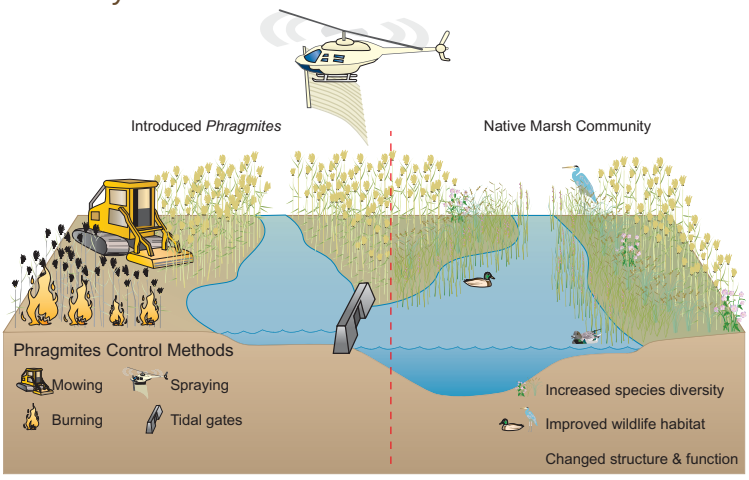
PHRAGMITES:

NATIVE OR INTRODUCED?

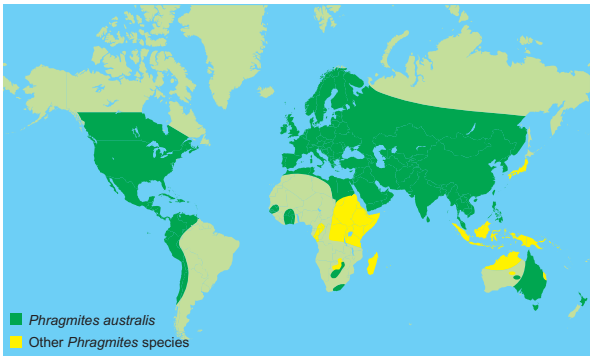

Typical introduced *Phragmites* stand

Over the past century, the distribution and abundance of *Phragmites australis* (the common reed, hereafter *Phragmites*) in North American wetlands has dramatically increased.[1,2] Not only has *Phragmites* increased its dominance in sites where it was historically found, but it has also spread into parts of the United States where it was not found prior to the 20th century. Recent research using molecular markers has demonstrated that although *Phragmites* is native to North America, a non-native lineage of the species has been introduced and is clearly linked to the widespread invasions that have been observed.[1] This lineage is most likely European in origin and first appeared along the Atlantic Coast of North America, probably in the 18th or 19th centuries. Today, *Phragmites* is found across the continent and dominates along the Atlantic Coast where few native populations remain.[2]

Phragmites is thought to be one of the most widespread plants on earth. *Phragmites* is found on every continent except Antartica and is common throughout North America, Europe, and Asia. Over the last 150 years, the distribution of this plant has increased across North America and this invasion has been attributed to factors such as disturbance, shoreline development, pollution, and eutrophication of waterways.[2,3]



Control methods utilized by managers to eradicate Phragmites *(left) and restore diverse marsh communities with native assemblages of plants (right).*



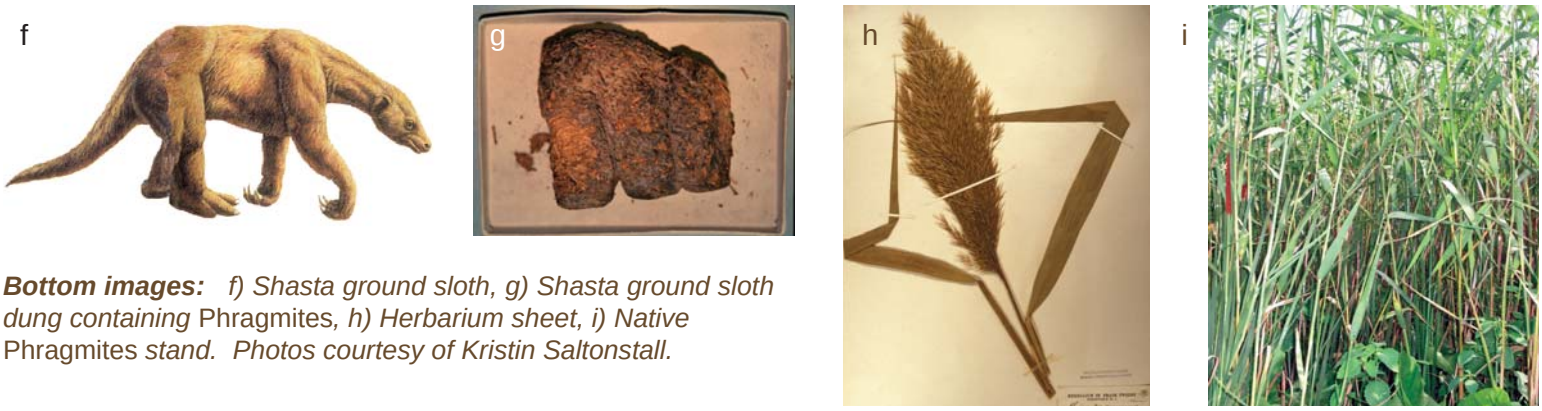
Global distribution of all varieties of Phragmites australis.

Due to its rapid spread and dominance in the marshes in which it invades, *Phragmites* has been actively managed in North American Atlantic Coast marshes for several decades. Such actions have typically included restoring tidal flows, or widespread application of herbicide, fire, and mowing, all of which can have unintended impacts on other plants and animals of the marsh community. Until now, management strategies have been implemented without regard to the native status of different *Phragmites* populations. It has been assumed that all *Phragmites* pose a threat to native biodiversity and will cause negative impacts on the ecosystem as a whole.[4]

PHRAGMITES IS NATIVE TO NORTH AMERICA

Top images: *The Anasazi peoples had several different uses for* Phragmites*: a) cigarettes from* Phragmites *stems, b) mat woven from* Phragmites *leaves, c) arrow shafts, d) prayer stick, e) flutes.*

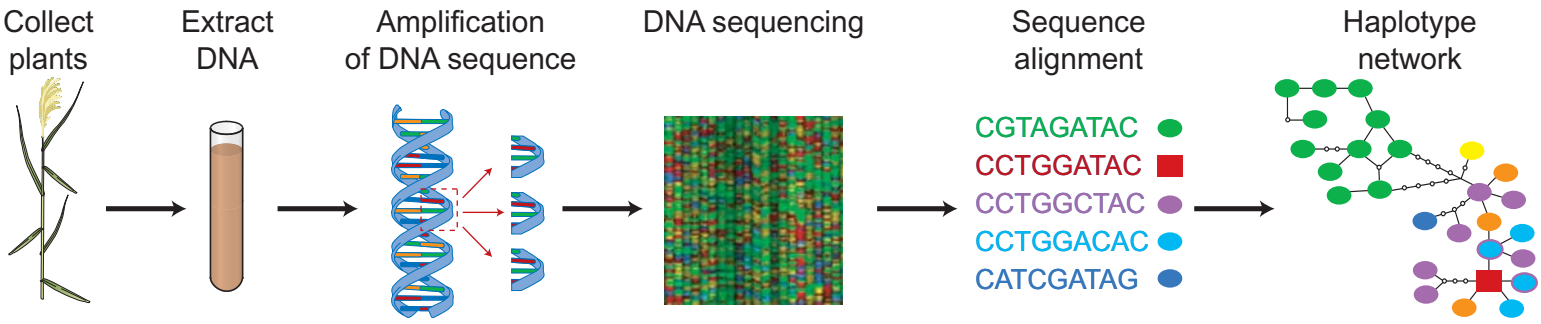
The historical record indicates that *Phragmites* should be considered a native plant. The oldest evidence comes from the Southwest where *Phragmites* remains have been found in preserved Shasta ground sloth dung which dates back 40,000 years. Archeological sites throughout the southwest dating from 600-1400 AD have also found a number of artifacts made of *Phragmites* indicating that during this time period it was also quite common and used by indigenous peoples for a number of purposes. In coastal areas, *Phragmites* rhizomes preserved in peat have been found in many sites, ranging from southern New England to Delaware and also in California. These remains indicate that *Phragmites* has been present in both coastal and inland marshes for thousands of years and certainly before the arrival of Europeans to North America. However, historical populations grew in mixed communities with sedges and forbs and not in monocultures as we commonly see today.[5] Herbarium records from the 1700s and 1800s indicate that *Phragmites* was found across the continent but was rare or not common. However, during the 1900s *Phragmites* became more common across the country, particularly in coastal areas. By the mid-1970s *Phragmites* had been recorded in all of the lower 48 states and across southern Canada.[1]



Bottom images: *f) Shasta ground sloth, g) Shasta ground sloth dung containing* Phragmites*, h) Herbarium sheet, i) Native* Phragmites *stand. Photos courtesy of Kristin Saltonstall.*

HOW DO WE CONDUCT GENETIC ANALYSIS?

Although we know that *Phragmites* is native to North America, changes in its ecology and growth patterns suggest that an exotic strain(s) has been introduced. To examine this further, molecular analyses were conducted to determine if an exotic strain of *Phragmites* has been introduced to North America. Genetic material (DNA: DeoxyriboNucleic Acid) was extracted from green leaf tissues of *Phragmites* plants that were collected worldwide. Genes were amplified using molecular techniques and sequenced. Different *Phragmites* strains were inferred from the different DNA sequences. By analyzing the different sequences a map of genetic relatedness could be created (haplotype network).



INTRODUCED *PHRAGMITES* IS INVADING

Following the collection of 345 different populations of *Phragmites* worldwide, genetic analysis of these populations shows the distribution of particular haplotypes, or variants of *Phragmites* throughout the world.

A total of twenty seven haplotypes were identified, with 11 of them unique to North America (Fig. 1). These 11 haplotypes share five mutations that were not found in individuals collected throughout the rest of the world and are considered to be native North American *Phragmites* haplotypes. Two other haplotypes were also found in North America – haplotypes I and M.

Through genetic analysis of samples of *Phragmites* collected and preserved in herbarium records prior to 1910, it was found that the 11 native haplotypes were historically distributed across North America, except for the southeast

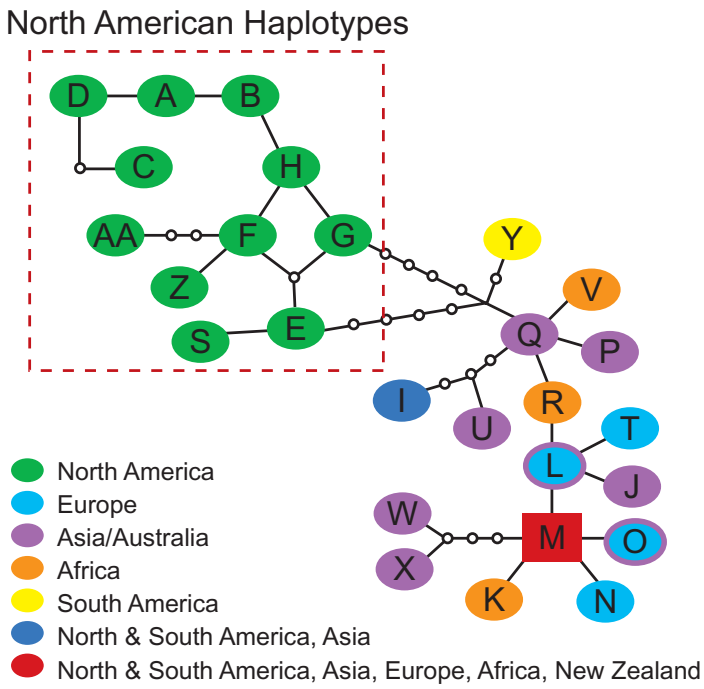


Figure 1: Haplotype network of Phragmites *chloroplast haplotype diversity obtained from sampling 345 populations worldwide. Each link between haplotypes represents one mutational difference, following coding of indels as single characters. Unlabelled nodes indicate inferred steps not found in the sampled populations. (From Saltonstall 2002).*

where *Phragmites* was not found. Haplotype I occurred across the southern states and haplotype M was only found at four sites on the north Atlantic coast (Fig. 2a).

Today, the 11 native haplotypes are still found across much of the continent, but their distribution on the north Atlantic Coast has become very rare. Haplotype I has maintained its historical distribution across the southern states. In contrast, the introduced *Phragmites* (haplotype M) has dramatically increased in distribution, dominating populations across the continent (Fig. 2b).

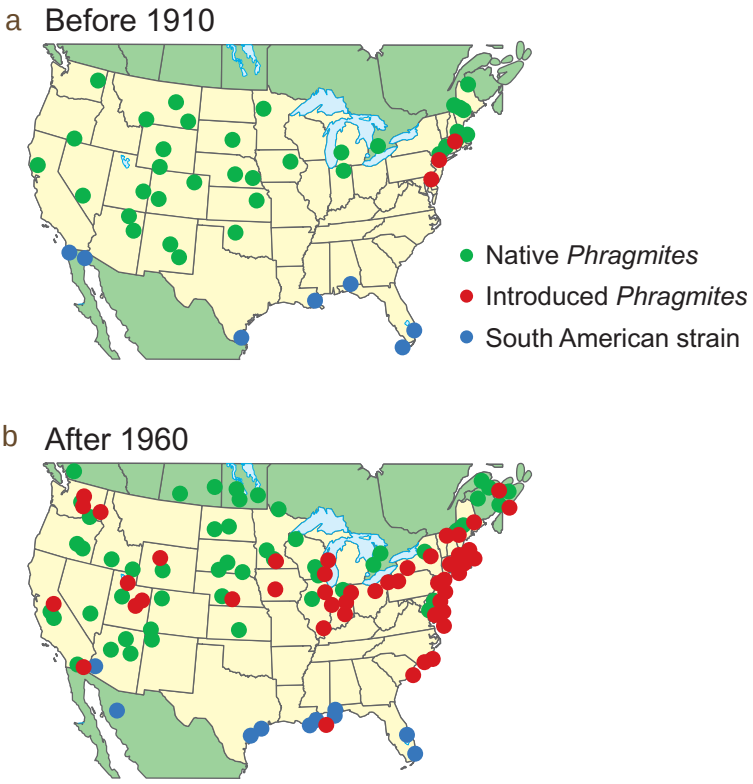


Figure 2: Distribution of Phragmites *haplotypes in North America. Green circles represent the 11 native haplotypes, blue circles are Haplotype I, and red circles represent the invasive Haplotype M. a) distribution of haplotypes in the 62 herbarium samples collected before 1910. b) distribution of haplotypes in 195 samples collected after 1960 (From Saltonstall 2002).*

An exotic strain of *Phragmites* was probably introduced to North America from Europe, sometime during the early part of the 19th century, most likely at one or more coastal ports along the Atlantic coast. Following several decades of persisting in low densities, the distribution of this haplotype rapidly expanded. This expansion was probably facilitated by human dispersal via the widespread construction of railroads and major roadways across North America in the late 19th and early 20th centuries.

Given the aggressive patterns of spread seen over the past century, it is likely that the expansion of the introduced *Phragmites* (haplotype M) will continue to occur into western and northern parts of the continent. The presence of native *Phragmites* lineages throughout these areas will only complicate efforts to control this spread using current management techniques.[1]

What is a haplotype?

Haplotype = a unique genetic profile for an organism that contains information from variation at several genes. In the case of chloroplast DNA, this information is inherited maternally and shows a strong geographical signal.

INTRODUCED vs NATIVE

Differences between introduced and native *Phragmites* are often very subtle, so morphology may not be the best way to distinguish between the two different varieties. However, there are some characteristics to look for in distinguishing the different types, including:

Stems

Introduced stems are typically green (but may have a little purple color along basal nodes.) Native stems have some purple color where tissue is exposed and are often shiny. Black spots often appear late in the growing season on native stems.

Leaf collars

Leaf collars on the introduced variety are always green, while leaf collars on native stems may be purple.

Leaf Sheaths

On dead stems, the leaf sheaths on introduced *Phragmites* remain attached. In comparison, leaf sheaths on native stems are lost or very loosely attached. This is the best indicator based on morphology that distinguishes native or introduced *Phragmites*.

The mid-Atlantic coast is unique in that native *Phragmites* persists today in many tidal marshes in the Chesapeake Bay region, particularly along undisturbed creeks and rivers. It typically grows in oligohaline marshes in mixed plant communities, where it may or may not be the dominant plant species in the community. However, at many sites, monocultures of introduced haplotype M *Phragmites* are present nearby. This poses a challenge for managers wishing to preserve native *Phragmites* and other native species while controlling the spread of introduced *Phragmites*.

Differences between the two varieties of Phragmites australis *are visible, with the introduced variety on the left and the native variety on the right.*

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