A paleoecological assessment of *Phragmites australis* in New England tidal marshes: changes in plant community structure during the last few millennia

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Abstract

Although *Phragmites* has been an upper border tidal marsh species for thousands of years, it is only recently (within the last century or so) that the distribution of this plant within the coastal marsh community has become prominent. Prior to approximately 100 years ago, *Phragmites* was an upper border/brackish marsh co-dominant in many marsh systems. Occurrence of this species varied between associations of sedges, *Typha*, forbs and a variety of woody shrubs. Paleoreconstructions rarely show the presence of a *Phragmites* monoculture or early associations with salt marsh species. However, since the turn of this century (and perhaps as early as the middle of the last century) the distribution of *Phragmites* has changed substantially. Today, this plant often forms dense monocultures and is commonly found in association with *Spartina* grasses. The results of this paleoecological investigation show that the changes that have been observed in *Phragmites* communities during the last 100 years are not part of the long-term cycle of development in these systems and are new to the landscape.

Introduction

*Phragmites australis* is an important member of the present-day plant community in tidal marshes of New England. Its distribution is extensive and it can be found growing in almost every habitat along the coast including hydrologically restricted systems (i.e., behind dikes and causeways), the estuaries of major rivers (i.e., lower Connecticut River) and the upper border of many non-restricted tidal marsh systems.

During the 1970s, there were suggestions that *Phragmites* might be an introduced species because of what was perceived as its sudden appearance in tidal marsh and roadside habitats. However, as early vegetation surveys (Muhlenberg 1813; Torrey 1826) and more recent paleoecological investigations (Niering et al. 1977; Orson et al. 1987) have shown, *Phragmites* has been a member of the plant community of New England and its surrounding region for thousands of years. The perception that this plant has suddenly appeared on the landscape is, however, understandable. Vegetation surveys conducted in Connecticut (Niering and Warren 1974), New York and New Jersey (Besitka 1996) and Michigan (McNabb and Batterson 1991) all note extensive increases in the occurrence of *Phragmites* during the last one hundred years or so. Such a change in the distribution of this plant could certainly explain the perception that this species only recently appeared in coastal and roadside habitats.

The question of why *Phragmites* has increased in recent times is subject to much discussion. A number of causes may be responsible for the proliferation of *Phragmites* including changes to the environment (i.e., hydrology; Roman et al. 1984) and possible shifts in the genetic structure of the plant community (either direct or through invasive strains; Besitka 1996). It is
also important that we do not overlook the possibility that the changes may be part of a long-term cycle of development within the plant community. In order to address the possibility of a long-term cycle, this paleoecological assessment was undertaken to identify what information is available in the peat record. Specifically, (1) is Phragmites an invasive species in tidal salt marshes of southern New England and (2) is the recent increase in Phragmites part of a long-term cycle of development in these marsh systems or is its present distribution something new to the landscape. The general assessments being presented, herein, are based on a comparison of the occurrence of Phragmites in marshes that existed between 700 and 4000 years ago with those that have developed during the last century.

**Study sites**

The sites included in this report are (from west to east) West River, New Haven, Connecticut; Sybil Creek, Branford, Connecticut; Hammock River, Clinton, Connecticut; Old Saybrook Marsh, Old Saybrook, Connecticut; Pataguanset River, Lyme, Connecticut; Barn Island/Pawcatuck, Stonington/Pawcatuck, Connecticut/Rhode Island, and Waquoit Bay, Mashpee, Massachusetts. All systems included in this analysis are tidal salt marsh systems dominated, now or at one time, by Spartina grasses. Although the tidal range and salinities vary between systems, most of the sites have a tidal range of about 1.0 m (range of 0.8–1.8) and salinities in the range of sea water (20–30 parts per thousand salts). The marshes are all peat dominated and their development extends at least 1 m in depth. Detailed developmental histories of a number of the sites have been published elsewhere (i.e., Orson et al. 1987, 1998; Orson and Howes 1992) and some, like the Barn Island marshes in Stonington, Connecticut have a long history of research associated with the site (i.e., Miller and Egler 1950; Harrison and Bloom 1977; Warren and Niering 1993; Orson et al. 1998) while others, such as Waquoit Bay in Massachusetts, have been the subject of extensive recent research projects (NERR).

Although the exact distribution of species varies by location, the overall structure of the salt marsh plant community follows the same general pattern noted for the New England type tidal marsh (Miller and Egler 1950). Spartina alterniflora dominates the low marsh and bay front borders and a mixture of Spartina patens, Distichlis spicata, Juncus gerardii and a variety of forbs (herbaceous dicots) dominates the high marsh zones. Pannes of stunted S. alterniflora, forbs and algae are common on many of the marsh surfaces and upper border areas include a variety of species including Panicum virgatum, Solidago and Aster spp., Scirpus spp., Iva frutescens, Baccharis halimifolia, Rosa spp. and Phragmites australis.

The systems themselves range from a fairly undisturbed habitat such as the Pataguanset River in Lyme, Connecticut (Orson et al. 1987) to a highly urbanized and restricted system such as the West River in New Haven, Connecticut (Casagrande 1997). Systems also cover a variety of settings from the open embayment found at Barn Island (Orson et al. 1998) to an inlet driven system at Waquoit Bay (Orson and Howes 1992).

**Methods**

The systems included in this analysis have been sampled over a period of 15 years. Sampling at Pataguanset River, Connecticut (Orson et al. 1987), Barn Island, Connecticut (Orson et al. 1998) and Waquoit Bay, Massachusetts (Orson and Howes 1992) were part of larger studies investigating general marsh development processes. Sampling conducted at Sybil Creek Connecticut, Old Saybrook, Connecticut, and Hammock River, Connecticut was part of a restoration assessment conducted during the early 1980s and West River was sampled in 1997 as part of a larger interdisciplinary restoration investigation (Casagrande 1997). The information being present here is a compilation of that data.

Sampling in the systems varied by location. At Pataguanset, the lower estuary marsh was sampled in a 100 m square grid pattern with cores taken at each grid intersection point (Orson et al. 1987, 1998; Orson and Howes 1992) and some, like the Barn Island marshes in Stonington, Connecticut have a long history of research associated with the site (i.e., Miller and Egler 1950; Harrison and Bloom 1977; Warren and Niering 1993; Orson et al. 1998) while others, such as Waquoit Bay in Massachusetts, have been the subject of extensive recent research projects (NERR).