Wetlands Program
Technical Report
January 2002 No. 02-2

A Summary of Methods for Controlling *Phragmites australis*

By Libby Norris, James E. Perry, and Kirk J. Havens

Introduction

Common Reed (*Phragmites australis*) is a tall perennial wetland grass with strong, leathery horizontal shoots growing on or beneath the ground surface (rhizomes). Its tough vertical stalks range in height from 1.5 -3 m and support broad sheath-type leaves that are 1-4 cm wide near the base, tapering to a point at the end. The foliage is gray-green during the growing season, with purple-brown plumes appearing by late June. The plant turns brown in the fall and most leaves drop off, leaving only the plume-topped shoot (VA NHP Fact Sheet).

Typical dense stand of common reed grass, Phragmites australis.

Common reed is found throughout the temperate regions of North America. It commonly inhabits riparian areas, brackish and freshwater marsh, riverbanks and lakeshores. The species is especially common in disturbed or polluted soils, ditches and dredged areas. The species can sprout from a portion of a rhizome or from seeds. New stems grow each spring and rhizomes spread horizontally in all directions during the growing season. Flowering begins in late June, and seeds are formed by August. In early fall, the food reserves move from the leaves and stems to the rhizome system.

Common reed is considered to be an invasive and undesirable grass along the East Coast. It quickly becomes established and the accumulation of dead leaves and stems, as well as the pervasive rhizome system, prohibits the growth of desirable plant species (VA NHP) resulting in a wetland monoculture. *Phragmites* is unique in that it is classified as a climax species but is also a strong colonizer. The aggressive nature of *Phragmites* is directly related to the combination of unique adaptive features. It produces abundant; wind dispersed, seeds, which makes it an outstanding colonizing species in disturbed wetland areas. Rhizomes and stolons provide additional sources of propagules, which can allow the plant to spread rapidly. Abundant aerenchyma and high stomatal densities found on both sides of the leaves create an efficient system for the exchange of both carbon dioxide and water vapor. The photosynthetic efficiency and high transpiration rate translates into rapid growth and the ability to modify marginal habitats by providing oxygen to the rhizomsphere and altering ambient soil moisture in ways that favor the expansion of *Phragmites* (Ailstock 2000).

To habitat managers, the rapid spread of Common Reed may seem new. *Phragmites* was once thought to be a non-native plant that had just recently invaded wetland areas of North America. But, *P. australis* is found world wide in moist soil habitats especially those of tidal and nontidal wetlands. More recently, paleoecology studies in New England have located *Phragmites* rhizomes nearly 3000 years old, indicating the species is indeed native to the U.S. (Orson 1999). New evidence suggests that modern *Phragmites* we work to control may indeed be a different, more aggressive ecotype. Saltonstall (2002) has identified distinct native and nonnative genotypes in North America.

A major cause for the spread of *Phragmites* can be linked directly to an increase in habitat manipulation. For the past 50 years, humans have greatly manipulated the environment and the results have provided *Phragmites* with optimal growing conditions (Orson 1999). In the past 40-50 years controlling *P. australis* has become a significant concern with resource managers (Silberhorn 1991, Barnard et al. 1997).

Wetlands Program
School of Marine Science
Virginia Institute of Marine Science
College of William and Mary
Gloucester Point, Virginia 23062
(804) 684-7380

Dr. Carl Hershner, Program Director
Dr. William Roberts, III, Editor
Published by: VIMS Publication Center

This technical report was funded, in part, by the Virginia Coastal Resources Management Program of the Dept. of Environmental Quality through Grant #NA97O20181-01 of the National Oceanic and Atmospheric Administration, Office of Ocean and Coastal Resources Management, under the Coastal Zone Management Act of 1972, as amended.

The following is a synopsis of the most common practices for eradicating *P. australis*. The purpose of this paper is not to endorse any one method but rather outline the options that are currently available.

I. Chemical Control

Spraying

Chemical spraying is one of the most popular choices of habitat managers. Translocation of the chemical to the root system can successfully kill the entire plant. The challenge lies in correctly timing the spraying application. Chemical spraying is most effective if applied in the fall, when a majority of the plants are in full bloom and leaves are fully open. During this time, the plant is actively moving stored energy from leaves to the complex rhizome system. Taking advantage of this energy shift insures the highest opportunity that the selected chemical will reach the rhizomes. In addition, in temperate zones, more desirable species such *Spartina alterniflora* and *Spartina cynosuroides* may have already begun to senesce reducing the potential for impacts to non-targeted species.

Glyphosate (N-(phosphonomethyl) glycine), sold under the trade name Rodeo 7 or Rodeo Pro 7 by Monsanto, is the most common herbicide used to control Phragmites. It should be noted, however, that using a high concentration of chemical designed to translocate in the rhizomes (such as glyphosate), can result in top kill of the plant before the herbicide can be translocated properly, thus decreasing the effectiveness of the treatment. It is noted that split applications of glyphosate (at 1/2 dosages) can work better that a single, full strength application. The second dosage should be applied 15-30 days after the first (Cross and Fleming 1989).

The dense nature of *Phragmites* may prevent complete chemical coverage and result in uneven stages of growth. So, repeat treatments may be necessary to maintain control (Brooker 1976). Seasonal burning, used in combination with spraying the vegetation, has been shown effective in reducing the above ground biomass thus increasing the opportunity for complete coverage when spraying (Cross and Fleming 1989).

Wicking

Wipe-on herbicide application, or wicking, has been investigated as a more environmentally acceptable alternative to spray applications. The method utilizes canvas-covered, Speidel 7 applicators attached to a boom on each side of the boat or low ground pressure application equipment. The chemical saturates the canvas strips and is only applied to the plants that come in direct contact with the fabric. Chemical application through wicking allows for the targeting of *Phragmites* without affecting the other, often shorter, plant species present in the treatment area. This method can be useful in areas where complete eradication of all vegetation is not desired.

However, care should be taken when using wicking equipment. The equipment can bend and break the plant, reducing the opportunity the chemical will reach the rhizomes and thus reducing the effectiveness of the treatment (Kay 1995). In addition to breaking plant stalks during application, the application boom also may cause much of the taller stalks to bend over and cover the shorter *Phragmites* plants. This can effectively shield the shorter plants from the chemical, therefore reducing the rate of contact with the desired vegetation. In heavy weed stands, a double application in opposite directions may improve the results (Monsanto 1995). Yet, double applications will increase the treatment cost, effort and likelihood of stem breakage.

Sulfide Treatments

Studies have shown that sulfides react with salinity to greatly impact *Phragmites* communities. Many of the die-back symptoms associated with field sites, namely stunted adventitious roots and laterals, bud death, callus blockages of the gas-pathways, and vascular blockages, were particularly acute at higher concentrations of acetic acid and sulfides (Armstrong et al. 1996). It has also been shown that an increase in sulfide in the rhizosphere reduces the ability of *Phragmites* to take up nutrients relative to species such as *Spartina alterniflora* that are better-adapted to sulfuric soil conditions, thus restricting the distribution of *Phragmites* in tidal saltmarshes (Chambers 1998).

II. Mechanical Control

Water Management

Regulating the water level within the treatment area can be used to controlling *Phragmites*. *Phragmites* roots require little oxygen and have well-developed mechanisms of flood tolerance. Therefore, flooding an established colony of *Phragmites* may not be effective (Gries et al. 1990). However, if a water level greater than 30 cm is maintained, colonies will not expand and further increasing water levels can easily kills seedlings.

Tidal flushing can be effective in preventing *Phragmites* from becoming established. But, a coastal location is required and increasing the salinity is more likely to hurt competing plants and the freshwater biota than control *Phragmites* to the desired levels (Cross and Fleming 1989). Due to the dense nature of root and rhizome systems, wave action has been shown to have no effect on established stands of *Phragmites*. In fact, the presence of *Phragmites* actually reduced the amount of erosion normally caused by repeated wave action.

Disking

Disking is more effective than plowing because the chopped rhizome pieces that result are often too small to be viable. The most effective time for cutting rhizomes is late in the growing season. In dry areas, the rhizome fragments may remain above ground to dry out or freeze. Disking in the summer or fall has shown a reduction in stem density during the next growing season. But, disking in late winter to mid-summer has actually stimulated bud production and resulted in *Phragmites* stands with greater stem density (Cross and Fleming 1989).

Bulldozing

Bulldozing can be destructive to *Phragmites* under certain conditions. Removal of vegetation can expose rhizome fragments to killing frosts, or fragments can dry out in non-flooded areas. However, this level of disturbance can also provide ideal growing conditions for *Phragmites* (Cross and Fleming 1989).

Dredging

Complete removal of *Phragmites* through dredging can be difficult and destructive to the surrounding area. Rhizomes can reach depths of 2 m or more (Haslam 1970). Horizontal rhizomes must be removed and the area must remain deeply flooded (more than 1.5 m) following dredging or regrowth will almost certainly occur (Cross and Fleming 1989).

Seasonal Mowing

Mowing a stand of *Phragmites* has been shown to reduce biomass and increase the available sunlight to competing plant species within the stand. Spring mowings have produced shorter, but more dense, *Phragmites* stands within the same growing season. Yet, mowing for three consecutive summers in Canada resulted in a reduction of *Phragmites* and a replacement of a short grass-sedge-sowthistle meadow (Cross and Fleming 1989).

Cutting

Reducing the above ground biomass through labor intensive cutting has produced mixed results. In one study, fall cutting did not increase species richness (Thompson and Shay 1989). Yet, hand cutting 30-40 cm below the water level in June resulted in total eradication of the *Phragmites* stand (Kay 1995). The level of the cut must be made below water level and a high water level maintained, to allow the shoot bases to become flooded with water from the top. This has been shown to result in the plant rotting beneath the water, especially when the cut is applied twice during one growing season (Husak 1978).

Short-term results were also obtained by cutting the vegetation at the onset of flowering. However, within two years, no significant differences were detected in the above ground biomass between treatment and control plots (Husak 1978).

Rhizome of reed grass.

Plastic Barriers

Applying large plastic sheets to a treatment area can be an effective, non-herbicide option for eradicating *Phragmites*. The site should first be mowed or burned to reduce the height of above ground biomass. Large sheets of 6-mm plastic can then be applied and held in place with stakes, sandbags or chains. As the under plastic temperatures increase, complete surface kill can be achieved in only 3-4 days. An increased application time could eventually kill the rhizomes as their energy storage is depleted and soil temperatures remain high (Boone et al. 1988). Using a clear plastic has been shown effective and it is suggested that using a black plastic could further increase under plastic temperatures.

However, large plastic sheets can be difficult to manage and hold in place, particularly in tidal marshes. Extended time in the sun can also increase the possibility of the plastic to deteriorate into hundreds of tiny pieces, making clean up difficult. Small animals located in the wetland area may be drawn to the warm temperatures located under the plastic sheeting and can potentially tear the material. The sharp tips of *Phragmites* rhizomes have also been known to easily penetrate plastic sheeting.

Perimeter Ditching

During construction of a new tidal wetland site, ditching around the perimeter may be effective in preventing the spread of rhizomes (Havens et al. 1997, Havens et al. 2002). While designing a new tidal wetland site, special attention should be given to elevation and flooding frequency. In polyhaline areas much of the potential for *Phragmites* invasion can be eliminated by concentrating restoration efforts to below mean high water (Priest 1989). Bare oxidized soils that do not experience regular tidal flooding may be more susceptible to invasion (Pyke and Havens 1999, Bart and Hartman 2000). The project should also include additional steps to eliminate areas available for *Phragmites* development. These steps include planting a high density of vegetation, using mature scrub/shrub species and plantings along the upland berm.

Burning

Controlled burning has traditionally been used by habitat managers as a quick and efficient method for removing above ground biomass and increasing soil nutrients. In fact, it is commonly used in combination with other *Phragmites* control methods such as chemical spraying. However, new discussions are taking place concerning annual burns to control *Phragmites* on wetland properties. Most professionals agree that removing the above ground biomass does indeed allow more sunlight to reach the soil surface and thus increases the opportunity for more desirable plants to sprout and grow. However, it is suggested that removing the above ground biomass on an annual basis may not allow the build up of nutrients to be returned to the wetland soil. In addition, the bare soil following a burn often provides prime disturbed conditions for the establishment of *Phragmites*.

Shading

Seedlings of *Phragmites* are susceptible to shading (Haslam 1971, Kudo and Ito 1988, Ostendorp 1989). Shading by shrubs and trees can reduce the density, height, and the proportion of flowering shoots, and can increase the number of dead tips (Lambert 1946, Kassas 1952, Haslam 1971). In created or restored areas, simply allowing scrub/shrub vegetation to mature can reduce *Phragmites* to a minor component of the vegetative community (Havens et al. 2002).

Mature seed head.

III. Biological Control

Classical biological weed control is the introduction of host specific natural enemies (usually insects, less often pathogens) from the native range of the plant. Over 100 insect species are known to attack *Phragmites* in Europe and about 50% of these are *Phragmites* specialists. This provides ample opportunity to assess their potential as biological control agents (Blossey 2000).

The most promising potential biological control agents are rhizome and shoot mining moths and flies. The highest priority for investigation lies in the rhizome feeding insects, and is followed by the stem and leaf feeders. If an insect is discovered to destroy the rhizomes, the entire *Phragmites* plant will be killed. When the desired control level is met, a controlled burn of the area destroys the insects along with the above ground biomass. Some of the insect species being investigated have recently been introduced to North America and the destructive potential of these species on *Phragmites* is very promising (Blossey 2000).

Summary

Although *Phragmites* is considered to be an invasive wetland species in North America, it can play a positive role in wetland habitat management. Waterfowl species benefit from *Phragmites* when the plant stands are interspersed with open water or with other vegetation. *Phragmites* stems provide cover and nesting habitat, and rhizomes provide a food source for waterbirds and small mammals. Its dense root systems have also been used to strengthen dikes and roads and reduce beach erosion.

The key may lie in integrated management of *Phragmites*. The first important step is deciding what level of control is needed for a stand. In some cases, although a monoculture of *Phragmites* exists, the best decision may be not to apply any control methods to the area. Yet, if it is decided that *Phragmites* control is part of an overall management plan, careful steps should be taken to select a control method.

When it is decided that action must be taken to decrease the amount of *Phragmites* in an area, having a plan and clear objectives is important. It is also crucial that the management plan include a long term monitoring program to insure the desired results are maintained. It was once thought that a 5-year monitoring plan was sufficient. However, monitoring for a longer time period is more likely the case (Mitsch and Wilson 1996, Havens et al. 1997).

Table 1. Glyphosate Application

Phragmites Table Chemical Application Conversions

Amount of Rodeo (or Round-up Pro)
-- x 100% = % solution
Amount of Water + Amount or Rodeo

Rodeo Application calculations:

4-7.5 pints Rodeo in 5-20 gallons of water plus 0.5% by volume nonionic surfactant

1 gallon = 128 fl oz
1 gallon = 8 pints

4 pints Rodeo / 5 gallons water + 4 pints Rodeo = 4 pints Rodeo / 44 pints water + Rodeo = 0.09 x 100% = 9.09%

4 pints Rodeo / 20 gallons of water = 4 pints Rodeo / 164 pints water + Rodeo = 0.0243 x 100% = 2.44 %

7.5 pints Rodeo / 5 gallons of water = 7.5 pints Rodeo / 47.5 pints water + Rodeo = 0.1473 x 100% = 14.74 %

7.5 pints Rodeo / 20 gallons of water = 7.5 pints Rodeo / 167.5 pints water + Rodeo = 0.0447 x 100% = 4.48 %

4-7.5 pints Rodeo in 10-30 gallons of water

4 pints Rodeo / 10 gallons water = 4 pints Rodeo / 84 pints water + Rodeo = 0.0476 x 100% = 4.76%

4 pints Rodeo / 30 gallons water = 4 pints Rodeo / 244 pints water + Rodeo = 0.01639 x 100% = 1.64%

7.5 pints Rodeo / 10 gallons water = 7.5 pints Rodeo / 87.5 pints water + Rodeo = 0.0.0857 x 100% = 8.57%

7.5 pints Rodeo / 30 gallons water = 7.5 pints Rodeo / 247.5 pints water + Rodeo = 0.0303 x 100% = 3.03 %

6-7.5 pints Rodeo in 3-20 gallons of water

6 pints Rodeo / 3 gallons water = 6 pints Rodeo / 30 pints water + Rodeo = 0.2 x 100 % = 20 %

6 pints Rodeo / 20 gallons water = 6 pints Rodeo / 166 pints water + Rodeo = 0.036144 x 100% = 3.61 %

7.5 pints Rodeo / 3 gallons water = 7.5 pints Rodeo / 31.5 pints water + Rodeo = 0.23809 x 100% = 23.81%

7.5 pints Rodeo / 20 gallons water = 7.5 pints / 167.5 pints water + Rodeo= 0.04477 x 100% = 4.48 %

3-6 quarts Rodeo in 100 gallons of water

1 gallon = 4 quarts

3 quarts Rodeo / 100 gallons water = 3 quarts Rodeo / 403 quarts water + Rodeo = 0.0074 x 100 % = 0.74%

6 quarts Rodeo / 100 gallons water = 6 quarts Rodeo / 406 quarts water + Rodeo = 0.0147 x 100% = 1.47%

6-10 oz Rodeo in 1 gallon water plus 0.78 % nonionic surfactant

1 gallon = 128 oz

6 oz of Rodeo / 1 gallon water = 6 oz Rodeo / 134 oz water + Rodeo = 0.0447 x 100% = 4.47 %

10 oz of Rodeo / 1 gallon water = 10 oz Rodeo / 138 oz water = 0.07246 x 100% = 7.25 %

Round-up Pro Applications:

6-13 oz Round-up Pro in 1 gallon water

6 oz Round-up Pro / 1 gallon water= 6 oz Round-up Pro / 134 oz water + Round-up Pro = 0.0447 x 100% = 4.48 %

13 oz Round-up Pro / 1 gallon water = 13 oz Round-up Pro / 141 oz water + Rodeo = 0.0921 x 100% = 9.22 %

1-2 gallons Round-up Pro in 100 gallons water

1 gallon Round-up Pro / 101 gallon water + Round-up Pro = 0.0099 x 100% = 0.99%

2 gallon Round-up Pro / 102 gallon water + Round-up Pro = 0.0196 x 100% = 1.96%

Literature Cited

Ailstock, M.S. 2000. Adaptive Strategies of Common Reed *Phragmites australis*. *Phragmites* in Virginia: A Management Symposium; 2000 December 14; Library of Virginia, Richmond, Virginia.

Armstrong, J., F. Afreen-Zobayed and W. Armstrong. 1996. *Phragmites* die-back: sulfide-and acetic acid-induced bud and root death, lignifications, and blockages within aeration and vascular systems. New Phytologist 134(4): 601-614.

Barnard Jr., T.A., C.H. Hershner, and M. Greiner. 1997. The Oldest Operating Wetland Mitigation Bank in The U.S. Technical Report 97-7. Virginia Institute of Marine Science, College of William and Mary.

Bart, D. and J.M. Hartman. 2000. Environmental determinants of Phragmites australis expansion in a New Jersey salt marsh: an experimental approach. OIKOS 89: 59-69.

Boone, J., E. Furbish, K. Turner, and S. Bratton. 1988. Clear plastic. A non-chemical herbicide. Restoration & Management Notes 6(2): 101.

Brooker, M.P. 1976. The Ecological Effects of the Use of Dalapon and 2,4-D for Drainage Channel Management. Arch. Hydrobiol. 78(3): 396-412.

Caffrey, J.M. 1996. Glyphosate in fisheries management. Hydrobiologia 340: 259-263.

Chambers, R.M. 1997. Porewater Chemistry Associated with *Phragmites* and *Spartina* in a Connecticut Tidal Marsh. Wetlands 17(3): 360-367.

Cross, D.H. and K.L. Fleming. 1989. Control of *Phragmites* or Common Reed. USFWS Leaflet 13.4.12.

Gries, C., L. Kappen, and R. Losch. 1990. Mechanism of flood tolerance in reed, *Phragmites australis* (Cav.) Trin. Ex Steudel. The New Phytologist 114: 589-593.

Haslam, S.M. 1970. The performance of *Phragmites* communis in relation to water supply. Annals of Botany 34: 867-877.

Haslam, S. M. 1971. Community regulation in *Phragmites communis* Trin. II. Mixed stands. J. Ecol. 59:75-88.

Havens, K.J., H. Berquist, and W.I. Priest, III. 2002. *Phragmites* expansion into constructed wetlands: Are we mortgaging our wetland future? *Phragmites australis*: A sheep in wolf's clothing? A special technical forum and workshop, January 6-9, 2002, Cumberland County College, Vineland, New Jersey, New Jersey Marine Sciences Consortium and the U.S. Environmental Protection Agency, Mid-Continent Ecology Division.

Havens, K.J., W. I. Priest, III and H. Berquist. 1997. Investigation and Long-Term Monitoring of *Phragmites australis* Within Virginia's Constructed Wetland Sites. Environmental Management 12(4): 599-605.

Husak, S. Control of Reed and Reed Mace Stands by Cutting. 1978. In D. dykyjova and J. Kvet eds. Pond Littoral Ecosystems, Structure and Functioning. New York: Springer-Verlag, 1978: 404-408.

Kassas, M. 1952. Studies in the ecology of Chippenham fen. III. The Forty Acre wood. J. Ecol. 40:50-61.

Kay, S. 1995. Efficacy of Wipe-on Applications of Glyphosate and Imazapyr on Common Reed in Aquatic Sites. Journal of Aquatic Management 33: 25-26.

Kudo, G. and K. Ito. 1988. Rhizome development of Phragmites australis in a reed community. Ecological Research 3: 239-252.

Lambert, J. M. 1946. The distribution and status of *Glyceria maxima* (Hartm.) Holmb. In the region of Surlingham and Rockland Broads, Norfolk. J. Ecol. 33:230-67.

Mitsch, W.J., and R.F. Wilson. 1996. Improving the Success of Wetland Creation and Restoration with Know-How, Time, and Self-Design. Ecological Applications 6(1): 77-83.

Monsanto. 1995. Rodeo 7 Emerged Aquatic Weed and Brush Herbicide; Complete Directions for Use in Aquatic and Other Noncrop Sites. Leaflet 1995-1: 21061T1-1/CG, 8pp.

Orson, R.A. 1999. A paleoecological assessment of *Phragmites australis* in New England tidal marshes: change in plant community structure during the last few millennia. Biological Invasions 1: 149-158.

Ostendorp, W. 1989. 'Die-back' of reeds in Europe - a critical review of literature. Aquatic Botany 35: 5-26.

Priest, W.I. 1989. Wetlands mitigation evaluation vegetation studies, Monkey Bottom disposal area. Final report to the City of Norfolk. College of William and Mary, School of Marine Science, Virginia Institute of Marine Science. 20pp.

Pyke, C.R. and K.J. Havens. 1999. Distribution of the invasive reed *Phragmites australis* relative to sediment depth in a created wetland. Wetlands 19: 283-287.

Saltonstall, K. 2002. Native or introduced? Genetic variation in North American populations of *Phragmites australis*. *Phragmites australis*: A sheep in wolf's clothing? A special technical forum and workshop, January 6-9, 2002, Cumberland County College, Vineland, New Jersey, New Jersey Marine Sciences Consortium and the U.S. Environmental Protection Agency, Mid-Continent Ecology Division.

Silberhorn, G. 1991. Reed Grass *Phragmites*. Technical report, wetland flora. Wetlands Program College of William and Mary, School of Marine Science, Virginia Institute of Marine Science, 2 pp.

Thompson, D.J. and J.M. Shay. 1989. First-year response of a *Phragmites* marsh community to seasonal burning. Canadian Journal of Botany 67: 1448-1455.

Virginia Natural Heritage Program (VA NHP) Invasive Plant Species of Virginia Fact Sheet. Common Reed (*Phragmites australis* (Cav.) Trin. Ex Steud.) Virginia Department of Conservation & Recreation, Richmond, Virginia USA.

This paper was funded, in part, from a grant from the U.S. Environmental Protection Agency, Region III, Wetland Program Development Grant (Grant# CD983029-01).