Investigation and Long-Term Monitoring of *Phragmites australis* at Long Point, Lake Erie, Ontario

Principal Investigators: Kerrie Wilcox, LPWWRF Researcher
Scott Petrie, LPWWRF Research Director

***PHRAGMITES* -What is it?**

Phragmites australis is a tall emergent grass, commonly known as 'giant reed' or 'common reed'. It is one of the most widely distributed plants in the world, occurring in every continent except Antartica. In North America, *Phragmites* is widespread, typically growing in marshes, swamps, fens and prairie potholes. There is evidence that *Phragmites* has been present in North America for at least 3500 years in North America (Breternitz et al. 1986; Kane and Gross 1986). *Phragmites* is highly variable - having at least 42 different phenotypes. *Phragmites* generally has annual cane like shoots that reach heights of 2 to 4m and disperses by seeds or rhizome fragments (Marks et al. 1999). Rhizomes are responsible for renewing and maintaining the population; a single plant spreads at a rate of 1-2m per year. The dead canes remain standing for 3 to 4 years before becoming part of the slowly decomposing litter layer. The biomass of the dead canes may exceed that of living shoots resulting in thick mats that even new *Phragmites* shoots can not penetrate (Haslam 1971a).

Recent Changes in *Phragmites* Distribution in North America

The expansion of *Phragmites australis* throughout Gulf and Atlantic Coast marshes has become a conservation concern in the past 30 years. Invasions typically follow disturbances or stresses such as an altered hydrologic regime, dredging or increased nutrient availability. However, recent *Phragmites* invasions may be the result of a more invasive genotype(s) from Europe or may be related to warmer, drier climatic conditions.

Possible Impacts of the Spread of *Phragmites* at Long Point

The spread of monodominant stands of *Phragmites* may be a threat to important food resources and habitat for waterfowl, fish and other wildlife. Benoit and Askins (1999) looked at the impact of *Phragmites* on the distribution of birds in tidal wetlands in Connecticut. Study plots in short grass meadows, and short Saltmarsh Cordgrass, (*Spartina alterniflora*) had a wide variety of species including waders, shorebirds and ducks, *Phragmites* dominant stands were lacking ducks, herons, egrets, terns and sandpipers entirely. Moller (1975) reported that part of a Danish marsh overgrown with *Phragmites* had greatly reduced numbers of ducks and waders, and that gulls and terns were absent.

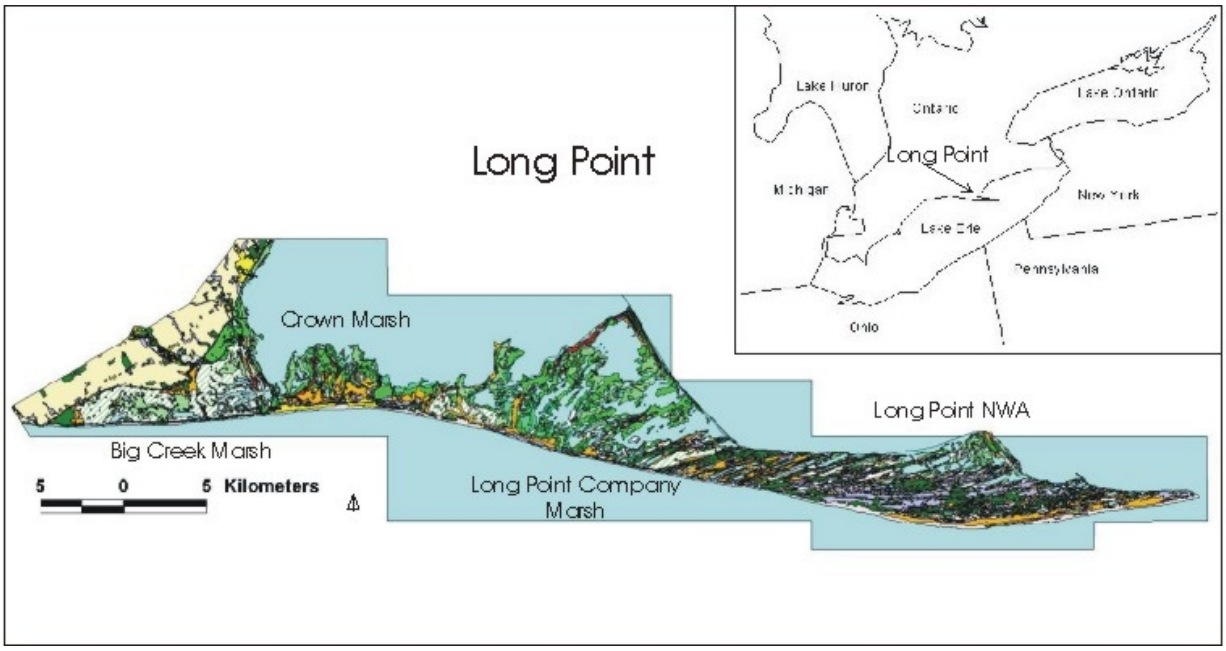

Figure 1. Long Point Marshes, Lake Erie, Ontario

At Long Point, the spread of *Phragmites* may be problematic because of the relatively pristine state of Long Point Bay, and its importance for migratory birds. Long Point is a 35km sandspit extending into the eastern basin of Lake Erie. This spit partially encompasses and protects a large shallow water area from the wave action of Lake Erie. This facilitated the formation of 24,000 ha of wetlands, and a 280,000ha embayment, the Inner Bay. The Inner Bay and its associated wetlands are considered to be the most important staging habitat on the lower Great Lakes, as well as one of the most important migratory stopover areas for waterfowl in eastern North America (Dennis et al. 1984; Prince et al. 1992; Pauls and Knapton 1993; and Petrie 1998). During peak migration, Long Point supports single day totals of over 200,000 waterfowl (Petrie 1998).

Our Objectives

Despite the concern regarding this invasive species, no study has measured or documented the current distribution or expansion rate of *Phragmites* on any Great Lake coastal wetlands. The purpose of this study is to; 1) map the current distribution of *Phragmites* at Long Point, 2) determine the expansion rate of *Phragmites*, and 3) relate these findings to Lake Erie water levels and air temperatures.

Methods

Aerial photos of Long Point were taken at a scale of 1:10,000 in June, 1999. We followed the methods used by the Canadian Wildlife Service (Snell and Cecil Environmental, 1992) to interpret and classify vegetation. Community types and boundaries were recorded with a grease pencil directly onto the aerial photographs and field checked during August and September, 1999. Wetland communities were than transferred onto clear plastic 1:10,000 Ontario Base Maps. This step was essential to obtain ground control points (GCPs). GCPs are required before entry into a Geographic Information System (GIS). The vegetation communities were then digitized using GIS software. Historical aerial photographs (1964, 1985, 1995) were interpreted and transferred to Ontario Base Maps by Snell and Cecile Environmental Research, (1992) as part of a larger study on wetland change in the Great Lakes. Each year was overlaid on the previous year to detect real changes in community size and type. Historical communities were input into GIS by Andrea Hebb at the Environment Canada Atmospheric Adaptation Centre, Faculty of Environmental Studies, University of Waterloo.

ArcView was used to calculate the total area colonized by *Phragmites* for each year. Area changes between time periods were further analyzed using a geometric or logarithmic growth equation following Rice et al. (2000). The following logarithmic growth equation was used.

$$N=N_0e^{rt}$$

The known terms of the equation were defined as follows:

N = Total area at time 1
N_0 = Total area at time 0
e = A constant, 2.718281828m the base of the natural logarithm
t = Difference (years) between time 1 and time 0.

The equation was solved for r:

= the intrinsic rate of natural increase per year.

PreliminaryResults

Phragmites Distribution and Abundance 1945-1999: In 1945 there was 54.1 ha of *Phragmites* in the 22,229 ha Long Point study area (Figure 2). Several small stands were located in the Big Creek National Wildlife Area, no *Phragmites* was distinguished from the aerial photography in the Crown Marsh, numerous large stands were located in the Long Point Company Marsh, and only a few small stands were located in the Long Point National Wildlife Area (NWA). By 1964, *Phragmites* had increased in abundance to 69.5ha and the largest stands had shifted and were located in interior areas of the Crown Marsh and the western shore of the Company Marshes. One large stand (5ha) was located in the Big Creek Marsh and very little *Phragmites* occurred in the Long Point NWA (Fig. 6). The rate of increase in *Phragmites* abundance between 1945 and 1964 was 0.013/yr. By 1985, *Phragmites* abundance had declined dramatically to less than 4ha. The growth rate between 1964 and 1985 was (-0.14/yr). The largest stands previously observed in the Crown and Company Marshes had disappeared by 1985, whereas a few small stands remained in the Big Creek Marsh.

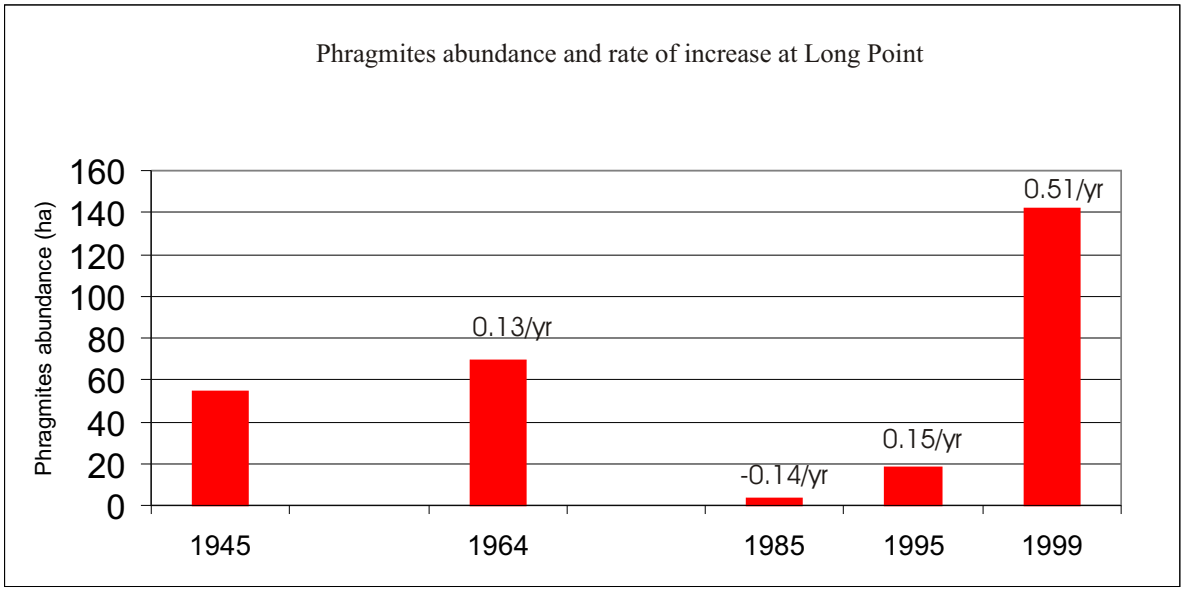

Figure 2. Phragmites abundance and rate of increase 1945-1999.

Phragmites abundance increased to 18ha by 1995 (0.15/yr); a number of small scattered stands occurred in the Big Creek and Crown Marsh, whereas *Phragmites* had shifted to the southern portions of the Long Point Company Marsh (see figure 3) and the Long Point NWA. *Phragmites* increased exponentially between 1995 (18 ha) and 1999 (142 ha)(0.51/yr). Within the Big Creek Marsh only a few small *Phragmites* stands occurred, most of which were located along the raised dykes. The Crown Marsh supported numerous variously sized *Phragmites* stands, whereas the Long Point Company Marsh and Long Point National Wildlife Area supported extensive stands which were located primarily along the southern portions of the Point in what was identified as meadow or cattail habitat in 1995.

The primary species/communities that were replaced by *Phragmites* between 1995 and 1999 were marsh meadow (32.7%), *Typha* spp. (32.0%), other mixed emergents (7.7%), sedge/grass hummock (9.9%), open water (5.5%), transition between sand and vegetation (2.2%), scrub (1.6%), sand (1.1%), and mixed grassland/woodland (1.1%) .

Influence of water levels and ambient temperature: - Lake Erie experienced large fluctuations in water levels and ambient air temperature throughout the study time period (1945-99). Although it was insignificant (P = >0.05), present years water level was negatively correlated with *Phragmites* abundance (r = -0.537), whereas *Phragmites* abundance was positively correlated with current years temperature (r = 0.576, P>0.05).

Preliminary Conclusions

1) *Phragmites australis* was present in 1945, 1964, 1985, 1995 and 1999, but the abundance of it has fluctuated over time.

2) *Phragmites* abundance was negatively correlated with Lake Erie water levels

3) A positive correlation was found between ambient air temperatures and *Phragmites* abundance

4) *Phragmites* expansion in the past 4 years was exponential (0.51 yr) - reasons for the rapid growth are unclear but lower water levels and a warmer climate may explain the change.

5) The primary species/communities that were replaced by *Phragmites* between 1995 and 1999 were marsh meadow (33%), typha spp. (32%), other mixed emergents (8%), sedge/grass hummock (10%), and open water (5.5%)

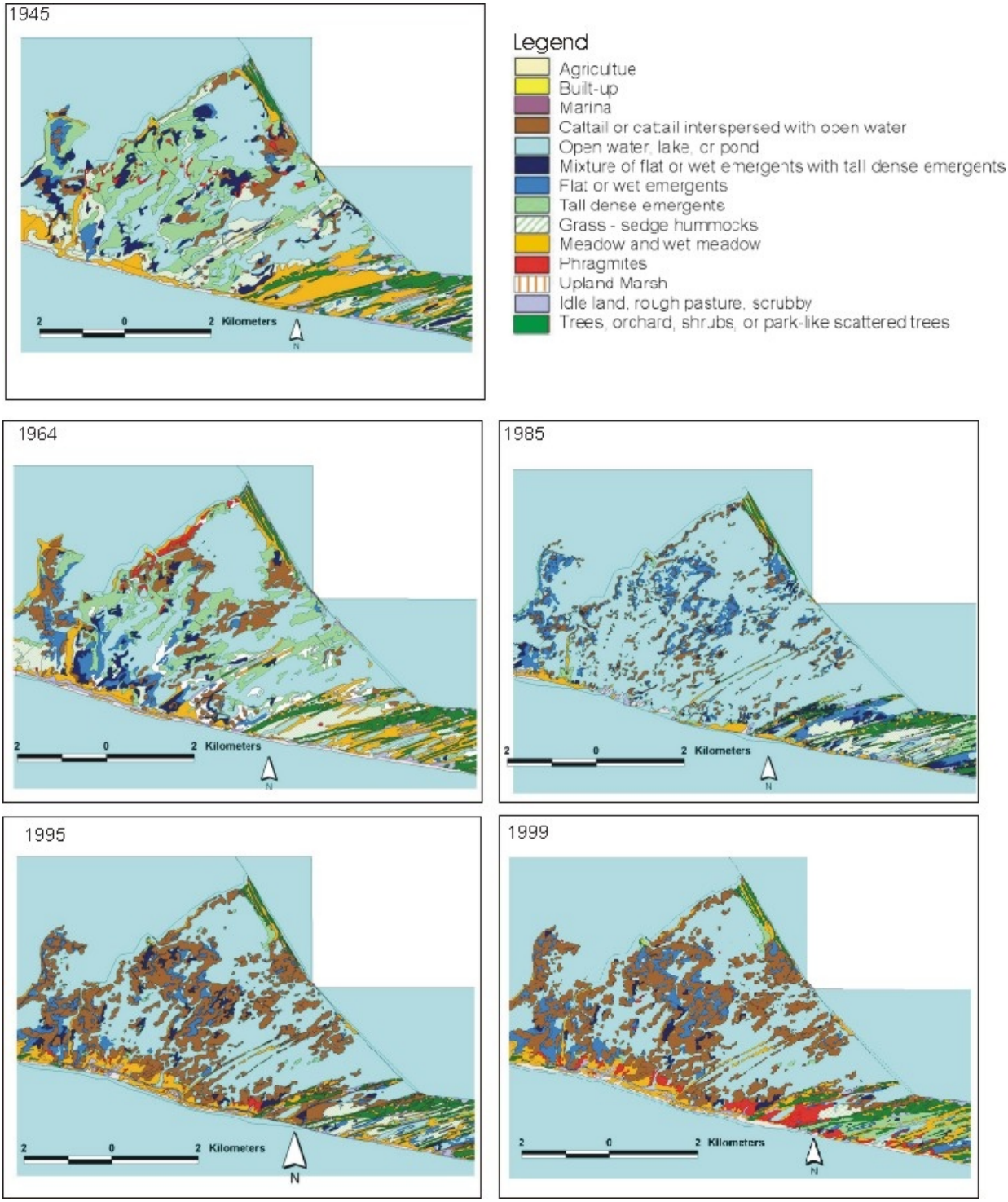

Figure 3. Phragmites distribution in the Long Point Company Marsh

5) Given the relation between *Phragmites* abundance and both temperature and water depth, we suggest that, if global warming predictions are realized, *Phragmites* will continue to expand on the lower Great Lakes.

Acknowledgements

Funding for the Long Point Waterfowl and Wetlands Research Fund's Phragmites research program has been provided by the Waterfowl Research Foundation, Eastern Habitat Joint Venture, the Trillium Foundation, the Fuller Foundation, and LPWWRF through funding provided by the Bluff's Hunt Club. Thanks to Lynda Mortsch and Andrea Hebb (Environment Canada Atmospheric Adaptation Centre) for providing historical GIS coverage of Long Point, Liz Snell (Snell and Cecile Environmental Research) for providing assistance and advice on aerial photo interpretation, and Bill Baskerville (Long Point Region Conservation Authority) for providing digitizing advice and use of GIS facilities.

References

Benoit, L.K. and R.A. Askins. 1999. Impact of the spread of *Phragmites* on the distribution of birds in Connecticut Tidal Marshes. Wetlands. 19:194-208.

Breternitz, D.A., C.K. Robinson, and G.T. Gross. 1986. Dolores archaeological program; final synthetic report. U.S. Department of the Interior, Bureau of Reclamation, Denver. As cited in Marks et al. 1994.

Canadian Hydrographic Service, Department of Fisheries and Oceans. Waterlevel Data.

Chambers, R.M., Meyerson, L.A., and K. Saltonstall. 1999. Expansion of *Phragmites australis* into tidal wetlands of North America. Aquatic Botany. 64: 261-273.

Dennis, D.G., McCullough, G.B., North, N.R., and R.K. Ross. 1984. An Updated assessment of migrant waterfowl use of Ontario shorelines of the southern Great Lakes. Pages 37-42 in Waterfowl Studies in Ontario, S.G. Curtis, D.G. Dennis and H. Boyd, editors. Canadian Wildlife Service Occasional Paper No. 54.

Haslam, S.M. 1971a. Community regulation in Phragmites communis Trin. 65-73.

Haslam, S.M. 1971b. The performance of *Phragmites communis* in relation to water supply. Ann. Bot. 34:867-877.

Haslam, S.M. 1969. The development of annual population in *Phragmites communis* Trin. Ann. Bot. 34:571-91.

Kane, A.E., and G.T. Gross. 1986. Anasazi Communities at Dolores: Early Anasazi Sites in the Sagehen Flats Area. Denver, CO, USA.

Marks, M., B. Lapin and J. Randall. 1999. Element Stewardship Abstract for *Phragmites australis*. The Nature Conservancy. Arlington, Virginia 22209.

Moller, H.S. 1975. Danish salt marsh communities of breeding birds in relation to different types of management. Ornis Scandinavia 6: 125-133. In Benoit, L.K., and R.A. Askins. 1999. Impact of the spread of *Phragmites* on the distribution of birds in Connecticut Tidal Marshes. Wetlands. 19:194-208.

National Oceanic and Atmospheric Administration. Temperature Data for Erie, Pennsylvania.

Niering, W.A. and R.S. Warren. 1980. Vegetation patterns and processes in New England salt marshes: BioSci. 30:301-307.

Pauls, K. and RW. Knapton 1993. Submerged macrophytes of Long Point's Inner Bay: their distribution and value for waterfowl. Long Point Environmental Folio Publication Series, Technical Paper 1. J.G. Nelson and P.L. Laurence, editors. Heritage Resources Centre, University of Waterloo, Waterloo, Ontario.

Petrie, S.A. 1998. Waterfowl and Wetlands of Long Point Bay and Old Norfolk County. Norfolk Land Stewardship Council, Simcoe, Ontario. Unpublished Report. 181 pp.

Prince, H.H., P.I. Padding, and R.W. Knapton. 1992. Waterfowl use of the Laurentian Great Lakes. Journal of Great Lakes Research. 27:5.

Rice, D. Rooth, J., and J.C. Stevenson. 2000. Colonization and expansion of *Phragmites* australis in Upper Chesapeake Bay Tidal Marshes. Wetlands 20: 280-299.

Snell and Cecile Environmental Research. 1992. Historic coastal wetland mapping study: Part 1 Vegetation Community Mapping for Six Lower Great Lakes Wetlands. Final Report for International Joint Commission Great Lakes- St. Lawrence River Levels Reference Study Board Working Committee 2.

Thao, L., White, D.A., and D.P. Hauber. 1994. *Phragmites australis* clones within Baptis Collete subdelta of the Missippi River: their morphological differences. Abstract. Amer. J. Bot. 81: 64.

Thompson, D.J. and J.M. Shay. 1984. The effects of fire on *Phragmites australis* in the Delta Marsh, Manitoba. Can. J. Bot. 63:1864-1869.

Thompson, D.J. and J.M. Shay. 1989. First-year response of a *Phragmites* marsh community to seasonal burning. Can. J. Bot. 67:1444-1455.

Tucker, G.C. 1990. The genera of Arundinoideae (Gramineae) in Southeastern United States. J. Arn. Arb. 71: 146-177.

Walmsley, David. May 2001. Warden Long Point Company Marsh. Personal Communication.

Wilcox, K. 1994. Planning for Waterfowl in Long Point Inner Bay. MES. Thesis. University of Waterloo, Waterloo, Ontario.

Wilcox, K, and R. Knapton, 1994. An ecosystem approach to management of an internationally significant waterfowl staging area: Long Point's Inner Bay. Long Point Environmental Folio Series. Technical Paper 5. J.G. Nelson and P.L. Lawrence, editors. Heritage Resources Centre, University of Waterloo, Waterloo, Ontario.

Wilson, E.O., and W.H. Bossert. 1971. A Primer of Population Biology. Sinauer Associates, Inc., Stamford, CT, USA.