Common Reed (*Phragmites australis*) in the Chesapeake Bay: A Draft Bay-wide Management Plan

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Table of Contents

Phragmites australis has been present in North America for over 3,000 years (Orson, 1999). Over the past century, however, *Phragmites* has invaded large areas of marsh in the mid-Atlantic. Recent genetic analysis of *Phragmites* collected throughout the world has revealed that an aggressive, competitively superior strain has been introduced from Europe and Asia to North America, competing with and limiting distribution of the native strain throughout the East Coast (Saltonstall, 2002). Resource managers in the Chesapeake Bay watershed face multiple challenges in managing marsh habitat for wildlife. Invasion of *Phragmites* in many of these marshes further increases the difficulty of managing for wildlife. Once *Phragmites* becomes established in a marsh, it often forms expansive stands, excluding native marsh plants and providing little food and shelter for wildlife. Resource managers are further challenged by the difficulty in controlling *Phragmites* once it becomes established. Control options are limited and costly. Finally, there are native stands of *Phragmites* that remain in the region that must be preserved at the same time the introduced strain is controlled. There is an urgent need for a Bay-wide approach to preventing new invasions and prioritizing control efforts of *Phragmites* in areas where effective management can be achieved and native plant diversity can be re-established.

To better coordinate prevention and control efforts for aquatic invasive species on a Bay wide basis, the Chesapeake Bay Program's Invasive Species Workgroup (CBP's ISWG) developed the following two goals for the Chesapeake 2000 Agreement: "By 2001, identify and rank non-native aquatic and terrestrial species which are causing or have the potential to cause significant negative impacts to the Bay's aquatic ecosystem. By 2003, develop and implement management plans for those species deemed problematic to the restoration and integrity of the Bay's ecosystem." In September 2001, the ISWG developed a questionnaire that was sent to the CBP signatory jurisdictions and federal partners to identify six species that are causing or have the potential to cause adverse ecological effects in the Bay's ecosystem. *Phragmites australis* was identified as one of the six priority species for which a Bay-wide management plan would be written. In May 2002, the CBP, in partnership with Maryland Sea Grant College, sponsored a workshop in Baltimore, Maryland aimed at developing draft Bay-wide management strategies for each of the six species. In 2003, a Chesapeake Bay *Phragmites australis* Working Group, comprised of many of the workshop participants, as well as other natural resource managers and researchers was appointed by CBP to develop a final Bay-wide management plan.

This final management plan is a product of the draft Bay-wide management strategy developed for *Phragmites* at the May 2003 workshop. Workshop participants developed a draft management strategy utilizing four different components: 1) Leadership, Coordination, and Regulatory Authority; 2) Prevention; 3) Control and Management; and 4) Communication and Information Access. Participants identified specific actions within each of the components that should be taken to meet the goal of their management strategy. An implementation table was developed and included a time frame for completing the actions, identification of agencies responsible for leading actions, alist of the partners that should be involved, the funding/cost share, and the source of funding. To insure that the draft management strategy developed at the workshop was realistic in terms of feasability of implementing actions, including agency leads and sources of funds available to implement actions, a Bay-wide Working Group was established to evaluate the draft management strategy, make changes if needed, and develop a final plan to

be submitted to the Implementation Committee of the Chesapeake Program for approval.

The goal of this plan is as follows:
By 2005, have a permitting process in development in each state (MD, VA, and PA) that includes control of *Phragmites* as a wetland permit condition, which will assist the states in achieving a long-term goal of no net gain in *Phragmites* acreage.

I. Introduction

Phragmites is among the most widespread and productive plant species in the world (den Hartog et al., 1989). It has been a component of eastern United States marshes for at least 3,000 years (Niering et al., 1977; Orson, 1999). Prior to the last one hundred years, *Phragmites* was commonly found along the marsh upper border in mixed associations with plants such as sedges and cattails. In the last century, however, *Phragmites* has become dominant in many mid-Atlantic marshes, where it is commonly found growing in monocultures that reduce both species diversity and wildlife habitat (Cross and Fleming, 1989). Recent genetic analysis of *Phragmites* collected throughout the world has revealed that an aggressive, competitively superior strain has been introduced from Europe and Asia to North America, competing with and limiting distribution of the native strain throughout the East Coast (Saltonstall, 2002). Marshes invaded by *Phragmites* can pose a problem for natural resource managers that are managing these areas for waterfowl and wildlife habitat.

Efforts to control introduced *Phragmites* in the Chesapeake Bay watershed have been extensive. Many of the states in the watershed are mandated to control *Phragmites* on state owned wildlife management areas and provide cost-sharing for private landowners that have substantial stands of *Phragmites* that are deemed a significant threat to preservation of valuable wildlife habitat. However, after extensive research on this species, we now know that there are native *Phragmites* lineages present in the Bay watershed and that *Phragmites* may have positive attributes in certain areas. This new knowledge demonstrates the need for a Bay wide approach to preventing new establishment and prioritizing control efforts for non-native genotypes in invaded areas where effective management can be achieved and native plant diversity can be re-established.

In January 2003, the CBP ISWG convened a Chesapeake Bay *Phragmites* Workgroup comprised of researchers and federal and state natural resource managers, to develop a management plan for the prevention and control of *Phragmites* in the Chesapeake Bay watershed. The overall goal of this Bay wide management plan is to have a permitting process in development in each state that includes control of *Phragmites* as a wetland permit condition, which will assist the states in achieving a long term goal of a no net gain in *Phragmites* acreage. The management plan consists of an introduction which summarizes our current understanding of the biology and ecology of this species, its invasion history, ecological impacts, current distribution and management efforts in the Chesapeake Bay watershed, and finally, state policies regarding management. A Management Actions section consists of the objectives and strategies that will work to meet the goal of the plan. Objectives and strategies were developed under four components, which include: 1) Leadership, Coordination, and Regulatory Authority; 2) Prevention; 3) Control and Management; and 4) Communication and Information Access. Finally, an Implementation Section was developed to assign appropriate cooperating agencies to

lead the implementation of specific strategies and includes a budget, source of funding, and a time line to accomplish the strategies.

A. Summary of Biology and Ecology

Phragmites australis, (Cav.) Trin. Ex Steudel or Common Reed, is a perennial, coarse wetland plant, belonging to the family Poaceae. *Phragmites* can be described as having erect culms 2-4 m tall that support broad sheath-type leaves that are 1-4 cm wide near the base, and taper to a point at the end. The foliage is grey-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).

Phragmites is found throughout the temperate regions of North America. It is found primarily in and near fresh to brackish wetlands, growing at or above mean high water, but can also inhabit riparian areas, riverbanks, and lakeshores. The species is especially common in disturbed or polluted soils, ditches, and dredged areas. Along the Atlantic Coast, it is common in moist uplands and wet areas of the dune systems of coastal barrier islands (Gleason and Cronquist, 1963; Fernald, 1970; Brown and Brown, 1984).

Phragmites colonization is commonly associated with disturbed marsh areas, which usually means areas where plant communities, hydrology, and topography have been altered through natural events (e.g., storms, lightning strikes, fires) or anthropogenic events (e.g., logging, mining, waste disposal, intentional flooding, dredge spoil disposal, and shoreline development). The plant can tolerate standing water, low oxygen levels, and acidic sediments, which allow it to thrive in disturbed habitats often unsuitable for other plants (Marks et al., 1994; Bart and Hartman, 2000). Researchers (Ailstock et al., 2001; Bart and Hartman, 2000; Burdick and Konisky, 2002) suggest that *Phragmites* has been successful in establishing itself, in part, because of an ability to modify disturbed habitats into conditions highly conducive to its further propagation and establishment. Numerous studies report on changes in disturbed marsh hydrology with the development of *Phragmites* stands (see Marks et al., 1994; Chambers et al., 2002). However, Osgood et al. (2002) reported that through physiological effects on ion, oxygen, and carbon balance, respectively, salinity, sulfide, and prolonged flooding combine to constrain the invasion and spread of *Phragmites*.

This plant is a highly successful colonizer due to a combination of unique adaptive features. It propagates in several ways, by seed dispersion and vegetatively from vertical and horizontal rhizomes and stolons. Disturbance of wetland substrate provides opportunities for seed germination. Spoil banks associated with ditching and filling marshes (especially along roads) disturbs the soil, and bare, oxidized soil provides an appropriate site for colonization by seed (Haslam, 1971; Wijte and Gallagher, 1996). Colony expansion, however, occurs primarily by rhizomes in wet organic soils and rhizomes and stolons in sandy soils. Under optimal conditions, there can be growth in excess of 10 m in one growing season. Such rapid growth is possible because the horizontal stems of *Phragmites* exhibit strong apical dominance. Growth is channeled to the extension of these stems rather than the production of new aerial stems from subtending nodes (Ailstock, 2000).

Hydrologic alterations are perhaps the major factor leading to the invasion of native marshes by pre-existing stands of *Phragmites*. Alterations to the natural hydrology of salt marshes include: (1) tidal restrictions that lower flood frequency as well as salinity, which at high levels,

may kill *Phragmites* (Roman et al., 1984; Burdick et al., 1997); and (2) increasing fresh water discharge in channels, over the soil surface, and through ground water (Burdick et al., 2001).

Phragmites has abundant aerenchyma and stomatal densities, on both sides of the leaves, which provide a much more efficient pathway for acquiring oxygen for aerobic respiration, carbon dioxide for photosynthesis, and mineral nutrients for growth and development than other emergent marsh vegetation. *Phragmites* also possesses three adaptations that inhibit the growth of other species of wetland vegetation. The quantity and arrangement of mechanical tissues allows *Phragmites* to attain greater heights than other species. Stem densities observed in monotypic colonies are high. In mature stands, an average of 30-400 shoots per m^2 can be counted (Haslam, 1972). *Phragmites* occupies the maximum available space and prevents light penetration, providing very little opportunity for other species to inhabit an area (Haslam, 1971). The combination of mechanical tissue and high stem densities results in a third adaptive strategy that makes use of dead aerial stems. These stems tend to persist but when they break, they generally do so at the first or second node above the soil surface. As a consequence, *Phragmites* colonies tend to form a dense thatch layer that can block sunlight from reaching the soil and inhibit the growth of other plants species in that area (Ailstock, 2000).

B. Introduction History

Paleoecology studies of peat samples show that *Phragmites* has grown in New England tidal marshes for at least the last 3,000 years (Orson et al., 1987). Phragmites has also been found at historical depths in marshes in Delaware (Kraft, 1971) and New Jersey (Waksman, 1943). Research by Kiviat and Hamilton (2001), Ford et al. (1970) and others have shown that *Phragmites* was used by native Amerind populations throughout North America prior to European settlement. Prior to the 1900s, *Phragmites* was often found along the marsh upper border in mixed associations with plants such as sedges and cattails. Many researchers (Blossey and McCauley, 2000; Norris et al., 2002; Rice et al., 2000) note that during the 1900s, in parts of North America, *Phragmites* rapidly expanded its range and successfully invaded high and low marsh zones where historically it has been scarce. Estimates indicate that in some states along the eastern U.S. coast, as much as one third of the tidal wetland acreage is now occupied by *Phragmites* (Chambers et al., 1999).

Although there is research currently underway to better understand the aggressive nature of expanding populations, many concur with Marks et al. (1994) and Roman et al. (1984) that the rapid population expansion of *Phragmites* may be driven partially by human activities that have led to habitat destruction, sedimentation, eutrophication and decreased oxygen levels in water, and sediments in marsh areas. There is also a growing concern in the region that the use of constructed wetlands to replace natural wetlands (lost to development) may compromise the function and value of the wetland ecosystem due to their susceptibility to invasion by *Phragmites* (Havens, 2000; Havens, 2002).

Others speculate that present expansion rates are due to an introduced genetic strain of *Phragmites* (Metzler and Roza, 1987; Tucker, 1990; Mikkola and Lafontaine, 1994; Besitka, 1996). Recent genetic analysis of *Phragmites* samples collected throughout the world has revealed that there are 11 haplotypes that are unique to North America. One haplotype (Haplotype M) however, which is the most common today in North America, Europe, and Asia, was found in few samples collected from the Atlantic Coast before 1910. Since 1910, this

haplotype has dramatically increased its distribution and dominates marshes in the Chesapeake Bay region, while only a few relict native populations exist (Saltonstall, 2002). It is likely that this competitive and agressive haplotype was introduced to North America as its genetic makeup is most closely related to Eurasian types (Saltonstall, 2002). This introduction probably occurred during the early part of the 19th century, most likely at one of many coastal ports along the Atlantic Coast. In the 1800's *Phragmites* was documented as growing in places where ship's ballast was dumped or used to fill marsh lands being converted to railroad and shipping hubs (Saltonstall, 2002).

C. Summary of Ecological Impacts

Many jurisdictions in the United States are concerned about the rapid invasion of *Phragmites* and the threat it may pose to biodiversity and ecosystem function. *Phragmites* can be considered a noxious weed and management of it is often aggressive. Many studies (Warren et al., 2001; Meyerson et al., 2000; Chambers et al., 1999; Weisser and Parsons, 1981; Szczepanska and Szczepanski, 1982; Galinato and van der Valk, 1986; Marks et al., 1994) report that stands of *Phragmites* produce conditions that are not conducive to the establishment of other plant species, and that colonization of disturbed wetland areas by this plant usually ensures the development of dense stands. By forming monocultures, *Phragmites* can take the place of other wetland species that are considered to be more important as food and cover for wildlife (Ailstock, 2001). *Phragmites* commonly replaces dominant plant species of tidal marshes, including *Spartina* species in salt marshes (Windham, 1995) and *Typha* species in freshwater marshes (Chambers et al., 1999) but can also threaten rare and endangered plant populations (Marks et al., 1993). Beyond the common lack of plant species diversity in *Phragmites*-dominated wetlands, however, other aspects of ecological change are less clear.

Intertidal marsh macroinvertebrates, most of which occupy habitats on or just below the marsh sediment surface, can be sensitive to habitat dominance by *Phragmites*. Phragmites induced changes to the marsh may include reduced microtopographic relief (Windham and Lathrop, 1999) and lower abundance of intertidal standing water microhabitats, increased detritus loading, decreased soil salinity, increased soil aeration, increased depth to the water table (Windham, 1995; Windham and Lathrop, 1999), increased shading and decreased benthic microalgal productivity (Wainright et al., 2000) and altered patterns of predation pressure (Levin and Talley, 2000). Angradi et al. (2001) found that changes in intertidal habitat of tidal brackish marshes in New Jersey resulting from the conversion from *Spartina* to *Phragmites* marsh influenced the structure of macroinvertebrate fauna and reduced biodiversity. Alternatively, Fell et al. (1998) found that the diversity and abundance of trophically important salt marsh macroinvertebrates was similar or greater within *Phragmites* for certain taxa.

Able and Hagan (2000) evaluated the impact of *Phragmites* on fish and decapod crustacean use of the marsh surface in the brackish water reaches of the Mullica River, in southern New Jersey. They reported that there was an overall negative effect of *Phragmites* on larval and small juvenile fish, particularly on *Fundulus heteroclitus*, an abundant resident fish that plays an important role in the transfer of energy from the marsh surface to adjacent subtidal rivers and thus estuarine food webs. Able et al. (2002) found fish abundance to be higher in treated *Phragmites* sites versus *Spartina* or *Phragmites* dominated sites. Additionally, Raichel et al. (2002) found that *F. heteroclitus* was more abundant on the marsh surface in the Hackensack

Meadowlands, New Jersey, in *Spartina*-dominated habitats versus *Phragmites* habitat. Other juvenile fish assemblages were similar in the different habitats. Alternatively, Fell et al. (2002) reported that fish (*F. heteroclitus*) and shrimp (*Palaemonetes pugio*) abundance was similar in *Phragmites*, *Typha angustifolia*, and treated *Phragmites* areas in the lower Connecticut River tidelands. A relatively small number of larval and juvenile *F. heteroclitus* were captured in *Phragmites* dominated marsh, however, suggesting that *Typha* and brackish meadow marshes may provide better nursery habitat.

Although *Phragmites* stands are considered important wildlife habitat in Europe (Holisova, 1975; Hudec and Stasny, 1978; Bibby and Lunn, 1982), there has been much dispute in North America regarding their value as food and habitat for birds and other wildlife. In examining northeastern saltmarshes, Benoit and Askins (1999) discovered that ecological specialists and rare species such as willet, seaside sparrow, and sharp-tailed sparrow were less abundant in *Phragmites* than in non-*Phragmites* vegetation. They theorized that while prey species may be abundant in *Phragmites*, stands may not be suitable habitat for birds if the density of the vegetation makes prey inaccessible or substantially reduces hunting efficiency. Additionally, Roman et al. (1984) reported that waterfowl usage was reduced substantially in *Phragmites*-dominated marshes. Alternatively, Parsons (2003) found that *Phragmites* marsh at colony sites, such as Pea Patch Island in Delaware Bay, provides critical nesting habitat for nesting wading birds both as substrate for nesting and buffer habitat to control human disturbance.

More than 70 species of birds breed in *Phragmites* stands and many use *Phragmites* as nesting material. Information is scarce, however, on nesting success in *Phragmites* versus non-*Phragmites* vegetation. *Phragmites* is more important to North American wildlife for shelter than food, and wildlife seems to use *Phragmites* edges, mixed stands, and patchy stands more than dense interiors of extensive stands (Kiviat et al., 2002).

Rooth and Windham (2000) argue that *Phragmites*-dominated habitats can have positive attributes. For example, *Phragmites* can serve as an important soil stabilizer through root growth and thatch accumulation in areas prone to erosion. It may enhance water quality through nutrient cycling and transpirational water loss (Ailstock, 2001). Further, in highly polluted or disturbed areas it may be the only plant that can survive under those conditions. Ailstock (2001) suggested that control programs be evaluated in light of costs, the goals of enhancing biodiversity, and the system attributes that influence conversion to *Phragmites*-dominated plant communities.

D. Distribution in the Chesapeake Bay Watershed

Phragmites is now the dominant macrophyte in a wide variety of intertidal environments in the Chesapeake Bay (Stevenson and Rooth, 2002) and in freshwater tidal wetlands (Ailstock et al., 2001).

Delaware

There have been no formal surveys conducted to determine *Phragmites* distribution in Delaware. The Delaware Division of Fish and Wildlife (DFW), through control efforts however, note that this species is distributed statewide. Largest concentrations of *Phragmites* are found in coastal brackish-fresh marshes specifically in the tax ditch drainage system, freshwater ponds, bordering the inland Bays, and dredge spoil areas (William Jones, personal communication).

Maryland

The United States Fish and Wildlife Service Chesapeake Bay Field Office (USFWS CBFO) conducted aerial surveys of tidal marshes in Maryland and Virginia from 1995 to 1997. The largest patches of *Phragmites* occur in dredge spoil areas. The greatest extent of *Phragmites* in natural marshes occurred on the lower Eastern Shore from the Nanticoke River south to the Pocomoke River, the Eastern Bay and Chester River area, Baltimore Harbor, C&D Canal, and Aberdeen Proving Grounds (Figure 1).

Pennsylvania

Highest concentrations of *Phragmites* in Pennsylvania occur in the southeast corner of the state along the Delaware estuary system (Figure 1).

Virginia

Occurrence of *Phragmites* is widespread in eastern Virginia and in some areas of western Virginia. The USFWS CBFO survey detected the largest expanses of *Phragmites* located in or near dredge spoil areas and highly disturbed marshes. Natural marshes with the greatest extent of *Phragmites* were the upper Eastern Shore south of the Pocomoke River, on the lower James River, and in marshes near the Tappahannock and the lower Pamunkey River (Figure 1).

E. Management of Phragmites

Methods to control *Phragmites* include chemical spraying with glyphosate (N-(phosphonomethyl) glycine), wicking (wipe-on herbicide application), and sulfide treatments. In November of 2003, Habitat® (Imazapyr) herbicide was registered for full aquatic use for emergent and floating aquatic vegetation. Preliminary indications are that Habitat® provides more effective, long-term control than glyphosate. A typical Habitat® program would include a spring burn, followed by one broadcast treatment (2 qts./acre) when the phragmites is 2-3 feet tall. The following year should require only spot treatments. Habitat will reduce the number of applications, increase the application window to include the entire growing season, and decrease the amount of active ingredient used in the environment (personal communication, Jim Bean, BASF Corporation). High cost, however, could limit the widespread use of this herbicide for phragmites control in the Chesapeake Bay region at this time.

Mechanical control options include water management, disking, bulldozing, dredging, seasonal mowing, cutting, use of plastic barriers, perimeter ditching, burning, and shading. Over 100 insects are known to attack *Phragmites* in Europe and about 50% of these are *Phragmites* specialists. Blossey (2000) is currently assessing their potential as biocontrol agents. Norris et al. (2002) and Marks et al. (1993) provide a comprehensive review of control options.

F. Management Efforts in the Chesapeake Bay Watershed

Delaware

The DFW initiated monitoring for *Phragmites* in 1949. At the same time, DFW began a cooperative study with USFWS aimed at developing *Phragmites* control methods in Delaware marshes. The DFW continued experimenting with different control methods up until the mid 1980's. Delaware's current strategy for *Phragmites* control involves aerially applying 4 pints Rodeo®/acre plus 1/2% non-ionic surfactant (LI-700®) per total spray volume in 5 gallons of

water per acre. Dead canes are burned the following spring. The DFW has used the "herbicide and burn" technique operationally on state wildlife areas and private lands since 1986. The Division cost shares 50/50 for private landowners on two helicopter applications of Rodeo®, with the option to spray an additional year under the original agreement. Landowners can then sign up for another three years if they desire. Landowners must have between 5 and 200 acres of *Phragmites* to treat on their property, and the property cannot be in a "developed" area. In 2002, DFW sprayed 2,410 acres of private lands and provided $64,585 in state match.

Maryland

Maryland initiated a *Phragmites* chemical control program in 1995 with private landowners. As part of a legislatively mandated program, landowners who have substantial stands of *Phragmites* that are deemed a significant threat to preservation of valuable wildlife habitat, are allowed to control *Phragmites* on their own property (Maryland General Assembly, SB65, HB 535). The State of Maryland offers landowners a 50 percent cost share program coordinated through the Maryland Department of Natural Resources (MDNR) in cooperation with the Maryland Department of Environment (MDE). Participants cannot receive more than $12,000/year and MDNR cannot spend more than $60/acre on control (Maryland General Assembly, SB65, HB 535). The mandating legislation, SB65, has no appropriation so, in 2002, MDE and MDNR provided support for control of approximately 688 acres of *Phragmites* on private lands in Dorchester, Somerset, Wicomico, Caroline and Talbot counties (D. Webster, personal communication). A Landowner's Guide is distributed by the MDNR to encourage participation in the program.

MDNR also applied Glypro® by helicopter to 500 acres of *Phragmites* on State owned Wildlife Management Areas on the Lower Eastern Shore and the Patuxent River (Maryland DNR, 2003). *Phragmites* management on public lands is supported by the Maryland Waterfowl Stamp Fund.

Pennsylvania

The Pennsylvania State Parks system treats limited acreage of *Phragmites* with herbicide. Additionally, in Presque Isle State Park in the Lake Erie area the State Parks Department has an ongoing applied research program on control management strategies for *Phragmites* (John Melei, personal communication).

Virginia

Cooperative efforts between state and federal agencies, academia, private landowners, and non-governmental organizations have resulted in a number of *Phragmites* control and management efforts in the Coastal Bays areas, including Parramore and Hog Island (Curtis Hutto, personal communication). A control and restoration demonstration project was conducted on 600 acres of the Hog Island Wildlife Management Area by the Virginia Department of Game and Inland Fisheries. They reported a reduction in *Phragmites* after two years of treatment; however, cessation of treatment resulted in recolonization within one year.

The Rappahannock Phragmites Action Committee, a coalition of federal, state, and private interests, initiated control of *Phragmites* in marshland along the Rappahannock River in 2001 (Wellford, 2001). This on-going program is supported by the USFWS. Other management efforts

in Virginia include a monitoring and control program at the Dameron Marsh Natural Area Preserve in Northumberland County, Virginia. Funded by the Wetland Trust Fund, this program was initiated in 2000 and will continue until 2004.

G. Policy Background

Delaware

The existence of *Phragmites* in Delaware is considered a public and common nuisance. The Department of Natural Resources and Environmental Control (DNREC) may make investigations, studies, and determinations to ascertain the extent of growth and infestation of *Phragmites* and its effect on wildlife and the environment. The Department may institute programs of control and eradication and may enter into agreements with federal or state entities to effect these controls. The Department may enter into an agreement with a county to control and eradicate *Phragmites* within that county. Under the agreement, the Department and county may conduct surveys to determine the location and amount of infestation, may provide technical and financial assistance to landowners on a cost-sharing basis in a cooperative control or eradication program, and may effect a program of mowing, spraying, or other control or eradication practices on road rights-of-way, drainage ditch banks, parks, playgrounds, and other public or private lands (Del. Code tit. 7 §3802).

Maryland

Although considered a public and common nuisance on lands and wetlands used for wildlife habitat areas, *Phragmites* is not a state listed noxious weed. As mentioned previously, legislation was enacted in 1995 to provide cost sharing assistance for private landowners (MD Code Ann. Nat. Res. §8-2101). Further, the Department of Natural Resources is required to implement a program to control the spread of *Phragmites*, where appropriate on lands that the Department owns (MD Code Ann. Nat. Res. §8-2105).

Virginia

The Department of Conservation and Recreation's Division of Natural Heritage is partnering with the Virginia Native Plant Society through the Invasive Plants Cooperative Project to identify alien plant species that have the potential to become invasive in Virginia; document the threat posed by specific invasive alien plant species; educate the public about the issue; coordinate with other agencies and organizations to identify mutual concerns and develop reasonable solutions; and develop and implement sound practices for the control of invasive alien plants in natural areas. An exception to the rules regulating the burning of woods, brush, and debris is made for prescribed burns being conducted to control exotic and invasive plant species that cannot be accomplished at times of the year that would otherwise satisfy regulations (VA Code Ann. §10.1-1142). *Phragmites* is on the Virginia Department of Conservation and Recreation's advisory list, which is a non-regulatory list. *Phragmites* received the highest "invasiveness" ranking on the list.

Pennsylvania

Phragmites is not on the Pennsylvania's noxious weed list and thus not managed by the state's Department of Agriculture (Leo Dunn, personal communication).

II. Management Actions - Explanatory Text for the Implementation Table

Goal:
By 2005, have a permitting process in development in each state (MD, VA, and PA) that includes control of *Phragmites* as a wetland permit condition, which will assist the states in achieving a long term goal of a no net gain in *Phragmites* acreage.

A. Leadership, Coordination and Regulatory Authority

Needs:
Workshop participants and regional workgroup members all agreed that there needs to be better coordination among the states in the Chesapeake Bay watershed with regard to management and understanding of *Phragmites*. Workshop participants suggested establishing a single *Phragmites* coordinator for each state. Regional workgroup members, however, believe that it would not be feasible to fund such a position due to budgetary constraints in many of the states.

Actions:
1.1-1.3: A web-based information clearinghouse will be used to document research, monitoring, and management activities within the states in the watershed. This will initially require creation of a directory of agencies, research institutions, and individuals that manage, monitor, or conduct research on *Phragmites*. The website then can provide a description of annual activities of these entities. A lead contact should be identified in each state to assist in the creation of the directory.

B. Prevention

Needs:
Workshop and regional workgroup members believe that development of a permitting process that requires wetland permit applicants to monitor and control *Phragmites* is the key to achieve a no net gain in *Phragmites* in the Chesapeake Bay watershed.

Actions:
1. Review the wetland permitting process in each of the states.
1.1: Determine if there are requirements for monitoring or controlling *Phragmites* in created wetland sites or other wetland areas where mosquito ditching, road development, and other activities that result in wetland disturbance are permitted by a federal, state, or local agency.

1.2: Identify agencies and individuals involved with reviewing permits concerning wetland construction or disturbances and incorporate into the web-based clearinghouse.

1.3: If current permit conditions are insufficient, work to develop new permit conditions that will assist in preventing new invasions from occurring in these sites. This will require working with state legislatures and agencies.

2. Monitoring
2.1: Establish a baseline rate of expansion in different physiographic regions using aerial surveys, aerial photography, or ground surveys.

2.2: Require monitoring of *Phragmites* as a condition of a wetland permit.

2.3: Determine whether NWI will be able to map *Phragmites* in the Chesapeake Bay watershed as part of its wetland mapping efforts in the northeast.

2.4: Determine the willingness and usefulness of watershed organizations or other citizen monitoring in mapping and coordinating control efforts for *Phragmites*.

2.5: Identify native stands of *Phragmites* and make information available on a GIS web-based clearinghouse for resource managers actively involved in controlling *Phragmites*.

C. Control and Management

1. Control

Needs: Workshop participants and regional workgroup members believe that there needs to be an assessment of which geographic areas in each of the states should be given high priority for control based on specified criteria.

1.1: Develop criteria to determine what geographic areas should receive the highest priority for control.

1.2: Evaluate long-term effectiveness and cost of control efforts, including: 1) control of large versus small stands; and 2) use of glyphosate versus Imazaypyr combined with different treatment timings and mechanical and cultural practices.

1.3: Develop "Best Management Practices" for federal, state, and local agencies that are involved with the wetland regulatory process.

1.4: Develop a control checklist that can be used by federal, state, and local natural resource managers to evaluate control options.

2. Research

2.1: Evaluate reproductive strategies of the native genotype and determine how it persists and competes with the non-native strain. Determine consistent morphological characteristics that can be utilized in identification of the native genotype in the field.

2.2: Evaluate biocontrol options for *Phragmites.*

D. Communication and Information Access

Needs:

Communication needs to be enhanced between the states in the Chesapeake Bay watershed regarding management and research of *Phragmites*.

Actions:

1.1: A web-based clearinghouse will be established to provide ready access to information associated with management actions which are implemented within the plan. The clearinghouse

will also include a directory of agencies, academic institutions, and individuals associated with the management and research of *Phragmites* and agencies involved with the wetland regulatory process. The site can also be used to post a current synthesis of results in the areas of research and management activities and for potential funding sources for research and control of phragmites.

1.2: Produce a "Best Management Practices" brochure for wetland regulatory agencies; post on web-based clearinghouse. The brochure can be given to permit applicants to assist them in preventing new invasions of *Phragmites.*

1.3: Produce a "Control Checklist" brochure for natural resource management agencies and private landowners; post on web-based clearinghouse.

III. Implementation Table

An implementation table is provided for each of the four management components. For each action identified under the components, we have identified a time frame for completing the actions, identification of agencies responsible for leading actions, the partners that should be involved, the funding/cost share, and the source of funding.

A. Leadership, Coordination, and Regulatory Authority

Action	Tasks	Task Description	Task Duration	Cost	Funding Source	Lead Agency	Partners
Coordinate *Phragmites* Management and Research Programs in the Chesapeake Bay watershed							
	1.1	**Identify agencies, research facilities, academic institutions and individuals within these entities within the Chesapeake Bay watershed that research and manage *Phragmites***	**6 months**	**none, in-kind services**		**CBP fellow**	**Key contact in state natural resource department (MDNR, VDGIF, PDCNR)**
	1.2	**Determine management activities, monitoring, and research being conducted by these entities; identify potential funding mechanisms to implement management actions**	**6 months to one year**	**none, in-kind services**		**CBP fellow**	**Key contact in state natural resource department (MDNR, VDGIF, PDCNR)**

	1.3	**Incorporate information on a web based information clearinghouse**	**on-going**	**in-kind services**		**CBP fellow**	**Key contact in state natural resource department (MDNR, VDGIF, PDCNR)**

B. Prevention

Action	**Tasks**	**Task Description**	**Task Duration**	**Cost**	**Funding Source**	**Lead Agency**	**Partners**
Review wetland permit process							
	1.1	**Determine if there are requirements for controlling *Phragmites* in created wetland sites or wetland areas where road development, ditching and other practices are permitted**	**6 months**	**In-kind services**		**USFWS-CBFO**	**state natural resource agencies (MDNR, VDGIF, PDCNR), MD Critical Areas Commission**
	1.2	**Identify agencies and individuals involved with reviewing permits concerning wetland construction or disturbances and incorporate into the clearinghouse**	**6 months**	**In-kind services**		**USFWS-CBFO**	**Key contact in state natural resource department (MDNR, VDGIF, PDCNR)**

B. Prevention (con.)

Action	Tasks	Task Description	Task Duration	Cost	Funding Source	Lead Agency	Partners
	1.3	**Work to develop permit conditions that will assist in preventing new invasions from occurring in these wetland sites and insure that these sites are monitored and controlled if *Phragmites* becomes established**	**One year**	**In-kind services**		**USFWS CBFO**	**MDE, VADEQ, VMRC, ACOE**
Monitoring							
	2.1	**Establish a baseline rate of expansion in different physiographic**	**3-5 yrs.**	**$100,000**	**DOD?**	**State universities**	**USFWS, NPS, USGS, ACOE, state natural resource agencies**
	2.2	**Establish monitoring of *Phragmites* as a requirement for a wetland permit**	**One year**	**In-kind services**		**MDE, VADEQ, VMRC, ACOE**	**ACOE**

B. Prevention (con.)

Action	Tasks	Task Description	Task Duration	Cost	Funding Source	Lead Agency	Partners
	2.3	**Determine feasability of NWI mapping *Phragmites* in the Chesapeake Bay watershed as part of their wetland mapping efforts in the northeast**	**6 months**		**NWI**	**USFWS**	**NWI**
	2.4	**Determine feasability and willingness of watershed organizations or other citizen monitoring groups in mapping *Phragmites* and coordinating control efforts**	**1 year**		**in-kind**	**USFWS CBFO**	**State natural resource agencies**
	2.5	**Identify native stands of *Phragmites* and make available on a GIS web based clearinghouse;**	**on-going**		**in-kind**	**MD Heritage Program (MDNR), Virginia Heritage Program (VA DCR), VIMS**	**UMD CEES, Cornell University**

C. Control and Management

Action	Tasks	Task Description	Task Duration	Cost	Funding Source	Lead Agency	Partners
Control							
	1.1	**Develop criteria to establish regional priorities for control of *Phragmites***	**3 years**	**in-kind**		**State natural resource agencies**	**USFWS**
	1.2	**Evaluate effectiveness of different control options over time**	**2 years**	**in-kind**	**BASF, in-kind (staff and equipment)**	**Virginia Department of Conservation and Recreation**	**State natural resource agencies, USFWS, BASF Corporation**
	1.3	**Develop a control checklist**	**2 years**	**in-kind**		**USFWS CBFO**	**State natural resources agencies**
	1.4	**Develop a "best management practices" document for land disturbing activities**	**1 year**	**in-kind**		**UMD-CEES**	**State natural resource agencies, FWS, NPS**

C. Control and Management (con.)

Action	Tasks	Task Description	Task Duration	Cost	Funding Source	Lead Agency	Partners
Research							
	2.1	**Evaluate reproductive strategies of the native genotype and determine how it persists and competes with the non-native strain**	**3 years**	**$50,000-100,000**	**Sea Grant Noninidgenous Species Research Grant?**	**UMD-CEES**	**DNREC, MDNR, USFWS**
	2.2	**Research biocontrol options**	**5 years**	**$500,000**	**Federal-Department of Defense**	**Cornell University**	**USFWS**

D. Communication and Information Access

Action	Tasks	Task Description	Task Duration	Cost	Funding Source	Lead Agency	Partners
Enhance regional communication regarding management and research of *Phragmites*							
	1.1	**Establish and maintain a web based information clearinghouse**	**2 years**	**$30,000**	**Sea Grant Nonindigenous Species Outreach Grant**	**CBP**	**EPA CBP, USFWS, NPS, USGS**
	1.2	**Produce a "Best Management Practices" brochure for regulatory agencies**	**1 year**	**$10,000**	**Chesapeake Bay Trust or Sea Grant Nonindigenous Species Outreach Grant**	**UMD-CEES**	**USFWS**
	1.3	**Create a "Control Checklist" for natural resource management agencies and private landowners**	**1 year**	**$10,000**	**Chesapeake Bay Trust or Sea Grant Nonindigenous Species Outreach Grant**	**State natural resource agencies**	**USFWS**

Agency Abbreviations: Army Corps of Engineers (ACOE), Delaware Department of Natural Resources and Environmental Control (DNREC), Maryland Department of Natural Resources (MDNR), Maryland Department of the Environment (MDE), National Park Service (NPS), National Wetlands Institute (NWI),

Pennsylania Department of Conservation and Natural Resources (PDCNR)**,** United States Fish and Wildlife Service Chesapeake Bay Field Office (USFWS CBFO), United States Geological Society (USGS), University of Maryland Center for Estuarine and Environmental Science (UMD-CEES), Virginia Department of Environmental Quality (VADEQ) Virginia Department of Game and Inland Fisheries (VDGIF), Virginia Institute of Marine Science (VIMS), Virginia Marine Resources Commission (VMRC).

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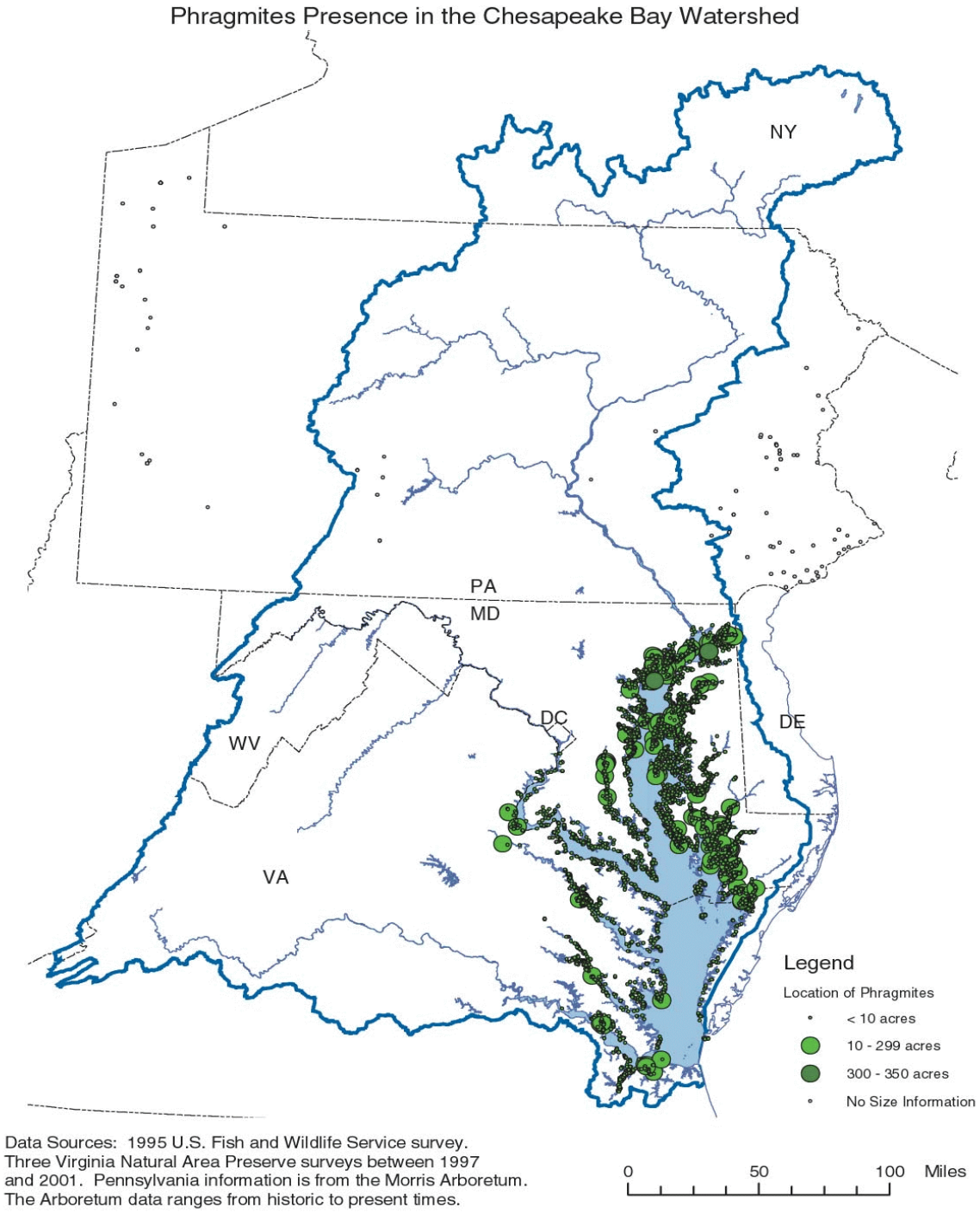
Figure 1.


Phragmites Presence in the Chesapeake Bay Watershed
NY
PA
MD
DC
DE
WV
VA
Legend
Location of Phragmites
< 10 acres
10 - 299 acres
300 - 350 acres
No Size Information
Data Sources: 1995 U.S. Fish and Wildlife Service survey.
Three Virginia Natural Area Preserve surveys between 1997
and 2001. Pennsylvania information is from the Morris Arboretum.
The Arboretum data ranges from historic to present times.
0
50
100
Miles