Changes in the distribution & abundance of common reed (*Phragmites australis*) between 1999 & 2006 in marsh complexes at Long Point – Lake Erie

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Executive Summary

Common reed (*Phragmites australis*) is a tall cane-like grass that can form dense monotypic stands in a variety of habitats, including wetlands. A cryptic non-native genotype of this plant is an aggressive colonizer that can have negative impacts on native wildlife and plants in wetland it invades. This non-native plant has invaded wetlands within the lower Great Lakes region in the past 30 years. A non-native strain of common reed, plus other favorable habitat conditions, has led to the rapid expansion of common reed at a globally important wetland, Long Point – Lake Erie between 1995 and 1999. Habitat conditions since 1999 likely have been favorable for the continued growth and invasion of new habitats at Long Point. There has been growing interest among scientists, resource managers, and the public about taking steps toward managing common reed within lower Great Lakes coastal wetlands, including Long Point. Thus, an initial step toward developing a sound management plan is having knowledge about the current abundance and distribution, as well as how much the plants abundance and distribution has changed since it was last assessed in 1999.

There were two major objectives for conducting this study. The primary purpose was to document the current (2006) distribution and abundance of common reed (and other major vegetation communities) at Long Point and within five of its major marsh complexes (Turkey Point Marsh, Big Creek Marsh, Crown Marsh, Long Point Company Marsh and tip of Long Point). The second objective was to assess changes in the abundance and distribution of common reed between 1999 and 2006 in four major wetland complexes (Big Creek Marsh, Crown Marsh, Long Point Company Marsh and tip of Long Point) where Wilcox et al. (2003) documented abundance and distribution of this plant in 1999.

Overall, we found that during 2006 common reed was present and widely distributed within each marsh complex, making it an important, although not the most dominant, vegetation community at each locale. We also found that common reed abundance increased greatly within each wetland complex between 1999 and 2006. Between 1999 and 2006, existing stands of common reed expanded in size and stands became established in new areas, thus contributing to overall increased distributions within all wetland complexes.

We conclude, as did Wilcox et al. (2003), that the increases in common reed abundance and distribution likely were due to an aggressive, non-native strain of the plant encountering favorable habitat and growing conditions. Further, these increases in common reed also could have negative impacts on native vegetation communities and wildlife within Long Point's major wetland complexes. We also suggest that continued monitoring of common reed abundance and distribution is paramount, both as a tool for guiding future management within wetland complexes and in evaluating effectiveness of management activities.

Introduction

Common reed (*Phragmites australis*) is a tall (2 – 4m) cane-like grass that grows in aquatic, semi-aquatic, and terrestrial habitats where it often forms large, dense monotypic stands. This perennial plant reproduces primarily through vegetative growth. Although it has been suggest that dispersal by seeds can occur at low frequencies (Roman et al. 1984, Marks et al. 1994, Chambers et al. 1999), common reed is a highly successful colonizer, especially of disturbed areas. Once established, stands can rapidly expand via growth (<1 – 10 m per growing season) and budding of horizontal rhizomes into suitable habitats (Marks et al. 1994).

Common reed has been present in North America for at least 3,000 years, but it has only been within the past 150 years that its abundance and distribution along the Atlantic coast, and more recently in other regions, has substantially increased (Niering and Warren 1999, Saltonstall 2002, Wilcox et al. 2003). This rapid expansion has largely been attributed to the introduction of a cryptic, invasive genotype of common reed native to Europe (Saltonstall 2002, Saltonstall 2003, Wilcox et al. 2003). In many parts of its current range, common reed is considered an aggressive invading species (Marks et al. 1994, Chambers et al. 1999, Rice et al. 2000). When this plant experiences optimal growing conditions, it can quickly colonize suitable habitats, kill and displace native marsh vegetation, establish large, dense monocultures, increase marsh substrate accretion, alter marsh hydrologic regime, modify nutrient cycling, and impact abundance and composition of marsh flora and fauna (Farnsworth and Meyerson 1999, Meyerson et al. 2000, Wilcox et al. 2003, Meyer 2003, Rooth et al. 2003, Rudrappa et al. 2007).

Common reed has expanded recently within coastal wetland complexes associated with the lower Great Lakes and Lake St. Clair (Wilcox et al. 2003, Getsinger et al. 2006). These coastal wetlands are some of the most limited and threatened, yet provide some of the highest quality, habitats for wetland-dependent flora and fauna within the Great Lakes basin (Herdendorf 1992, Environment Canada 2002). Thus, expansion of established stands of common reed in Great Lakes coastal wetlands, along with continued colonization and invasion into new wetlands, may threaten food and habitat for wetland-dependent wildlife and plants (Meyer 2003, Wilcox et al. 2003), especially rare species that occur within these unique habitats (Anonymous 2007, COSEWIC 2006).

Some of the most extensive coastal wetland complexes within the lower Great Lakes basin occur at Long Point Bay – Lake Erie (Herdendorf 1992, Petrie 1996). Wilcox et al. (2003) evaluated the historical abundance and distribution of common reed within four wetland complexes at Long Point (Big Creek Marsh, Crown Marsh, Long Point Company Marsh and Long Point National Wildlife Area) at various periods (1945, 1955, 1964, 1968, 1972, 1978, 1985, 1995, & 1999) between 1945 and 1999. Results of that study showed that overall phragmites abundance at Long Point averaged around 24 ha and fluctuated between 4 ha and 70 ha between 1945 and 1995. Between 1995 and 1999, however, distribution of common reed expanded greatly within all wetland complexes and its overall abundance increased (from 18 to 137 ha) exponentially by 50% per year. These substantial increases were attributed to several interacting factors that had

occurred over that period including, relatively mild annual temperature, declining and relatively low Lake Erie water levels that increased habitat suitability, and the probable invasion of the non-native strain of common reed (Wilcox et al. 2003). Since 1999, annual temperatures have remained relatively mild in the Long Point area, plus Lake Erie water levels have remained well below the long-term average.

Recent research conducted at Long Point suggests that expansion of common reed can influence the abundance and diversity of both native wildlife (Meyer 2003) and wetland plant communities (Wilcox et al. 2003). As a result, scientists, resource managers, marsh-enthusiasts, and the general public have proposed that measures be taken to control or manage common reed at Long Point and at other important coastal marsh complexes within the lower Great Lakes basin. An initial step toward development of a management plan is to document the current distribution of common reed within major marsh complexes at Long Point, plus evaluate changes that have occurred since 1999 when abundance and distribution of the plant was last estimated by Wilcox et al. (2003).

There were two major objectives for conducting this study. The primary purpose was to document the current (2006) distribution and abundance of common reed at Long Point and within five of its major marsh complexes (Turkey Point Marsh, Big Creek Marsh, Crown Marsh, Long Point Company Marsh and tip of Long Point), as well as to calculate its rates of expansion between 1999 and 2006. A secondary purpose was to document the current abundance and distribution of other marsh plant communities, and to assess if there have been any major shifts in dominant plant communities within marsh complexes since 1999.

Study Area

Long Point (42º 35’ N, 80º 30´ W to 42º 33’ N, 80º 03´ W) is a 35-km sand-spit in the eastern basin of Lake Erie that partially encompasses and shelters a shallow (<1 to 3m deep) 280,000 ha lacustrine embayment, Inner Long Point Bay, and 24,000 ha of palustrine and lacustrine wetlands (Petrie 1998). Emergent marsh and wet meadow are the dominant wetland habitat types, but Long Point also has a diversity of upland habitats including, sand dunes, savannah, hardwood forest, and coniferous forest (Reznicek and Catling 1989).

The habitat diversity at Long Point makes it an important area for a wide range of migratory and resident wildlife. Long Point’s wetlands are globally significant and have thus been designated as a Ramsar site. Birdlife International has designated Long Point a globally Important Bird Area mainly because of its significance to migratory songbirds. Long Point contains numerous rare species that have been classified as federally Endangered, Threatened, or of Special Concern (COSEWIC 2006). Long Point also is one of the most important waterfowl stopover sites on the lower Great Lakes and in eastern North America (Dennis et al. 1984, Petrie 1998, Prince et al. 1992).

Methods

We used the Geographic Information Systems (GIS) software ArcMap to display/map the spatial distribution and estimate abundance (ha) of common reed and other wetland plant communities within five wetland complexes at Long Point, including Turkey Point Marsh, Big Creek Marsh (BCM), Crown Marsh (CM), Long Point Company Marsh (LPCM), and the tip of LP (TLP),

from orthophotos (1:10,000) taken during spring 2006. Orthographic photographs at 30 cm were downloaded into Arcmap to be analyzed and then digitized. After doing this, however, we determined that the photographs were not of sufficient quality to be directly interpreted and digitized. Instead, we made large copies of the orthographic photos and took them into the field to help us accurately identify and locate vegetation stands/communities within each marsh complex. Prior to making site visits to some wetland complexes, we spoke with several marsh managers to get their help in determining locations of common reed stands within the marsh. We spent several days ground truthing (walking, boating, & using all-terrain vehicle) as much assessable area as possible within each wetland complex to accurately identify and locate where on photos each common reed stand and other vegetative communities were located. While in the field, we used a Global Positioning System (GPS) to determine precise lat/long coordinates of important geographic locations and vegetation communities within each marsh.

After all wetland complexes had been evaluated and ground-truthed, we digitized all orthographic photos using Arcmap. We created unique shapefiles for each vegetation community within each wetland complex. Because of the diversity of vegetation communities occurring within each wetland complex, we combined several individual plant groups to form more general vegetation groupings. We categorized major habitat features and wetland plant communities as follows: built-up area (roads, dikes, buildings, etc), dry upland land / trees; open marsh meadow (sedges, graminoids, sparse shrub, etc); common reed; cattail; mixed emergents, open water (incl. submerged & floating-leaved aquatic vegetation). After digitizing photos, we created a geodatabase into which we then imported all major habitat / vegetation community shapefiles. We calculated area (ha) for each habitat feature and vegetation community within each wetland complex from values reported in attribute tables.

In order to assess temporal changes in abundance and distribution of common reed (and other wetland plant communities) between 1999 and 2006 within wetland complexes at Long Point, required that we re-categorize several of our wetland plant community groups so they were the same as those evaluated by Wilcox et al. (2003). We then recalculated area estimates for our 2006 data based on these revised wetland plant community groupings. Unfortunately, we were not able to use the same method that Wilcox et al. (2003) employed for calculating open water areas, so those data were not comparable, plus total hectares within marsh complexes also differs slightly between years. However, area estimates of habitat features/wetland plant communities should be comparable between study periods. In addition to assessing absolute changes in wetland plant community areas, we also used a variant of a logarithmic growth equation to calculate percent annual change in habitat area, thereby allowing direct comparison of habitat changes among complexes varying greatly in size (Rice et al. 2000, Wilcox et al. 2003). The formula we used was as follows: $r = (\ln (N_1 / N_0) / t) \times 100$, where r = rate of change; ln = natural logarithm; N_0 = total area (ha) at time 1; N_1 = total area (ha) at time 0; t = difference (years) between time 1 and time 0, corresponding to the interval 2006 – 1999.

We created GIS-based maps to visually display both current spatial distribution and extent of wetland plant communities within each major wetland complex at Long Point. Despite the quantitative limitations mentioned above, comparison of recent maps with those created by Wilcox et al. (2003) allow for an adequate qualitative assessment of temporal changes in common reed and other wetland vegetation communities between 1999 and 2006. In this report,

we have presented digital habitat maps depicting both the 1999 (courtesy of Wilcox et al. 2003) and 2006 distributions of common reed and other wetland plant communities.

Results

Turkey Point Marsh – Cattail was estimated at 798 ha and made up 73% of the total marsh area, making it the most dominant vegetation community within the Turkey Point Marsh complex (Table 1, Figure 1). Open water, mainly boat channels and ponds of various sizes, made up 153 ha or 14% of the total marsh area (Table 1). Trees / dry upland habitat (62 ha) and built-up area (1 ha) comprised 6% and less than 1% of the total marsh area, respectively.

Common reed was present on 79 ha of marsh, which accounted for about 7% of the total area of the Turkey Point Marsh complex during 2006 (Table 1). Common reed was widely distributed within the marsh interior, mainly along the edges of channels and large open water areas, plus along the southern and southwestern edges of the marsh adjacent to and also where it interfaces with Inner Long Point Bay (Figure 1). Abundance and distribution of common reed was not documented in this marsh complex in 1999, so there is no data available to assess temporal changes in abundance or distribution.

Big Creek Marsh – During 2006, the Big Creek Marsh complex was dominated by emergent vegetation (mainly cattail, graminoids, and sedges), which were estimated to make up 792 ha or 66% of the total marsh area (Table 2, Figure 2). Open water, trees / dry uplands, and built-up area were much less abundant (36 – 192 ha) and comprised much smaller percentages (3 – 16%) of the total marsh area (Table 2).

In 2006, there was an estimated 76 ha of common reed, which accounted for 7% of the total area, within the Big Creek Marsh complex (Table 2). In 1999, the amount of common reed present in the marsh was considerably lower, thus the increase from 3 ha in 1999 to 76 ha in 2006 represents an increase of about 48% per year or an absolute increase in area of about 12 ha per year. This marsh complex had the highest annual rate of increase between 1999 and 2006.

Between 1999 and 2006, common reed has increased, plus has spread and become more widely distributed throughout the Big Creek Marsh complex. During 1999, there were only small, localized stands of common reed, most of which occurred in the eastern end of the complex (Figure 2). During 2006, this plant was much more widely distributed throughout the marsh complex, with larger stands occurring in the east end of the marsh and smaller stands located generally to the west (Figure 2).

Crown Marsh – The Crown Marsh in 2006 contained 280 ha of cattail, which comprised 48% of the total marsh area, making it the most dominant vegetation type. Built-up area, mixed emergents, open marsh meadow, open water, and tree/dry upland, made up about 16%, 9%, 7%, 7%, and 3%, respectively (Table 3).

There were 56 ha of common reed, making up 10% of the total area, in the Crown Marsh during 2006. In 1999 there was 8 ha of common reed, thus the 48 ha increase between that year and 2006 represents a 7 ha per year growth rate and an annual increase of 27.8%. Between 1999 and 2006, common reed has expanded its distribution, but mainly within the southwestern portion of

the marsh; established stands have become more extensive and new stands have developed along the interface with Inner Long Point Bay and well into the marsh interior of the west end (Figure 3). Thus, both abundance and distribution of common reed have greatly increased between 1999 and 2006 in the Crown Marsh.

Long Point Company Marsh – During 2006, there was 1,211 ha of cattail, which comprised 47% of the total area, in the Long Point Company Marsh complex (Table 4). Open water was the second most dominant habitat feature and accounted for about 38% (970 ha) of the total marsh area, whereas open marsh meadow, shrub / sparse land, trees / dry upland, and built-up area were less dominant features that individually made up between less than 1% and 3% of total marsh area (Table 4).

Despite recent control efforts, common reed had an area of 212 ha and comprised 8% of the total marsh area, making it the third most dominant habitat type within the Long Point Company Marsh during 2006 (Table 4). There was 126 ha more common reed present in 2006 as compared to 1999, which represented an increase of 12.9% per year (Table 4). Common reed appears to be much more widely distributed throughout the marsh complex in 2006 as compared to 1999 (Figure 4). Between 1999 and 2005, previously established stands of common reed increased in size and several new stands have become established along the southern marsh edge (adjacent to Lake Erie), plus many relatively smaller stands have become established within the central marsh interior and along the northeastern (Outer Long Point Bay) edge of the marsh (Figure 4). These findings indicate that both abundance and distribution of common reed have greatly increased in the Long Point Company marsh between 1999 and 2006.

Tip of Long Point – In 2006, trees/savannah/sedge meadow occurred on 1,841 ha or 57% of the total area of the tip of Long Point (Table 5). There was 526 ha (16% of the total area), of cattail/bulrush (emergent aquatic vegetation), 451 ha (9% of total area) of open water, and 149 ha (5% of total area) of built-up area at the tip of Long Point (Table 5).

There were 289 ha, which made up 14% of the total area, of common reed that occurred at the tip of Long Point during 2006. In 2006, there was 262 ha more common reed present than in 1999, which resulted from a 37 ha per year increase in the absolute amount of the plant or a relative increase of 33.9% per year (Table 4). This marsh complex had the largest absolute increase and second highest relative annual rate of increase in common reed between 1999 and 2006.

Discussion

Overall, our results show that common reed abundance and distribution between 1999 and 2006 has increased considerably within the Big Creek Marsh, Crown Marsh, Long Point Company Marsh, and wetlands associated with the tip of Long Point. Wilcox et al. (2003) showed that earlier major increases in common reed abundance at Long Point generally coincided with the invasion of a cryptic, non-native genotype and declining Lake Erie water levels, which provided new habitat and ideal growing conditions for the plant during the mid- to late-1990s. Since 1999, Lake Erie water levels have remained below long-term average levels (Canadian Hydrographic Service, unpublished data). It appears that established stands of this non-native strain of common

reed have continued to experience favorable growing conditions thereby furthering its growth and expansion into new areas and habitats within the marsh complexes at Long Point.

Common reed, because of its invasive tendencies and rapid growth and expansion in recent years, is becoming an increasingly dominant vegetation community within major marsh complexes at Long Point. In 2006, for example, we found that common reed occupied from 7% to 14% of the total area within four major wetland complexes at Long Point. As common reed becomes more dominant there is increased potential for it having adverse impacts on native (or rare) wildlife and plants. Evidence suggests that expansion of common reed into adjacent habitats and/or its establishment of dense monocultures may reduce wildlife species diversity and abundance (Benoit and Askins 1999, Able and Ragan 2000, Fell et al. 2003, Meyer 2003, Weis and Weis 2003). Several studies have shown that common reed can replace native plant communities (Farnsworth and Meyerson 1999, Keller 2000, Wilcox et al. 2003), which is of particular concern at Long Point where there are several rare species and habitats/communities (COSEWIC 2006).

For many years, scientists, resource managers, hunting marsh managers, and some of the public/marsh users have been concerned about the expansion of common reed in several of Long Point's marshes, including the Crown Marsh (Anonymous 2007). This concern mainly stems from historic changes observed in habitat and wildlife within some of the marsh complexes at Long Point (Badzinski et al. 2006, Anonymous 2007), plus predictions of short and longer-term anticipated changes in climatic conditions, and the potential indirect impacts on coastal wetlands, within the region. Some climate change models (and scenarios) for the Great Lakes region, for example, predict lowered lake levels and reduced amplitude (more stable) in seasonal and longer-term fluctuations in lake water levels (Mortsch 1998, Mortsch and Quinn 1996), which are conditions that likely would facilitate future common reed invasions and its expansion within Great Lakes coastal marsh habitats.

More recently, there has been increasing recognition and acceptance among scientists and resource managers that management/control of common reed is needed within some Great Lakes coastal wetlands in order to mitigate effects and/or to rehabilitate marsh habitats in some areas (Anonymous 2007). The quantitative and compelling evidence presented in this study (i.e., the substantial and extensive increases in common reed that have been occurring at Long Point since the late 1990s) should provide the impetus needed to garner additional support from the resource management community (and the public) to initiate formal plans for management/control of common reed at Long Point and other important Great Lakes coastal wetland complexes (e.g., Rondeau Bay, Lake St. Clair).

Continued monitoring and periodic assessment of the abundance and distribution should be included as a major part of any formal management plan for common reed. Doing so will better enable managers to identify the best or most effective areas within wetlands to apply management activities. Monitoring before and after employment of management activities will allow for an assessment of their short- and long-term effectiveness, thereby ultimately providing a measure for the overall success of any formal management drafted for controlling this plant within Long Point's marshes.

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Table 1. Estimates for area (ha), percent of - total area, and percent annual change of major habitat types within the Turkey Point Company Marsh in 2006.

	2006	
Habitat type	Area (ha)	% area
Common reed	79	7
Cattail	798	73
Trees / dry upland	62	6
Built-up area	1	< 1
Open water	153	14

Table 2. Estimates for area (ha), percent of total area, and percent annual change of major habitat types within the Big Creek Marsh from 1999 to 2006.

Habitat type	1999	2006		
	Area (ha)	Area (ha)	% area	% change/yr
Common reed	3	84	7	+ 47.6
Cattail/blue joint/sedge	845	792	66	− 1.0
Trees / uplands	80	96	8	+2.6
Built-up	51	36	3	− 5.0
Open water	269	192	16	

Table 3. Estimates for area (ha), percent of total area, and percent annual change of major habitat types within the Crown Marsh from 1999 to 2006.

	1999[a]	2006		
Habitat type	Area (ha)	Area (ha)	% area	% change/yr
Common reed	8	56	10	+ 27.8
Cattail (*Typha* spp)	227	280	48	+ 3.0
Mixed emergents	47	53	9	+ 1.7
Open meadow	57	44	7	− 3.7
Trees/dry land	7	15	3	+ 10.9
Built-up	98	97	16	− 0.1
Open water	141	39	7	

[a] Data from Wilcox et al. 2003; methodological differences between studies preclude comparison of 1999 and 2006 open water areas.

Table 4. Estimates for area (ha), percent of total area, and percent annual change of major habitat types within the Long Point Company Marsh from 1999 to 2006.

	1999	2006		
Habitat type	Area (ha)	Area (ha)	% area	% change/yr
Common reed	86	212	8	+12.9%
Cattail	947	1,211	47	+ 3.5
Open meadow	176	55	2	− 16.6
Shrub / sparse land	132	71	3	− 8.9
Trees / dry upland	76	89	3	+ 2.3
Built-up area	5	14	<1	+ 14.7
Open water	1,128	970	38	

Table 5. Estimates for area (ha), percent of total area, and percent annual change of major habitat types within the tip of Long Point from 1999 to 2006.

	1999	2006		
Habitat type	Area (ha)	Area (ha)	% area	% change/yr
Common reed	27	289	14	+33.9
Cattail/bulrush	541	526	16	− 0.4
Trees/savannah/sedge	1804	1841	57	+ 0.3
Built-up	164	149	5	− 1.4
Open water	547	451	9	

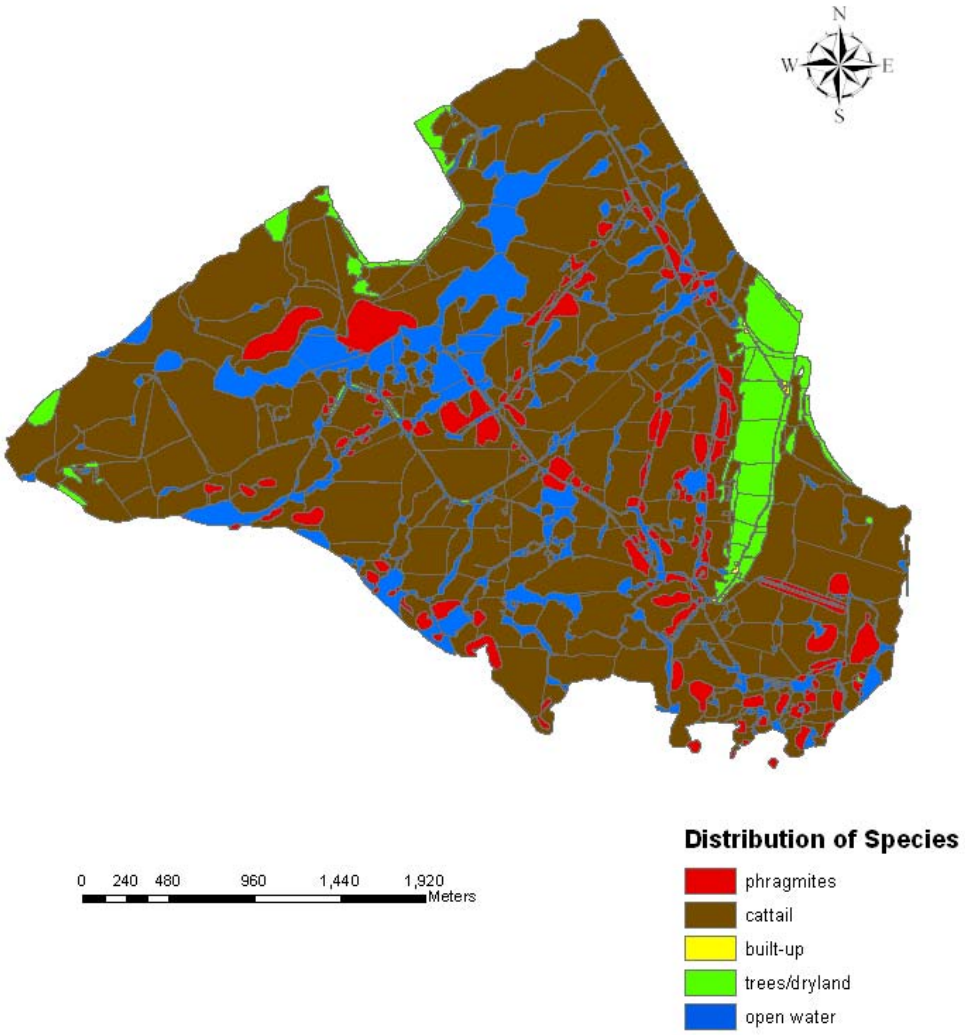


Figure 1. Spatial distribution and relative abundance of common reed (*Phragmites australis*) (red) during 2006 in the Turkey Point Marsh at Long Point – Lake Erie.

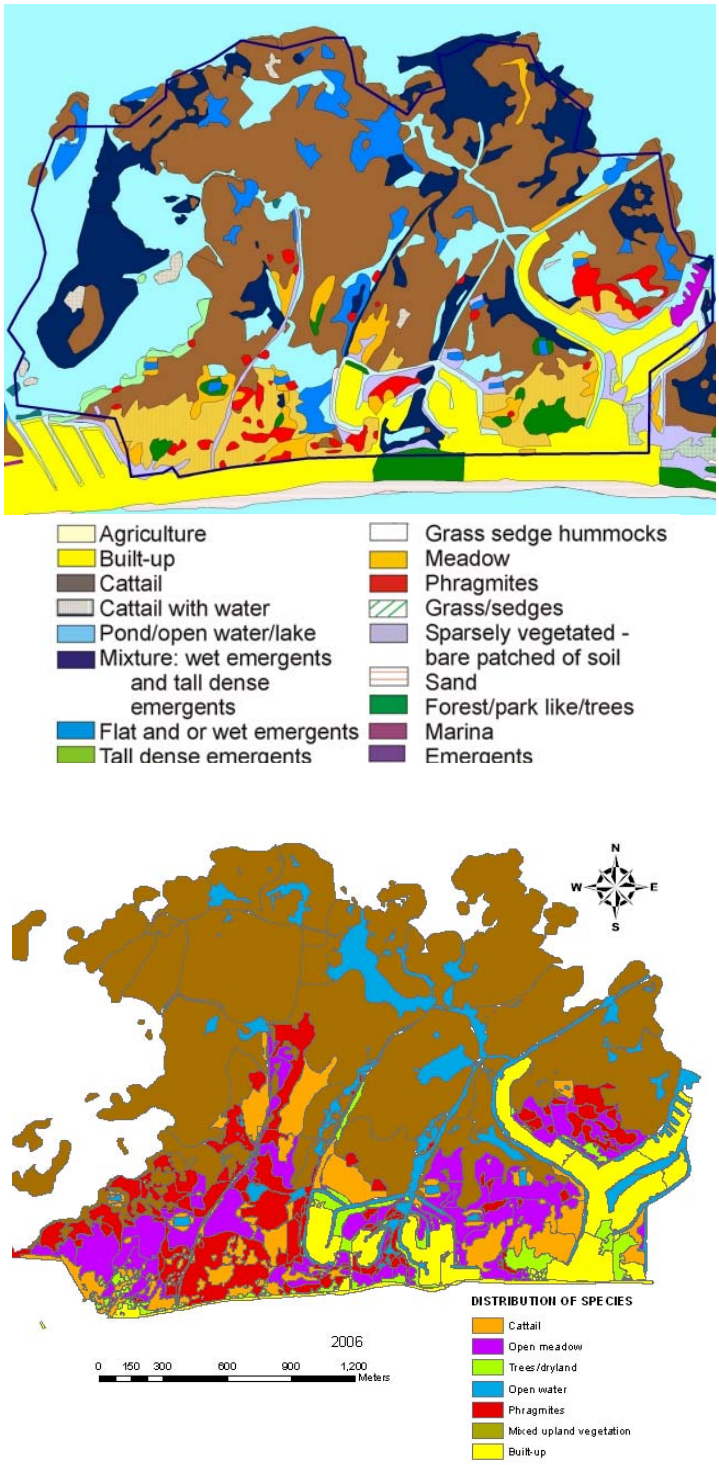
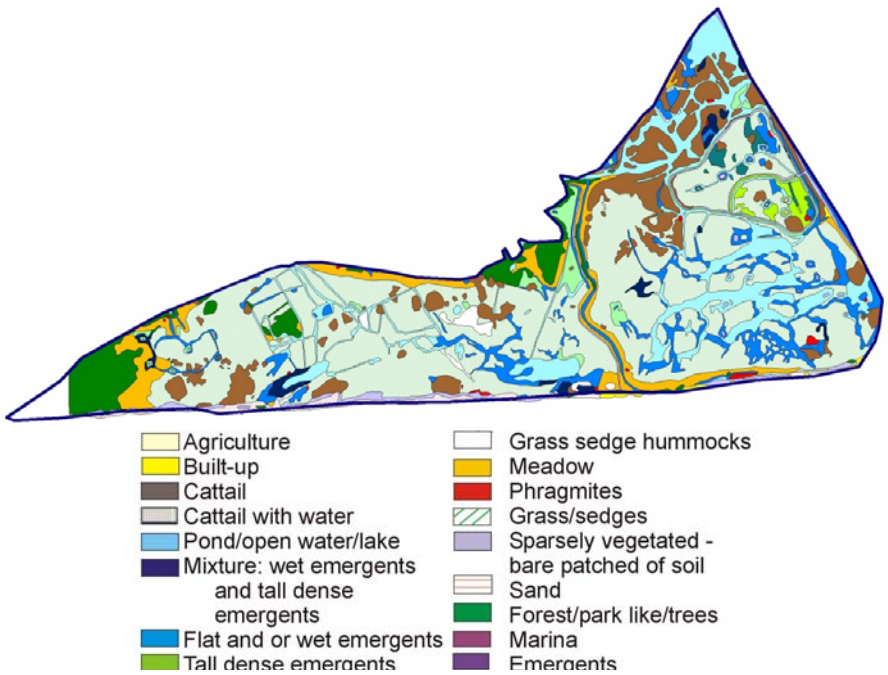


Figure 2. Spatial distribution and relative abundance of common reed (*Phragmites australis*) (red) during 1999 (top; from Wilcox et al. 2003) and 2006 (bottom) in the Crown Marsh at Long Point – Lake Erie.



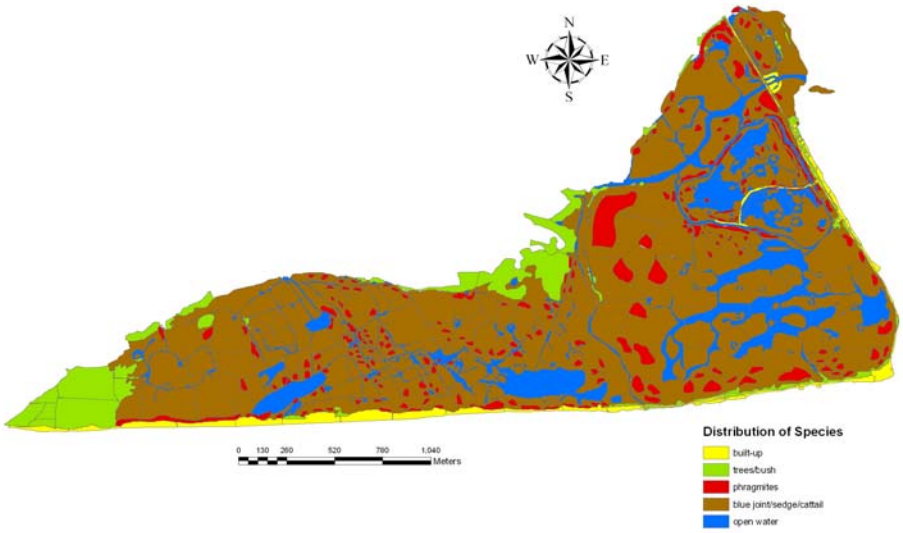


Figure 3. Spatial distribution and relative abundance of common reed (*Phragmites australis*) (red) during 1999 (top; from Wilcox et al. 2003) and 2006 (bottom) in the Big Creek Marsh at Long Point – Lake Erie.

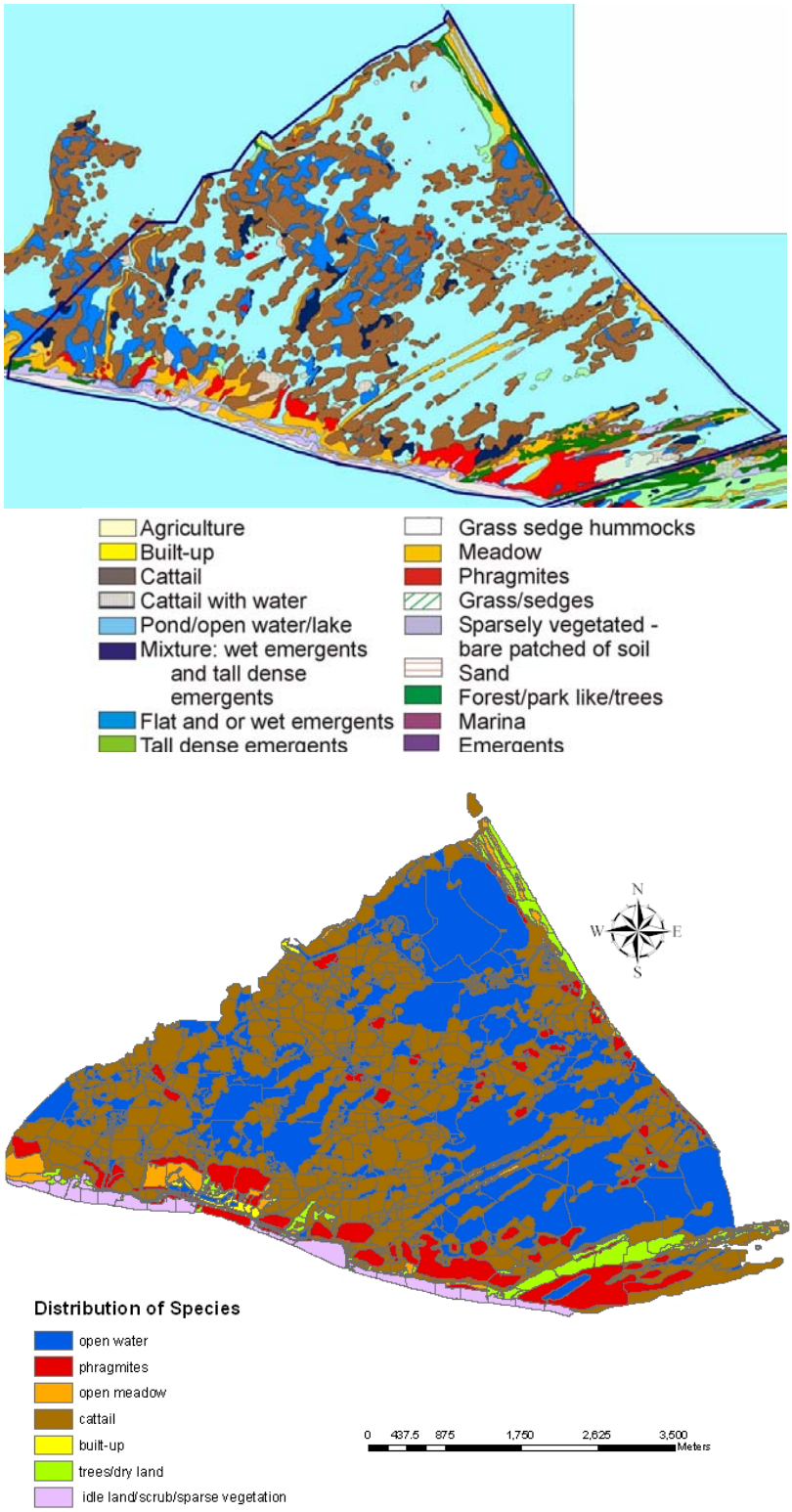


Figure 4. Spatial distribution and relative abundance of common reed (*Phragmites australis*) (red) during 1999 (top; from Wilcox et al. 2003) and 2006 (bottom) in the Long Point Company Marsh at Long Point – Lake Erie.

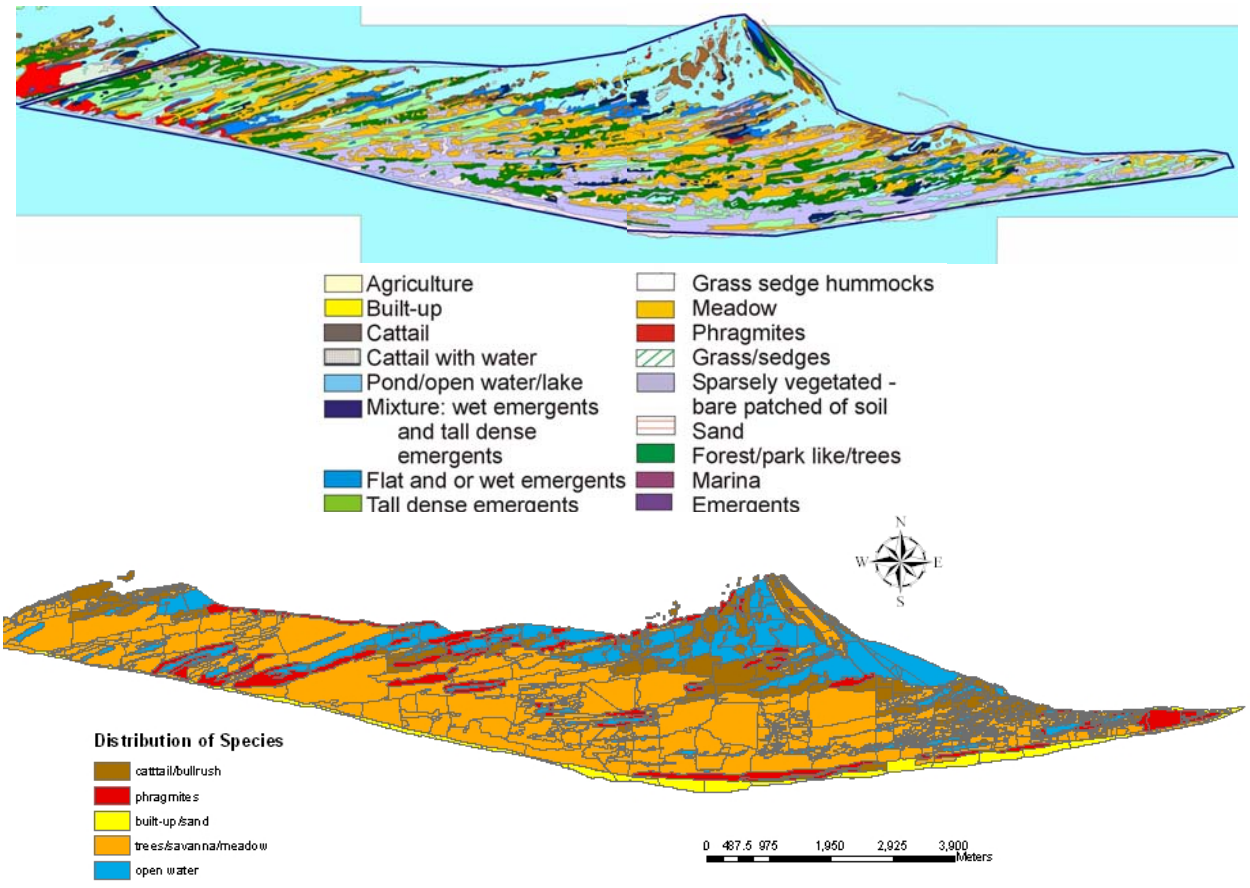


Figure 5. Spatial distribution and relative abundance of common reed (*Phragmites australis*) (red) during 1999 (top; from Wilcox et al. 2003) and 2006 (bottom) in wetlands at the tip of Long Point – Lake Erie.