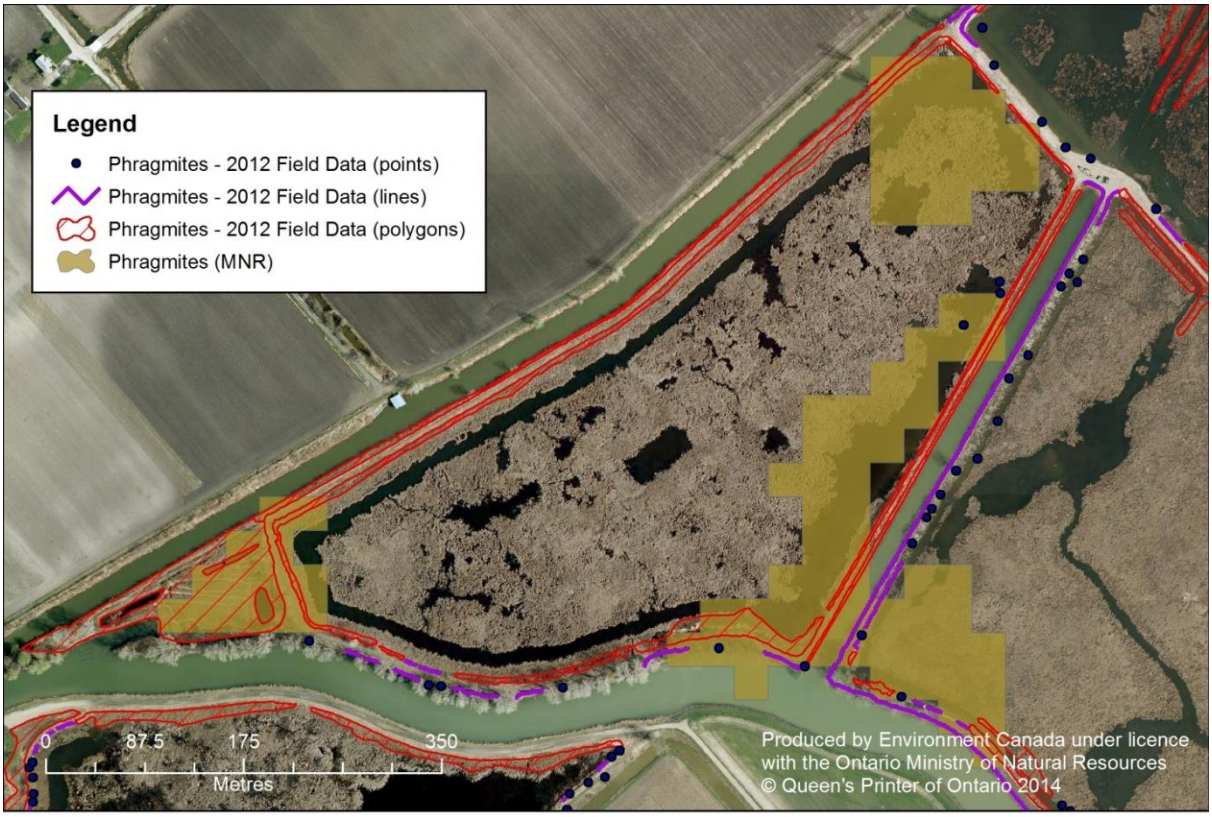

Figure A4. Comparison of MNR *Phragmites* layer (remote sensing derived) and field data from 2012 at St. Clair National Wildlife Area.

In the second example (Figure A5), the over estimation of *Phragmites* by the remote sensing layer is very high – approximately 98.5 ha versus a field value of 4.6 ha (air photo interpretation identified 1.9 ha). The majority of field patches in this example are small or narrow linear features yet remote sensing identifies a number of patches and most are much larger than the minimum mapping unit. It would be worth further investigation to understand why these areas were identified as *Phragmites* when they are in fact not *Phragmites*.

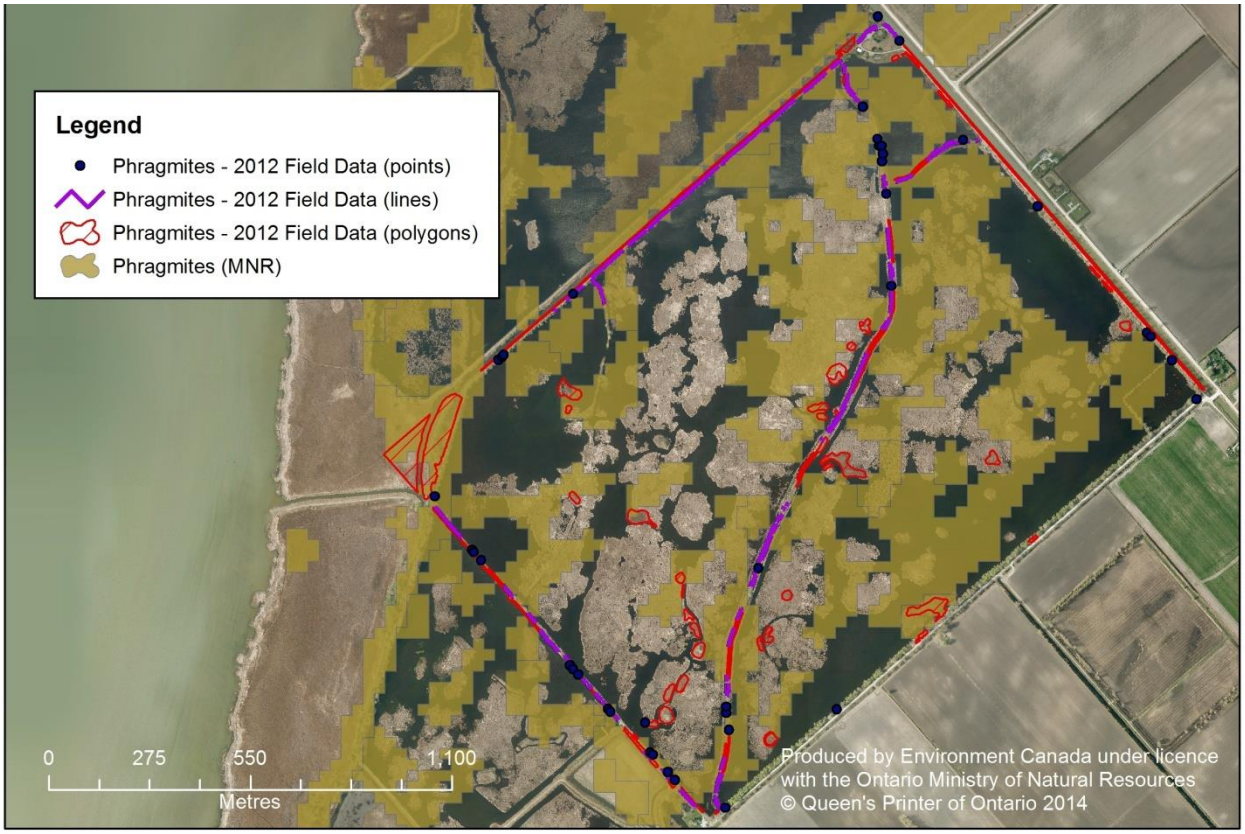

Figure A5. Comparison of MNR *Phragmites* layer (remote sensing derived) and field data from 2012 at St. Clair National Wildlife Area.

Reference

Ontario Ministry of Natural Resources (OMNR). 2011. Using LANDSAT TM NDVI Change Detection to Identify Phragmites Infestation in Southern Ontario Coastal Wetlands. PGSC #9300: Phragmites Inventory. Draft version 6.