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INVASIVE SPECIES TECHNICAL NOTE

ECOLOGY AND MANAGEMENT OF PHRAGMITES (*Phragmites australis* ssp. *australis*)

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Phragmites, also known as common reed, is one of the most widespread plant species in the world and is the tallest grass species in Montana. Phragmites is a member of the grass family Poaceae and genus *Phragmites*. There are two subspecies of *Phragmites* in Montana, the native *Phragmites australis* ssp. *americanus*[1] and an exotic *P. australis* ssp. *australis*. The two subspecies are known respectively as native phragmites or American common reed, and exotic phragmites or European common reed. Both subspecies are perennial, reed-like grasses over six feet tall (Figure 1). The two subspecies are known to hybridize, though no known hybrids have been found in Montana. This document focuses on the exotic subspecies, which we will refer to as exotic phragmites.

Figure 1. Exotic phragmites forms dense infestations of 6 to 15-foot-tall plants.
(Photo credit: L. Mehrhoff, University of Connecticut, Bugwood.org, used under CC BY-NC 3.0 US)

Exotic phragmites was introduced to North America from Eurasia in the late 1700s or early 1800s. It has since spread to 32 states and is mostly located along the Atlantic coast but is spreading in midwestern and western states. Exotic phragmites establishes new populations by wind or water dispersed seed and sometimes by rhizome fragments. Established populations spread primarily through stolons and rhizomes. Control options include repeated herbicide applications integrated with mowing, burning, or grazing.

[1] Nomenclature follows USDA PLANTS Database, accessed January 2018.

Exotic phragmites was confirmed in Hill and Blaine Counties, Montana, in 2014 and was listed as a Montana state noxious weed in 2015. The State of Montana designated exotic phragmites a priority 1A noxious weed, indicating that it has limited presence in Montana and management criteria should focus on eradication, education, and prevention.

IDENTIFICATION AND ECOLOGY

Proper identification is critical for early detection and eradication of exotic phragmites, especially because it is important to control this plant in the early stages of invasion. Native and exotic phragmites have many overlapping characteristics. Differentiation between the two subspecies involves focusing on a combination of characteristics such as stem color, leaf sheath persistence, upper and lower glume length, ligule length, and stem density (Table 1). Make sure to examine several distinguishing characteristics in combination, as well as several individual stems within a population when determining whether you have exotic or native phragmites. Exotic phragmites has recently been observed to hybridize with the native subspecies. It is not clear at this time whether hybridization will lead to increased invasiveness, but it will make distinguishing between native and exotic phragmites even more difficult. When a visual assessment is not sufficient to differentiate between the two subspecies, genetic testing is needed.

If you need help identifying exotic phragmites, contact your local NRCS, Extension or weed district office, or send a sample to Montana State University, Schutter Diagnostic Laboratory, 121 Plant BioScience Building, Bozeman, MT 59717-3150.

Table 1. Distinguishing characteristics of native and exotic phragmites.

Characteristic	Native Phragmites	Exotic Phragmites
Leaf Sheaths	Lower leaf sheaths easily fall off stem once the leaf dies.	Lower leaf sheaths attach tightly to live stem and persist on stem as long as it remains standing.
Stem Color	Stem beneath leaf sheath usually turns red from exposure to sunlight.	When leaf sheaths are removed, dull green or tan stems are visible.
Stem Texture	Generally smooth to touch and shiny	Rigid, rough with small ridges
Stem Spots	May be present	Not present
Leaf Color	Yellow-green	Blue-green
Ligule length	> 1.0 mm, likely to look shredded	< 1.0 mm, more likely to be intact
Glume length	Upper glume 5 – 11 mm Lower glume > 4 mm	Upper glume 4.5 – 7.5 mm Lower glume < 4 mm
Flowering Inflorescence	Brown, not dense	Purple or golden, highly branched, dense
Stem Density and Persistence	Often grows with other species, stems less persistent than exotic subspecies through winter.	Often in monotypic stands with very high stem density, and stems often persist to next growing season.

Roots, Stems and Leaves

Exotic phragmites, a perennial rhizomatous or stoloniferous grass, can reach heights of 6 to 15 feet and remains standing through winter months. It is capable of forming dense stands with 5 to 10 stems per square foot. In fact, the genus name *phragma* means fence and refers to the dense populations containing live and standing dead stems from the previous year's growth. The rigid, slightly ridged stems contribute to the persistent erect stems (Table 1, Figure 2).

Figure 2. Dry stems of exotic phragmites persist and remain erect through the winter months.
(Photo credit: J. Mangold, MSU)

The leaf sheath (lower portion of the leaf) wraps tightly around the stem throughout the growing season and persists on the stem as long as the stem remains standing. Stems are dull green or tan when the leaf sheath is removed (Figure 3). While native phragmites may have spots on the stem, stem spots are usually not present on exotic phragmites, but light mildew staining may be visible. Leaves of exotic phragmites are 8 to 24 inches long, blue-green, and appear darker than the native phragmites, which are yellow-green. Leaf blades are ½ to 1½ inches wide and flat. The ligule length (membrane at junction of leaf blade and sheath) is less than 1 millimeter and appears intact.

Figure 3. Stems of native phragmites are smooth, shiny, and often reddish (left). Stems of exotic phragmites are dull green or tan with small ridges (right).
(Photo credit: L. and S. Namestnik, handlensandbinoculars@blogspot.com)

Flowers and Seeds

Exotic phragmites has large, plume-like flowering inflorescences that are usually purple or golden in color and can persist into the winter (Figure 4). Flowering occurs in August and September. The branching inflorescence is 6 to 14 inches long and typically nods to one side of the stem. One of the most diagnostic features distinguishing native and exotic phragmites is the glume length (bracts at base of grass spikelet; usually an upper and lower). The upper and lower glumes of exotic phragmites are shorter than native phragmites (Table 1). Exotic phragmites has 4.5 to 7.5 millimeter long upper glumes and a lower glume less than 4 millimeters long (Figure 5). Seeds are 2 to 3 millimeters long.

Figure 4. Exotic phragmites has a large, dense, feathery flowering inflorescence.
(Photo credit: C. Slemmons, National Ecological Observation Network, Bugwood.org, used under CC BY-NC 3.0 US)

Figure 5. Glumes of native phragmites (left) are larger than those of exotic phragmites (right).
Photo credit: A. Reznicek, University of Michigan Herbarium, modified by N. Orloff and J. Mangold.

Life History

Exotic phragmites is a perennial cool season grass reproducing by both seed and rhizome. Aboveground growth begins in spring when soil and ambient temperatures trigger aboveground growth. Growth continues throughout summer until seed set. Feathery plumes begin growing in early summer, plants flower and cross-pollinate in late summer (August to early September), and seed rain occurs in the fall. Plants produce 500 to 2000 seeds per stem. Seed bank longevity in North America is short lived, and in Europe has been documented at less than one year. Seed viability is <1% to 27% and does not vary with wetland type. Some exotic phragmites seed is dormant at maturity, but cold–moist treatment or environmental conditions help to break dormancy and facilitate seed germination. After seed set, plants senesce and shift growth to belowground tissues.

Expansion of existing phragmites patches is primarily through vegetative reproduction. Phragmites forms a dense underground rhizome network that can be several feet deep and spread several feet horizontally in a single season. In fact, rhizomes have been documented to grow up to 10 feet in a single growing season and reach lengths of 60 feet. In addition, stolons from young stands can reach over 43 feet in length and aid in reproduction, especially during low standing water (Figure 6).

Figure 6. Phragmites spreads by stolons over bare ground exposed during low water.
(Photo by: L. Mehrhoff, University of Connecticut, Bugwood.org, used under CC BY-NC 3.0 US)

Spread

Exotic phragmites was accidentally introduced to coastal ports of eastern North America over 200 years ago. Due to its close resemblance to the native phragmites subspecies, it was not detected until 2002 when genetic testing confirmed an introduced lineage was present in North America. Exotic phragmites spread with the construction of railroads and roadways, shoreline development, habitat disturbance, and other alterations leading to increased bare ground and available nutrients. It is now widespread across Canada and the eastern United States and is becoming more prevalent along roads and waterways in the midwestern and western United States. Montana State University herbarium records first confirmed a population of exotic phragmites in 2014 in Hill County, Montana, where it is found primarily along railroads.

Wind, water, and birds spread seeds to locations where they can germinate and form new infestations. Seeds typically require bare ground to establish, so disturbance is a key factor in phragmites establishment in new areas. Stolons and rhizomes expand populations downward and horizontally in the soil (Figure 6). In addition, rhizomes or rhizome fragments spread in water or on equipment have been known to start new infestations. Humans also disperse phragmites through landscaping introductions, use of the inflorescence in floral displays, utilizing the stems for bird blinds, and on machinery, recreational vehicles, and watercraft. In Montana, new infestations have been associated with importing rock for railroad track ballast.

Habitat

The habitat associations of native and exotic phragmites overlap and result in a mixing of both subspecies at a site. Exotic phragmites can survive and reproduce in a wide range of habitats but prefers the wetland-upland interface. It grows on moist, fine clay to sandy loam soils, and can tolerate soil salinity and soil pH ranges of 3.9 to 8.6. Suitable wet habitats include wetlands, sloughs, ditches, riparian corridors, and along streams, lakes, and ponds (Figure 7). In general, exotic phragmites is more likely found in disturbed sites with altered hydrology, sedimentation, and nutrient enrichment than native phragmites. Disturbed habitats include areas along roadways and construction sites, near agricultural fields, and developed shorelines.

Figure 7. Phragmites grows in wet areas associated with disturbance and sedimentation.

ECONOMIC IMPACTS

Exotic phragmites has the potential to impact wetlands in Montana. It has the capacity to spread rapidly, forming large, dense, monotypic stands that replace native phragmites and other native species. For example, since its introduction in Connecticut in 1970, 90% of cattail/bulrush wetlands have become dominated by exotic phragmites resulting in decreased native plant diversity. Human-caused changes to wetlands that increase runoff, reduce water quality, and increase bare ground may be the cause of most exotic phragmites invasions. These human-caused changes may include on- or off-site development, application of fertilizers, and alterations to stream natural buffers. Once established, the large, dense stands of exotic phragmites may further increase sedimentation rates and alter wetland hydrology.

Exotic phragmites invasion results in decreased plant community diversity, making stands more homogenous. Exotic phragmites infestations are also associated with decreased bird diversity, decreased abundance and diversity of fish, and decreased abundance of some mammal species such as muskrat. Reports on its impact to macroinvertebrates have been mixed. Some reports found exotic phragmites invasion associated with increased macroinvertebrate diversity, while others report a neutral effect. Ecosystem responses and impacts related to exotic phragmites invasion may be associated with stand age. At early stages of invasion, or in areas with low relative dominance of exotic phragmites, this species can provide habitat for many wetland species by increasing habitat complexity. However, in older monotypic stands, increases in detritus and sedimentation rates and decreases in plant diversity can be detrimental to native plant and animal communities.

Exotic phragmites can also cause visual, recreational, and wildfire impacts. With heights reaching 15 feet, it can obscure views for landowners, recreationists, and motorists (Figure 7). Recreationists have difficulty walking through dense stands of exotic phragmites, and sharp leaf blades have been known to cut skin. When the dense, tall plant material dries, exotic phragmites becomes a wildfire danger with the large concentrations of dry vegetation rapidly carrying fire.

It is important to note that exotic phragmites can be beneficial in some circumstances. This species can be used for nutrient removal (i.e. phytoremediation) and provide wildlife and bird habitat, particularly if populations have a patchy distribution.

MANAGEMENT ALTERNATIVES

Preventing new infestations is the most cost-effective management strategy for exotic phragmites since established stands are extremely difficult and expensive to eradicate. Currently, exotic phragmites is only known to occur in a few scattered and isolated areas in Montana. As a first step to prevention, it is critical to be able to identify this subspecies so new populations can be controlled when they are small and manageable. If exotic phragmites is found, notify the landowner and report the exact infestation location to your local weed district or Extension office.

Additional best management practices to prevent invasion and spread include:

- Minimizing disturbance to wetland areas where seeds typically require bare ground to establish.
- Maintaining a vigorous perennial plant community since wetlands with intact desired plant communities are more resistant to exotic phragmites invasion than disturbed wetlands.
- Preventing soil spread from an area with exotic phragmites to other areas since this soil will likely contain rhizomes that can easily regenerate into new plants.
- Treating and cleaning rock ballast before moving material to new locations.
- Cleaning equipment and vehicles used in wetlands with exotic phragmites to avoid spread to new areas.
- Eliminating or reducing sediment, fertilizer, and herbicide runoff that can cause altered hydrology, sedimentation, and nutrient enrichment.
- Increasing the width of, and maintaining existing, vegetative riparian buffers.
- Removing undersized culverts, berms, ditches or roads that may alter wetland hydrology.

Herbicide Control[2]

Herbicides containing the active ingredients glyphosate and imazapyr can be effective means of exotic phragmites control when used individually or in combination. These two chemicals are nonselective and available in separate formulas for aquatic and terrestrial sites. There are many trade names for glyphosate (e.g. Roundup®, Rodeo®, Aqua Neat®, etc.) and imazapyr (e.g. Arsenal®, Habitat®, etc.). Make sure the trade name is labeled for exotic phragmites, adjust rates as specified, follow recommendations for adjuvants or surfactants, and follow all label instructions.

Herbicide application rates may vary slightly with the specific product trade name. In general, application rates are 1 to 2% solution for glyphosate and a 1 to 5% solution for imazapyr. Apply the herbicide to the green, growing foliage. Both herbicides are more effective at controlling exotic phragmites if applied in the early growing season (June) or when the inflorescences start to form (early July). Some research found that imazapyr reduced exotic phragmites more than glyphosate. However, glyphosate is reported to have fewer non-target plant impacts than imazapyr when used on exotic phragmites. This is attributed to glyphosate only being absorbed through foliage and having a <7 day degradation period, while imazapyr is absorbed through foliage and roots and has a one month to four year degradation rate. Repeated spot applications in years following an initial treatment may keep large populations contained or eliminate small infestations. Eradication of large infestations with herbicide is not usually a realistic objective due to the rapid recolonization potential of this species from individuals that escape treatment (Figure 8).

Figure 8. Eradication of large exotic phragmites infestations is not realistic.
(Photo by: L. Mehrhoff, University of Connecticut, Bugwood.org, used under CC BY-NC 3.0 US)

Excavation or Digging

Excavation and removal of exotic phragmites rhizomes provides complete control if done consistently on newly established, small patches. When digging plants, remove, bag, and

[2] Any mention of products in this publication does not constitute a recommendation by the NRCS. It is a violation of Federal law to use herbicides in a manner inconsistent with their labeling.

properly dispose of all vegetative parts to prevent spread from rhizomes. The physical removal of mature stands, including the dense mat of underground rhizomes, is difficult, costly, and requires large machinery. Large-scale excavation may result in secondary impacts such as soil compaction, soil erosion, and altered hydrology. Managers should obtain any necessary wetland permits prior to excavating in a wetland.

Biological Control

Currently, biological control through insect herbivory has not been successful at controlling exotic phragmites or preventing its spread. There are insect herbivores in the Eurasian native range that are also found in North America. Unfortunately, several of the biological control insects prefer the native subspecies.

Grazing

Grazing has been a common method of managing phragmites stands in Europe. In fact, exotic phragmites is grown commercially for livestock fodder and cellulose production. Early in the growing season, young leaves and stems are forage for cattle and horses, but late season growth becomes tough and unpalatable. The plant may be cut for hay forage early in the growing season. Grazing animals should be fed a protein supplement with phragmites forage.

In North America, land managers report some success using goat and cattle grazing to manage exotic phragmites. Goat grazing has been shown to decrease exotic phragmites density, biomass, and height, and increase desired species diversity. Utilizing high-intensity, short-duration grazing in wetlands reported the best success for controlling large stands of exotic phragmites while promoting desired native vegetation. Grazing may not be an appropriate management option for low density or small stands of exotic phragmites because animals may select other preferred vegetation. Managers should be aware of potential side effects from grazing in wetlands including soil compaction and nutrient enrichment.

Burning or Mowing

Burning or mowing can be part of effective integrated management program but are not effective for exotic phragmites control when used alone. Mowing exotic phragmites has mixed management outcomes, depending on the plant phenology. Both mowing and burning can stimulate growth of the perennial rhizomatous grass and increase stand density. Mowing when the plant is actively growing can negatively affect the above and below ground biomass the following growing season. Mowing late in the growing season has no effect on exotic phragmites control. Late summer burns destroy seed heads and reduce seed spread. Burning before herbicide applications removes standing stems and improves contact between the herbicide and new growth of exotic phragmites. On slopes, burning may not be advisable due to soil erosion risks. In addition, exotic phragmites burns hot and quickly, so use caution to avoid risks associated with burning. Both burning and mowing need to be repeated for several years to be successful. Time burning or mowing treatments to minimize impacts to nesting birds and wildlife.

Revegetation

Long-term exotic phragmites management hinges on the vigor of the perennial plant community. From a prevention perspective, wetlands with intact plant communities are more resistant to exotic phragmites invasion than disturbed wetlands. Native perennial plants also suppress

exotic phragmites resprouting from rhizomes following management, and they can be competitive with exotic phragmites seedlings. Revegetation of heavily disturbed areas after control measures is critical to long-term management.

Integrated Pest Management

Exotic phragmites control efforts will typically require integrating management options over multiple years. Herbicide, the most common management method for exotic phragmites, may be most effective if integrated with other control measures, especially for large infestations. Mowing, burning, or grazing removes thatch and reduces aboveground biomass in exotic phragmites stands, which may encourage germination of native plants or improve herbicide contact with live vegetation. There is also research indicating integrating late summer herbicide treatments with spring mowing is an effective means of restoring wetland plant communities. In Hill County, Montana, a spring burn followed by a July application of glyphosate, imazapyr, and a high-quality surfactant provided 90 to 95% control of exotic phragmites.

Burning or mowing may be more effective if subsequent shoots remain underwater for an extended time period to deprive the plant of oxygen. Mowing followed by covering with plastic for one growing season is thought to be an effective way to control small patches of exotic phragmites.

Monitor infestations for re-growth. Herbicide applications and other mechanical treatments may leave the area vulnerable to other invasive weeds. After infestations appear to be successfully controlled, revegetate the site with appropriate species if desirable vegetation is not returning naturally.

Historic Uses

There are three subspecies of *Phragmites* found throughout the world, and all have had a long history of human use. Phragmites was extensively used for building and crafts including thatching roofs and constructing walls, partitions, fences, and livestock pens. In many cultures, stems and leaves were used to weave baskets, mats, shoes, and cord. Stems were used for pen tips, prayer sticks, and measuring devices. In Africa and Romania, it has been used to produce paper. Egyptians used it for fishing poles, and flowers are bundled for household brooms in the Philippines. Middle Eastern countries use phragmites to create a small instrument (sipsi) which resembles a clarinet. In Africa, reeds are made into flutes and whistles. Some cultures used the reeds for arrows and light spears. In addition, reeds are used to create nesting structures for bees. Native Americans used phragmites for arrow shafts, musical instruments, and woven mats.

Human cultures have eaten the young shoots cooked or raw similar to bamboo shoots. Dried young green stems were pounded into a fine powder, then moistened for roasting or used as flour for dumplings. The seeds were ground into flour or made into porridge. Stem gum was eaten as a sweet treat in North America, and the rhizomes are harvested and processed into starch in Russia. The young leaves and stems are used for livestock forage and hayed early in the growing season.

In current times, phragmites is used for water treatment phytoremediation. As part of a waste-water treatment, greywater trickles through constructed wetlands containing phragmites to remove nutrients, pollutants, and heavy metals. Phragmites is also used in wetland rehabilitation and stabilization projects.

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