COMMONWEALTH of VIRGINIA

Management Plan for Taskinas Creek Chesapeake Bay National Estuarine Research Reserve

Prepared by:
Virginia Department of Conservation and Recreation
Division of Natural Heritage

Natural Heritage Technical Report #07-10
2008

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CONSERVING VIRGINIA'S NATURAL AND RECREATIONAL RESOURCES

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Management Plan for Taskinas Creek Chesapeake Bay National Estuarine Research Reserve

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Management Plan for Taskinas Creek
Chesapeake Bay National Estuarine Research Reserve

PLAN SUMMARY

Taskinas Creek Reserve is one of the four components of the Chesapeake Bay National Estuarine Research Reserve System in Virginia (CBNERRVA). The National Estuarine Research Reserve System (NERRS) is administered nationally by the National Oceanic and Atmospheric Administration (NOAA) for the primary purpose of addressing research and management issues in coastal and estuarine environments across the United States.

CBNERRVA is administered by the Virginia Institute of Marine Science (VIMS) within the College of William and Mary. Reserve components currently comprising CBNERRVA are Goodwin Islands, Catlett Islands, Taskinas Creek, and Sweet Hall Marsh. Taskinas Creek Reserve is situated within York River State Park (YRSP), which is owned and managed by the Virginia Department of Conservation and Recreation, Division of State Parks (DCR-DSP). Resource management and use of Taskinas Creek is coordinated by managers and staff of YRSP and the CBNERRVA Program Director.

The 1034-acre Taskinas Creek Reserve is located on the north side of the "Lower Peninsula" between the James and York Rivers in the central Coastal Plain of Virginia. The regional landscape is one of considerable relief, characterized by broad rolling uplands that are extensively incised by secondary streams. Downcutting of these streams has resulted in the formation of numerous dendritic ravine systems draining into the larger streams and rivers, which are subestuaries of the Chesapeake Bay. The Taskinas Creek Reserve is a pronounced example of this dissected upland topography, containing more than ten deep ravines, a large number of steep to almost bluff-like slopes, and numerous narrow ridges forming the interfluves.

Taskinas Creek Reserve supports outstanding occurrences of two natural forest communities, a healthy population of the state rare plant species mountain camellia (*Camellia montana*), high quality Bald Eagle habitat, significant historic and recreation resources, and a well-developed environmental education program associated with the surrounding York River State Park. Key management issues at Taskinas Creek include invasive species control and monitoring, protection of surface and groundwater resources, protection and monitoring of rare species and natural communities, and balancing recreational use demands at the park with the research and outreach mission of the Reserve.

The purpose of this management plan is to guide an adaptive management process that supports the research mission of Taskinas Creek Reserve and protects natural resources. This plan has an intended timeline of approximately five years.

INTRODUCTION

Site Purpose

The core mission of CBNERRVA is to preserve a network of research reserves that represent the diversity of coastal ecosystems found within the York River estuary and its principal tidal tributaries and to manage these reserves to support informed management of coastal resources through estuarine research, education, stewardship, and advisory service.

Taskinas Creek Reserve was selected as a component representing mesohaline conditions the York River transition zone where salinity ranges annually from 5 - 19 ppt (NOAA/NERRS SWMP Data, Taskinas Creek, 2003-2006). The reserve is characterized by extensive forested uplands flanking the tidally-influenced Taskinas Creek – a small northeast-flowing tributary of the York with a watershed located mostly within York River State Park (YRSP).

York River State Park is owned and managed by the Virginia Department of Conservation and Recreation, Division of State Parks (DCR-DSP). The portion of the park comprising the Taskinas Creek Reserve is incorporated into the CBNERRVA system through a formal memorandum of understanding (MOU) between VIMS and DCR-DSP which guides the management relationship between the two organizations. VIMS and DCR staff most recently met on December 14, 2007 to review the current MOU (from 1997, Appendix A) and discuss appropriate changes and updates. Some major changes to the current MOU included:

- identifying the recently acquired Harrison tract (2002) as a buffer area to the Reserve
- reviewing the research permit language and modifying to reflect desired practices.
- addressing issues regarding advisory and committee service as needed.
- incorporating MOU's into primary DCR and CBNERR management documents
- setting meeting requirements for DCR and CBNERRVA staff
- agreement to update the MOU on a 5 year time cycle

Management Approach and Policies

The operation and management of CBNERRVA is the responsibility of VIMS and is facilitated by the Program Director. The Virginia Department of Conservation and Recreation, Division of Natural Heritage (DCR-DNH), as well as other state and federal agencies and private organizations are available to serve in advisory roles and provide technical assistance in management of CBNERRVA components. Visitor use of Taskinas Creek Reserve is managed by staff at YRSP (see Public Access Plan, Appendix B).

Management policies for CBNERRVA are provided in Appendix C, and can be summarized as follows:

> *The health and natural integrity of reserve sites will be protected and, where necessary, restored, to provide a productive, stable environment for research, education, and compatible traditional activities. Reserve programs, activities, and facilities will not augment or replace the conservation, research, education, and historical uses of the site. Reserve programs will also complement traditional uses outside reserve boundaries. Resource protection and non-manipulative research will be given the highest priorities in the management of reserve sites (VIMS 1991).*

BACKGROUND INFORMATION

Description and Location

Taskinas Creek is located on the southern shore of the York River in James City County, about 24 nautical miles upstream from river's confluence with the Chesapeake Bay. Here, the York River reaches 1.5 to 3 miles in width. The mouth of Taskinas Creek lies within the lower to mid-estuarine reaches of the York River and its headwaters are near the small town of Croaker (approximately six miles north of Williamsburg). The creek flows for about three miles northeast to its confluence with the York River (Figure 1).

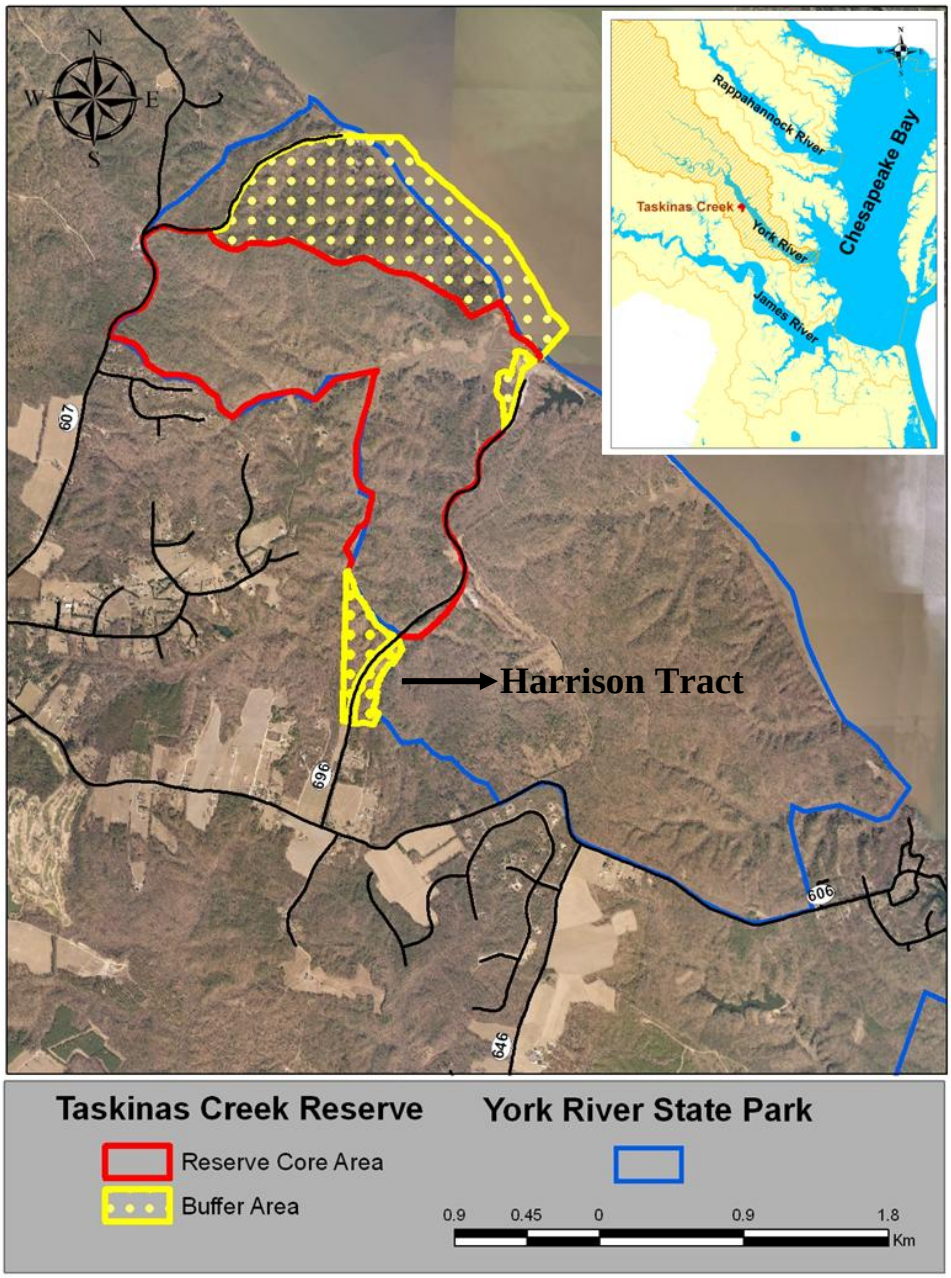

Figure 1. Boundaries and location of Taskinas Creek Reserve in Virginia.

Climate

While detailed long-term climatic data are not specifically available for Taskinas Creek Reserve, data collected at nearby Williamsburg 2N, VA (449151) from 1948 – 2005 show an average annual minimum temperature of 8.61° C (47.5° F) and an average annual maximum temperature of 21.06° C (69.9° F). Average monthly maximum temps for the same time period are in July (31.39 ° C; 88.5° F) and the average minimum monthly temps are in January (-2.22° C; 28.0°F). Average total precipitation for the same period is 121 centimeters (47.5 inches) with highest amounts falling in July and August (Southeast Regional Climate Center 2006). Precipitation is generally well distributed throughout the year with slightly more than average rainfall in the summer and slightly less in the autumn. Soils tend to be wettest in winter and early spring due to reduced evaporation and evapotranspiration. Snow can be expected any time from November to April. The average growing season length is approximately 197 days, and although variable, first fall frosts usually occur in late October and the last spring frosts are often in early to mid-April.

Taskinas Creek Reserve is vulnerable to hurricanes, tropical storms, and northeasters that affect the Chesapeake Bay and its major tidal tributaries such as the York River. Northeasters, usually the least severe of the three storm types, tend to occur in the autumn, winter, and spring. Hurricanes and tropical storms are less frequent, generally more severe, and usually occur in late summer through autumn. Some northeasters may reach the strength of a tropical storm. These storm events are capable of causing drastic changes in tides, violent wave action, and high winds which can result in profound alterations to the physical aspects and vegetation of the Taskinas Creek Reserve and surrounding area. For example, Hurricane Isabel in 2003 caused extensive tree blowdowns on the uplands of the Reserve and surrounding state park lands.

Understanding the role of storms as well as long-term change in sea level is an essential part of coastal planning. In particular, knowing the projected rate of change in water levels is essential for determining coastal hazards from storms and flooding risks. Tide gauges maintained by NOAA record water levels above a fixed point. These data have been used to determine rate of sea-level change for the past 50 years at Gloucester Point and other locations in the region. The tide gauge, located at VIMS, showed that sea level has been rising 1.3 ft/century (3.95 mm/yr) (NOAA, 2006). This rate is slightly less than the overall rate for the Hampton Roads region as shown at the Sewells Point tide gauge on Hampton Roads which is 4.42 mm/year or 1.45 feet/century (Hardaway, 2006).

Seasonal variations in the mean sea level cycle can impact the reach of storms and flooding risks. The months of August, September, and October have the highest heights; these months correspond to the highest risk of extratropical activity along the East Coast and Chesapeake Bay. Superimposed on the storm surge and astronomical tide, long-term sea level change can significantly increase the reach of storm waters (Boon, 2003).

Physical Setting

The 1034-acre Taskinas Creek Reserve is located on the north side of Virginia's "Lower Peninsula" between the James and York Rivers in the central Coastal Plain of Virginia. York River State Park, within whose boundaries the Reserve is located (Figure 1), was originally

purchased in 1969 and covers a total of 2,550 acres (DCR 2000). The surrounding area is transitioning from low- to moderately-dense rural development as residential land uses continue to increase in this formerly rural part of Virginia's coastal plain (Ciminelli 2006).

Geology and landforms. This portion of the Lower Peninsula has considerable topographic relief characterized by broad rolling uplands extensively incised by secondary streams. Downcutting of these streams has resulted in the formation of numerous dendritic ravine systems draining into the larger streams and rivers, which are estuaries of the Chesapeake Bay. The Taskinas Creek Reserve is a pronounced example of this dissected upland topography, containing more than ten deep ravines, a large number of steep to almost bluff-like slopes, and numerous narrow ridges forming the interfluves.

Sea level rise and waves generated by local winds are the dominant agents of erosion in the lower York River. The magnitude of shoreline erosion in the vicinity of Taskinas Creek is moderate to severe. Historically, the rate of shoreline erosion in the stretch of the York River near the confluence of Taskinas Creek is approximately 1.1 to 2.0 feet per year (VIMS 1991).

Soils. The soils of Taskinas Creek Reserve and surrounding region are weathered from unconsolidated sand, silt, clay, and gravel of Pliocene age. Underlying the mantle of sediments are local deposits of Lower Tertiary shells, shell marl, and limey sand that are frequently exposed on steep ravine slopes and stream bottoms at low relative elevations (usually < 15 m above sea level). Compared to many nearby areas, exposed shells are rather uncommon at Taskinas Creek, but are occasionally seen at the toe of slopes and on eroded stream banks. As a rule, most upland soils in the region are highly acidic and very low in available nutrients. However, local areas with soils weathered from shells or lime sand may have high pH and moderate to very high calcium concentrations. Soils on well-drained uplands include Caroline, Craven, and Emporia fine sandy loams. Bohicket muck soils characterize the tidal marshes flanking Taskinas Creek and its tributaries (VIMS 1991).

Hydrologic conditions. Hydrology within the lower to middle estuarine reaches of the York River system is strongly influenced by tides. Historical surface water temperatures range from 5.4º C to 27.4º C and dissolved oxygen concentrations range from 4.2 to 14.0 mg/l (Brooks 1983). These values are indicative of transitional conditions and reflect seasonal freshwater inputs. CBNERRVA also participates in the NOAA/NERRS System-Wide Monitoring Program and maintains a network of long-term, year-round continuous water quality stations within the York River system. One station is located in the lower reach of Taskinas Creek and has been collecting information on water quality since 1995. Recent measurements for three water quality measurements can be found in Table 1.

Table 1: Summary of water quality measurements collected from the Taskinas Creek SWMP Station over the time period from January 2003 to December 2006.

		Water Temp ©	Salinity (ppt)	DO (mg/l)
Annual	**Min**	**-0.75**	**0.15**	**0.05**
	Max	**36.11**	**19.19**	**22.29**
	Average	**17.07**	**8.85**	**8.05**
Winter (Dec-Feb)	**Min**	**-0.75**	**0.20**	**5.31**
	Max	**16.90**	**14.63**	**18.54**
	Average	**5.13**	**7.65**	**11.65**
Spring (Mar-May)	**Min**	**1.98**	**0.19**	**1.53**
	Max	**30.34**	**16.65**	**20.35**
	Average	**15.77**	**7.97**	**8.14**
Summer (Jun-Aug)	**Min**	**17.17**	**0.15**	**0.05**
	Max	**36.11**	**19.19**	**22.29**
	Average	**27.72**	**10.34**	**5.42**
Fall (Sep-Nov)	**Min**	**5.14**	**0.41**	**1.83**
	Max	**30.83**	**18.78**	**15.51**
	Average	**18.15**	**9.31**	**7.29**

Water quality Impacts. Overall phosphorus and nitrogen levels in the York River meet EPA and state criteria and are below the state median, although phosphorus levels are rising in the middle section and nitrogen levels are rising throughout the river. Approximately 57 percent of nitrogen and 47 percent of phosphorus reaching York waters originate from nonpoint sources (DCR 2005). Dissolved oxygen levels in the middle York range from good to poor and fecal coliform bacteria levels in Taskinas Creek have been sufficiently high to force closure of shellfish beds in the past (Virginia State Water Control Board 1980) and recently as June of 2006 (VDH, 2006). The York River has potential for impacts from point-source pollution due to the Smurfit-Stone paper mill located upstream at West Point, as well as from other manufacturing facilities nearby. Residential development is also increasing rapidly in this part of Virginia, with associated increases in the potential for negative impacts on water quality (Cimminelli, 2006).

General Vegetation Description

Except for tidal wetlands along the York River and Taskinas Creek, the Reserve is covered by deciduous forest. Individual trees and small patches of *Pinus taeda* (loblolly pine) are scattered through the site. The predominant community type on the moderately steep to steep uplands is the Piedmont / Coastal Plain Oak-Beech / Heath Forest, which is dominated by several *Quercus* spp. (oaks), *Fagus grandifolia* (American beech), and several heath-family shrubs, particularly *Kalmia latifolia* (mountain-laurel). Small patches of forests classified as Mesic Mixed Hardwood Forest and Oak / Heath Forest occur as inclusions within the matrix of Oak-Beech /

Heath (see Fleming et al. 2001 for more detailed descriptions of these natural communities). In addition, small patches of early-successional, forests dominated by *Pinus virginiana* (Virginia pine) occur on the wider crests and divides that were once cleared. Much of the forest growth on the slopes at this site is medium-age or older, and a few areas have notably large, old trees. Portions of the forest that were severely impacted by high winds that accompanied Hurricane Isabel in 2003 have extensive blowdowns and tangles of fallen branches.

Tidal wetlands occupy the shore of the York River and the floodplains of Taskinas Creek and its major southern tributary forming the southwestern boundary of the Reserve (Moore 1980). Most of these areas support Tidal Mesohaline / Polyhaline Marsh dominated to varying degrees by *Spartina alterniflora* (saltmarsh cordgrass), *Spartina patens* (saltmeadow cordgrass), and *Distichlis spicata* (saltgrass). With increasing distance from the York River along Taskinas Creek and its southern tributary, there is a gradual transition toward more oligohaline conditions and the dominance of *Spartina cynosuroides* (big cordgrass) and *Scirpus robustus* (salt marsh bulrush). Small patches of *Phragmites australis* (common reed) occur in this zone. At the mouths of large ravines, where large volumes of fresh groundwater enter the estuary, there is often an abrupt transition to small zones of Tidal Freshwater Marsh. These are dominated by *Zizania aquatica* var. *aquatica* (wild rice), *Pontederia cordata* (pickerelweed), and *Peltandra virginica* (arrow arum), which transition to Tidal Hardwood Swamp. These communities give way quickly to palustrine forests in the bottoms of the larger ravines. Most ravine-bottom sites are influenced by calcareous soils and abundant groundwater emerging in braided streams and seeps; these support good examples of the Coastal Plain / Piedmont Basic Seepage Swamp community type. Better drained ravine bottoms with little or no seepage influence support relatively well drained floodplain forests dominated by *Liriodendron tulipifera* (tulip-poplar) and *Liquidambar styraciflua* (sweetgum). One rather anomalous ravine bottom supports vegetation that is best classified as Coastal Plain / Piedmont Acidic Seepage Swamp. This stand is underlain by sandier soils and supports such acidophiles as *Magnolia virginiana* (sweetbay) and *Sphagnum* spp. (sphagnum moss) (Fleming et al. 2001).

Site History

The area surrounding Taskinas Creek Reserve has a rich human history. A recent archaeological investigation within YRSP (Traver 2003) has uncovered the presence of a large prehistoric site which extends 1,600 feet along the York River south of Taskinas Creek (outside of the Reserve) with evidence of Paleo-Indian occupation. More recent residents of the area include prehistoric peoples from the Middle and Late Archaic to Woodland Periods, including the Mattaponi and Pamunkey Indians. Early historic inhabitants include Bryan Smith who apparently first settled the land north of Taskinas Creek around the mid 1600s, and the Blair family which established the first recorded colonial plantation south of Taskinas Creek as early as 1749. From the colonial period up until the late Twentieth Century, the area around Taskinas Creek Reserve has changed little from its rural agrarian beginnings.

Land Uses, Water Uses and Natural Resources

During the early 1900s, the Lower Peninsula of Virginia started to become more urban as military facilities were situated in York County and Newport News. At this time, the Yorktown Naval Weapons Station, Fort Eustis, Cheatham Annex, and Camp Peary were established which

involved displacement of private landowners as large amounts of land were taken over by the federal government (Traver 2003).

In the area surrounding the Taskinas Creek Reserve, agricultural uses are declining and residential growth is on the rise as urban areas expand from both Richmond and the Hampton Roads regions into James City County and adjoining areas. This is especially evident in the growth of small-lot subdivisions dotting the increasingly less rural landscape (Traver 2003; Ciminelli 2006). The northern portion of James City County has an increased rate of residential construction largely due to its proximity to Williamsburg, which has become a popular retirement community for military and federal workers and others who are interested in the area's rich cultural history. This trend contributes to landscape fragmentation, an increased demand for services and infrastructure, and subsequent increases in surface water pollution and runoff into local watersheds including Taskinas Creek (Traver 2003).

North of the Reserve, the York River is commercially navigable with channel depths ranging from 30 to 60 ft. The river is used by tugboats with barges carrying pulpwood and wood products in transit to and from West Point, commercial fishing boats, general recreation and sportfishing boats, research vessels, the U.S. Coast Guard, and the Virginia Marine Resources Commission (VMRC) marine patrol.

As part of the York River Park System, the Taskinas Creek Reserve is currently used for day-use recreation, environmental education, and research opportunities. YRSP is an increasingly popular destination for Virginians. The Park opened to the public in 1980 as a day-use facility. Today, the park offers various amenities and visitor experiences including extensive hiking, biking, and equestrian trails, a Visitor Center, picnic shelters, rest rooms, and playgrounds (DCR 2000). A new fishing pier was constructed north of Taskinas Creek at Croaker Landing which opened to the public in 2005.

Taskinas Creek Reserve and the rest of YRSP support a host of wildlife species including Great Blue Herons, nesting Ospreys, and Kingfishers plus overwintering Black Ducks, Canvasbacks, Canada Geese and many other bird species which forage in or use the marshes, swamps, and uplands. As with most parts of the Commonwealth, white-tailed deer are numerous within the Reserve. DCR conducts managed deer hunts at YRSP to help control the size of the local deer population.

The waters of the York River and Taskinas Creek provide suitable habitat for many fish species and are an important nursery ground for anadromous fish species. Oyster grounds offshore from the Reserve are leased to commercial fishermen by VMRC. While some viable oysters remain, there has not been only minor commercial harvest from these beds since 1990. DCR holds a perpetual lease on 6.13 acres of oyster grounds near Croaker Landing (DCR 2000).

NATURAL HERITAGE RESOURCES

Overview

Natural heritage resources are defined in the Virginia Natural Areas Preserves Act (Section 10.1-209 through 217, Code of Virginia), as "*the habitat of rare, threatened, or endangered plant and animal species, rare or state significant natural communities or geologic sites, and similar features of scientific interest benefiting the welfare of the citizens of the Commonwealth*." Natural heritage resources are the most likely natural resources to be lost without conservation action in the near future. DCR-DNH conducts extensive inventories and maintains current lists of the natural heritage resources of the state.

A variety of rarity patterns exist based on the geographic range, habitat specificity, and local abundance of species (Rabinowitz 1981). The Natural Heritage Network ranks plants, animals, and natural communities on two scales of rarity. The global rank (G-rank) and state rank (S-rank) are based on the number of occurrences of a species at a global scale and state scale, respectively (Appendix D). G- and S-ranks help direct conservation actions to the rarest species and communities since these are usually the most vulnerable to extinction.

Ecological Communities

The inventory and classification of ecological communities constitute a "coarse-filter" approach to biological conservation that ensures protection of diverse organisms. Identification and protection of excellent examples of all natural community types facilitates protection of the majority of component native plant and animal species, including a host of taxa too cryptic, poorly known, or numerous to receive individual management strategies. At present, DCR-DNH classifies communities principally at the level of ecological community group, representing a broadly defined unit based on combinations of topographic, edaphic, physiognomic, and gross floristic similarities (Fleming et al. 2001). The majority of Taskinas Creek Reserve is covered by one broad ecological community, Piedmont / Coastal Plain Oak-Beech / Heath Forest.

Significant Natural Communities

Field inventory of natural communities at Taskinas Creek Reserve was conducted by DCR-DNH ecologists Gary Fleming, Karen Patterson and Kristin Taverna on May 11, August 8-9, and September 12-13 of 2006. Field work resulted in the documentation of three significant occurrences of two community types at the Reserve.

Piedmont / Coastal Plain Oak-Beech / Heath Forest. The Piedmont / Coastal Plain Oak-Beech / Heath Forest at Taskinas Creek is part of an exceptionally large stand that extends well outside the Reserve boundary onto both private lands and other portions of YRSP (Figure 2). Although incompletely inventoried, this stand is estimated to cover more than 1,700 ac (690 ha), of which approximately 850 ac (350 ha) lie within the reserve. This community type is uncommon in the Mid-Atlantic region, where it is confined to dissected topography and oligotrophic soils of the inner Coastal Plain and fall line zone of the Piedmont in Virginia, Maryland, and possibly Delaware. The stand in the Taskinas Creek Reserve / YRSP area is the largest stand that has been documented. Additionally, it is generally in good to excellent condition, and parts of it are impressively mature. Based on ring counts of trees which were blown down in Hurricane Isabel and then cut by the Park, ages of 100 years or more are probably

frequent among the dominant oaks and beech. Typical sites for this community include steep, submesic ravine slopes and narrow ridge crests with extremely acidic, infertile soils. Data were collected from two 400 m^2 plots of the Piedmont / Coastal Plain Oak-Beech / Heath Forest. Although both plots were located just outside the Reserve boundary in YRSP, they are representative of stands over the whole area (Figure 2).

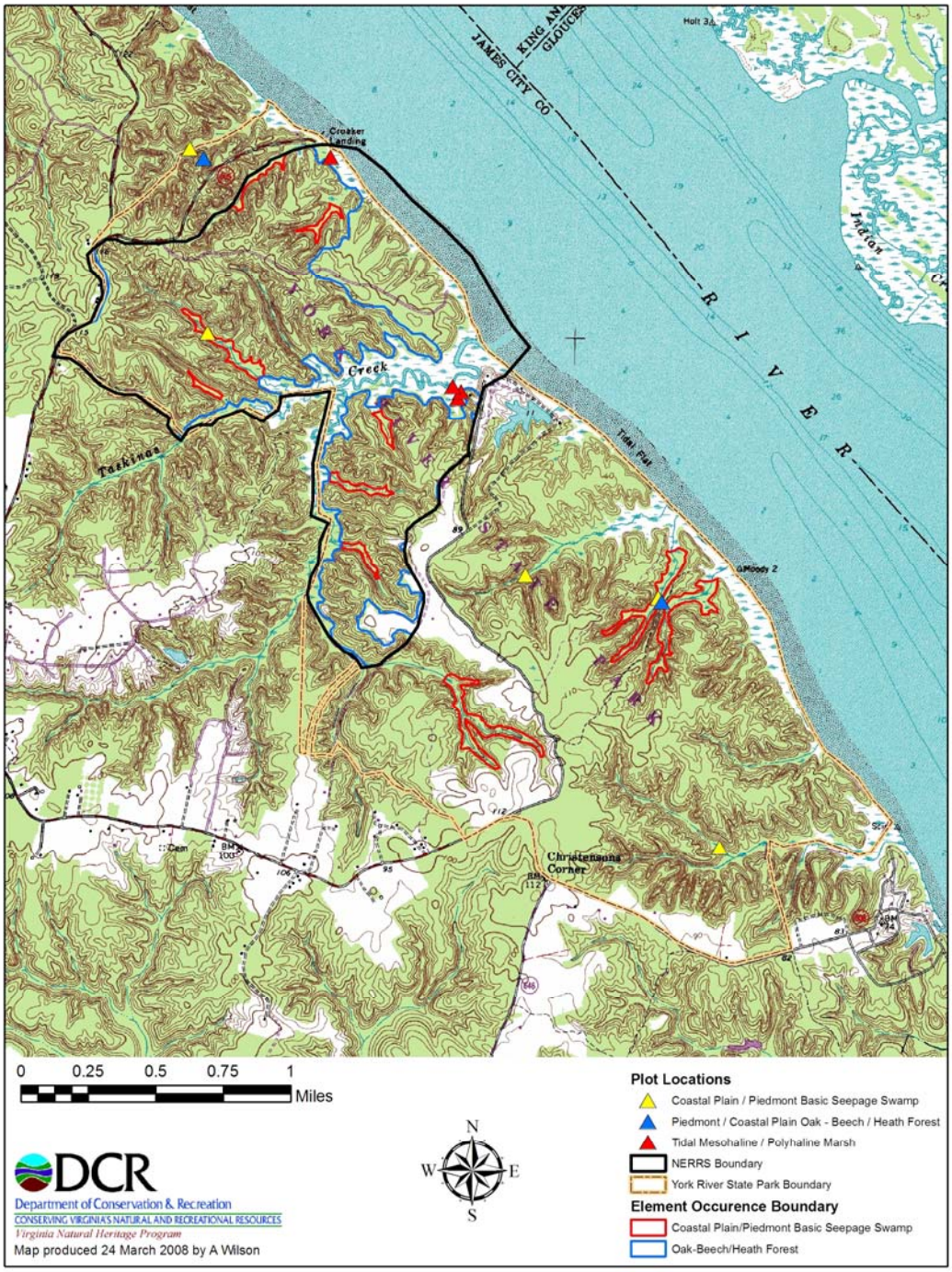

Figure 2. Map depicting locations of significant natural communities and vegetation sample plots at the Taskinas Creek Reserve and York River State Park.

The overstory of this community is typically co-dominated by variable combinations of *Quercus montana* (chestnut oak), *Quercus alba* (white oak), *Quercus velutina* (black oak), and *Fagus grandifolia* (American beech). Other tree species, including *Quercus rubra* (northern red oak), *Carya alba* (mockernut hickory), and *Liriodendron tulipifera* (tulip-poplar) are minor overstory associates. The larger overstory trees in this community are characteristically 50-80 cm (20-32 in) in diameter and approximately 30 m (98 ft) tall. Young *Fagus grandifolia* and *Ilex opaca* var. *opaca* (American holly) are usually the most abundant small trees, along with occasional *Acer rubrum* (red maple), *Liquidambar styraciflua* (sweetgum), *Cornus florida* (flowering dogwood), and *Sassafras albidum* (sassafras). The shrub layer is characterized by patchy to very dense *Kalmia latifolia* (mountain-laurel), but can also contain patches of *Gaylussacia baccata* and *G. frondosa* (huckleberries), *Euonymus americanus* (American strawberry bush), and *Vitis rotundifolia* (muscadine grape). Herbaceous plants are typically very sparse, but scattered individuals of *Polystichum acrostichoides* (Christmas fern), *Chimaphila maculata* (spotted wintergreen), *Hexastylis virginica* (Virginia heartleaf), *Danthonia spicata* (poverty oat grass), *Luzula acuminata* var. *carolinae* (southern hairy woodrush), and *Carex albicans* var. *australis* (southern bellow-beaked sedge) are typical. Mean species richness of the two vegetation sample plots was 24. Soil samples collected from these plots had a mean pH of 4.0, low base cation levels, and mean total base saturation < 15%.

Because of its size and quality, this occurrence of Piedmont / Coastal Plain Oak-Beech / Heath Forest has been assigned a rank of "A" and must be considered the standard against which all other occurrences should be evaluated. This community type has not yet been assigned a global conservation rank by NatureServe and the Natural Heritage network. It is now ranked "S3" in Virginia, reflecting its scattered but localized distribution (Figure 3).

Figure 3. Large-diameter *Quercus montana* (chestnut oak), *Fagus grandifolia* (American beech), and a dense shrub layer of *Kalmia latifolia* (mountain-laurel) are characteristic of the Piedmont / Coastal Plain Oak - Beech / Heath Forest.

Coastal Plain / Piedmont Basic Seepage Swamp. Eight high-quality patches of this palustrine forest community totaling approximately 26 ac (10.5 ha) were identified within the Reserve (Figures 4 and 5). These are divided into two separate element occurrences, one with two patches located in ravines draining into the York River and the other with five patches located in ravines draining into Taskinas Creek. Data were collected from five 400 m^2 plots, one within the Reserve boundary (YRSP009) and four just outside in YRSP (Figure 2). Mean species richness of the five vegetation sample plots was 57.

The co-dominant overstory species throughout these occurrences are *Fraxinus pennsylvanica* (green ash), *Acer rubrum* (red maple), and *Nyssa biflora* (swamp tupelo). *Ulmus americana* (American elm), *Liquidambar styraciflua* (sweetgum), *Liriodendron tulipifera* (tulip-poplar), and *Pinus taeda* (loblolly pine) are very minor overstory associates. The larger overstory trees in this community are characteristically 40-60 cm (16-24 in) in diameter and 30-32 m (98-105 ft) tall. Understory trees are generally absent or sparse. The shrub layer is typically sparse or patchy, with *Carpinus caroliniana* (American hornbeam), *Cornus foemina* (stiff dogwood), *Myrica cerifera* var. *cerifera* (southern bayberry), *Dirca palustris* (leatherwood), and the liana *Decumaria barbara* (climbing hydrangea) the most characteristic species. In several ravines *Asimina triloba* (paw-paw) forms locally dense colonies of shrubs but this species is absent elsewhere. The ravine-bottom sites occupied by this forest are characterized by braided drainage channels and hummock-and-hollow microtopography, which fosters a diversity of herbaceous species and repeating patterns of herbaceous patch-dominance. Abundant herbs in mucky, groundwater-inundated hollows and stream braids are *Bidens laevis* (smooth bur-marigold), *Saururus cernuus* (lizard's-tail), *Pilea fontana* (black-fruited clearweed), *Impatiens capensis* (spotted jewelweed), and *Boehmeria cylindrica* (false nettle). The usual patch-dominants of better-drained hummocks and flats are *Carex bromoides* (brome-like sedge) (Figure 4), *Packera aurea* (golden ragwort) (Figure 5), and *Leersia virginica* (Virginia cutgrass). Other less abundant but nevertheless characteristic species of this swamp forest include *Carex amphibola* (narrow-leaved sedge), *Carex crinita* (long-hair sedge), *Carex styloflexa* (bent sedge), *Cicuta maculata* (water-hemlock), *Cinna arundinacea* (wood reed grass), *Glyceria striata* (fowl mannagrass), *Poa autumnalis* (autumn bluegrass), *Polygonum arifolium* (halberd-leaved tearthumb), *Polygonum setaceum* (swamp smartweed), *Ponthieva racemosa* (shadow-witch orchid), *Thelypteris palustris* var. *pubescens* (marsh fern), and *Scirpus lineatus* (drooping bulrush).

Figure 4. Coastal Plain / Piedmont Basic Seepage Swamp at York River State Park. *Carex bromoides* (brome-like sedge) is the dominant graminoid, while a patch of *Saururus cernuus* (lizard's tail) occupies a mucky hollow in the foreground.

Soil samples collected from the five plots had a mean pH of 5.4, with moderate to high calcium levels (mean = 1637 ppm) and mean base saturation of 70%. Despite having high calcium concentrations, one plot had notably lower pH (4.8), which may reflect the influences of exceptionally high organic matter content (27%) and iron (1061 ppm). Species such as *Dirca palustris*, *Pilea fontana*, *Carex bromoides*, and *Scirpus lineatus* are generally restricted in the Coastal Plain to calcium-rich soils.

The aggregate sizes of these occurrences are relatively large and the stands are in excellent condition except for local encroachment by the highly invasive, non-native grass *Microstegium vimineum* (Japanese stilt-grass) in the drier microhabitats of some patches. As a result, both occurrences of Coastal Plain / Piedmont Basic Seepage Swamp at the reserve have been assigned a rank of "AB." This community type has not yet been assigned a global conservation rank by NatureServe and the Natural Heritage network, but is almost certainly globally rare. The known distribution is limited to the inner portion of the southeastern Virginia Coastal Plain in portions of Isle of Wight, Surry, James City, York, and Lancaster Counties. It is now ranked "S1S2" in Virginia, reflecting its very limited, small-patch distribution in specialized habitats of the Coastal Plain. Continued invasion by *Microstegium* is the greatest threat to the future viability of existing stands.

Figure 5. Coastal Plain / Piedmont Basic Seepage Swamp, with *Packera aurea* (golden ragwort) dominating the herb layer.

Other Natural Communities

A field inventory of tidal marsh communities along the York River and Taskinas Creek was conducted by DCR-DNH ecologist Phillip Coulling on September 8, 2000.

Tidal Mesohaline / Polyhaline Marsh. The tidal marsh vegetation along Taskinas Creek and neighboring portions of the York River is characterized by exceedingly low species diversity and localized patch dominance, which reflects subtle gradients in elevation, hydroperiod and salinity. Salinity at Taskinas Creek Reserve ranges from near zero in the non-tidal headwaters of the creek to river salinities ranging from 5 – 19 ppt depending on time of year (NOAA/NERRS SWMP Data, Taskinas Creek, 2003-2006). Thus, conditions are oligohaline to slightly mesohaline, but the vegetation is characteristic of distinctly mesohaline to even polyhaline (18-30 ppt) conditions. High salt marsh, or salt meadow, occurs on the highest microsites, which may not flood with every tidal cycle and where salinity is enhanced by evaporation. This vegetation consists of short-statured *Spartina patens* (saltmeadow cordgrass) and *Distichlis spicata* (saltgrass), with *Symphyotrichum tenuifolium* (perennial saltmarsh aster) as an occasional associate. Lower elevations support *Spartina alterniflora* (saltmarsh cordgrass), in pure stands or in co-dominance with *Schoenoplectus robustus* (saltmarsh bulrush), *Schoenoplectus americanus* (Olney threesquare) or *Spartina patens*. At least one small patch dominated by *Juncus roemerianus* (black needlerush) occurs along Taskinas Creek.

Data were collected from four 100 m^2 plots and captured three distinct community types: *Schoenoplectus robustus – Spartina alterniflora* (plot YRSP001), *Spartina patens – Distichlis spicata* (YRSP002 and YRSP003), and *Spartina alterniflora – Spartina patens* (YRSP004). In addition to Taskinas Creek, the *Schoenoplectus robustus – Spartina alterniflora* community is

known from a number of sites along the lower Mattaponi and Pamunkey Rivers. Since its distribution elsewhere in Virginia remains unknown, it is at present ranked "S2S4." This vegetation type has not yet been assigned a global conservation rank by NatureServe and the Natural Heritage network. The *Spartina patens – Distichlis spicata* community (plots YRSP002 and YRSP003) is both common and widespread on the western shore of the Chesapeake Bay and the Eastern Shore of Virginia (rank of "S5"); a roughly equivalent type is considered globally common ("G4G5") by NatureServe and the Natural Heritage network. Plot YRSP003 is transitional between low salt marsh and more mixed high salt marsh; hence *Spartina patens* and *Distichlis* co-occur with *Schoenoplectus robustus* and *Schoenoplectus americanus*. A community dominated by *Spartina alterniflora* and *Spartina patens* (plot YRSP004) has not been recognized by NatureServe and the Natural Heritage network and its status in Virginia is unclear ("SNR"). Similar vegetation has been documented from Chincoteague National Wildlife Refuge on the Eastern Shore, where a short form of *Spartina alterniflora* co-occurs with *Spartina patens* in zones transitional between high and low salt marsh. Mean species richness of the four vegetation sample plots was three and ranged from two to four species.

Tidal Oligohaline Marsh. Along the upper portions of Taskinas Creek and its tributaries, oligohaline conditions support tall marsh vegetation dominated by *Spartina cynosuroides* (big cordgrass) with patches salt marsh bulrush (Scripus robustus)(Moore 1980). A few small stands of non-native invasive *Phragmites australis* (Saltonstall 2002) occur in this community but have been greatly reduced or eliminated through herbicide treatments applied by DCR staff. At the upper reach of tidal influence, tidal oligohaline marsh grades abruptly into narrow zones of tidal freshwater marsh dominated by *Zizania aquatica* (wild rice) and thence into tidal hardwood swamp. None of the oligohaline marsh vegetation was captured in vegetation sample plots in 2000.

Tidal oligohaline marshes at Taskinas Creek Reserve do not meet DCR-DNH criteria of size, quality, and landscape context to qualify as an significant community occurrence. While they could be delineated on aerial photo maps based on vegetative signature, the polygons would not be based on comprehensive surveys. Even though they do not meet criteria necessary to consider them as exemplary natural community occurrences these native plant associations are an important part of the Reserve's natural resources and are deserving targets for protection, monitoring, and management if needed.

Rare Species

Rare species are defined as the rarest known species in Virginia as designated by DCR-DNH. In Virginia, rare animals include species with global ranks of G1, G2, and G3, and state ranks of S1, S2, S3, SH, SX, and SU (see Appendix D). Data on species with state ranks of S1, S2 (or S2S3), SH, and SX are maintained in the *Biotics* system and summarized annually on master Rare Species Lists of Virginia's rare plants and animals (Townsend 2007; Roble 2006). Element occurrences (EOs) are specific sites where a particular rare species or exemplary ecological community occurs. EOs are mapped and tracked by DCR-DNH in the natural heritage database, *Biotics*. DCR-DNH also maintains Vascular Plant and Animal w*atchlists* which list those plants and animals uncommon in Virginia but not rare enough to be included on the Rare Species Lists.

Rare plants. In summer 2006, DCR-DNH botanists conducted a rare plant survey of the Taskinas Creek Reserve. One rare plant species was located, which was the only rare or *watchlist* plant encountered during the four days of field work in July and August.

Mountain camellia. A population of mountain camellia (*Stewartia ovata)* (G4/S2), first discovered by Dr. Donna M.E. Ware in 1990, was rediscovered at the Reserve in 2006. Thirty two plants were located in six subpopulation areas (Figure 6). This compares with 22 plants found in seven subpopulation areas in 1990. The six subpopulations found in 2006 include four of the seven that were located in 1990 and two that are new. Location data for all sub-populations are provided in Table 2.

Mountain camellia is a small tree or large shrub in the Theaceae (tea family). It is primarily a species of the southern Appalachians where it is most abundant on the Cumberland Plateau of Tennessee and Kentucky (Weakley 2004). In Virginia, it is known from four mountain and western piedmont counties (Patrick, Henry, Pittsylvania, and Franklin) and is also disjunct to three coastal plain counties (York, James City, and Lancaster). Twelve occurrences are known from Virginia, eight of which are historical (Harvill et al. 1992; DCR 2006).

The *Stewartia ovata* population is located just north of Taskinas Creek, where it is associated with a series of four parallel southeast-trending ridges. Most subpopulations are on narrow ridges or spurs above Taskinas Creek. While mountain camellia is a forest species, it appears to favor areas with ample sunlight. At Taskinas Creek Reserve, the plant is found within the Piedmont / Coastal Plain Oak-Beech / Heath Forest natural community. Plant associates include *Quercus montana* (chestnut oak), *Quercus alba* (white oak), *Fagus gradifolia* (American beech), *Pinus virginiana* (Virginia pine), *Pinus taeda* (loblolly pine), *Acer rubrum* (red maple), *Carya alba* (mockernut hickory), *Carya pallida* (sand hickory), and *Ilex opaca* var. *opaca* (American holly). Dense stands of heaths, primarily *Kalmia latifolia* (mountain-laurel), *Vaccinium stamineum* (deerberry), *Vaccinium pallidum* (early lowbush blueberry), *Gaylussacia baccata* (black huckleberry), and *Gaylussacia frondosa* (dangleberry) are usually nearby, but mountain camellia occurs in microhabitats where shrub layer coverage is sparse.

Stewartia ovata plants found in 2006 ranged in size from about 0.25 to 3.0 m high. Six plants produced fruit, and two others had flowers that failed to produce fruit. Most plants had multiple stems from the base. Information is presented below on each of the six subpopulations.

Subpopulation A. This subpopulation was newly found in 2006 and is the largest of the six. Thirteen plants were found here within a 0.65 ha area on or near an open knoll at the junction of two tidal creeks. Most of the plants were on a short, steep northeast-facing slope above a marsh. The knoll appears to have been partially cleared in the past, and the remains of a wooden structure (of unknown purpose) were observed. Only one of the 13 plants encountered here produced fruit. This fertile plant was about 2.5 m tall. Each of the remaining 12 individuals was less than 1.0 m tall.

Table 2. Latitude-longitude coordinates for six mountain camellia sub-populations at Taskinas Creek Reserve.

Subpopulation	Latitude	Longitude
A	37.41281122	-76.73166236
B	37.41296017	-76.72842066
C	37.41356643	-76.72891318
D	37.41588361	-76.72898996
E	37.41498238	-76.72394430
F	37.41666572	-76.72500595

Subpopulation B. This subpopulation, also newly found in 2006, consists of one plant about 2.0 m tall. The plant was located near the crest of the steep western slope of a narrow south-trending spur ridge above Taskinas Creek. This habitat afforded ample sunlight, and the plant had a large spreading crown and numerous fruits.

Subpopulation C. Six plants comprise this subpopulation, which is located near the top of a steep, high north-facing slope above a tributary of Taskinas Creek. The plants were found within a 4.0 square m area where a break in a dense stand of *Kalmia latifolia* creates an open shrub layer. A cut *Juniperus virginiana* was noted nearby. The plants ranged in height from 0.25 to 1.5 m. One plant had a withered flower, but none produced fruit.

Subpopulation D. This subpopulation consists of one plant with four living stems from the base. The longest of these was about 3.0 m long and narrow and arched to take advantage of the somewhat limited sunlight reaching below the canopy in this area. Five fruits from the current year were observed, and a dry capsule from the previous year was also present. This plant was located just above the juncture of two small non-tidal stream forks at the base of an open, moderately steep knoll facing southwest.

Subpopulation E. Seven plants were found in this area within a 5 x 15 m area. These plants were located on the steep northeastern-facing slope of a southeast-trending spur ridge above Taskinas Creek. Three of the plants were near the top of the slope; the rest were at mid-slope. Plants ranged in height from 0.25 to 1.5 m. One plant had a withered flower, but none produced fruit. It appeared that fire had moved through this area in the not to distant past, removing the dense cover of *Kalmia latifolia* in some areas.

Subpopulation F. This subpopulation consists of four plants in a 3 x 3 m area. These plants were located on a south-facing slope at a mid-slope position. The plants were found on the

steepest, most open portion of this slope. Plants ranged in height from 0.5 to 2.0 m, and three of the plants produced fruit.

Figure 6. Location of six mountain camellia (*Stewartia ovata*) populations and one patch of non-native invasive Phragmites (*Phragmites australis*) mapped in 2006 at Taskinas Creek Reserve.

Three additional 1990 subpopulation areas were carefully searched for mountain camellia, but no plants were found. Hurricane Isabel had extensive effects on the Reserve in 2003, resulting in a large number of windthrown trees. Areas along ridge crests were particularly hard hit, and this is often the habitat of *Stewartia ovata*. It is possible that *Stewartia ovata* plants were destroyed directly by windthrows or that microhabitat alteration caused a die-off of plants.

The *Stewartia ovata* population is located in a remote area of the Reserve with little human visitation. No invasive species were observed in the vicinity of the plants, and no other threats to the population were discerned.

Rare animals. To initiate inventory of rare animals at Taskinas Creek Reserve, existing data on element occurrences within and near the marshes were obtained from the Tracker database and reviewed. Additional information was gathered from zoological literature and from examination of selected collections at the following institutions: U.S. Museum of Natural History, the Carnegie Museum, Lord Fairfax Community College, Eastern Mennonite College, Old Dominion University, Virginia Polytechnic Institute and State University, Virginia Commonwealth University, and the Virginia Museum of Natural History. Prior to this survey, rare animal occurrences near Taskinas Creek consisted of several pairs of nesting Bald Eagles (*Haliaeetus leucocephalus*). No other rare animals were known from the Reserve.

Aerial photographs and other map sources were consulted to determine the extent of potential rare animal habitats. Subsequently, a field plan, based on all the available preliminary information, was developed to direct investigation of potential rare species habitats for the targeted animal groups. Appropriate survey techniques were planned and the methods employed are summarized below. Inventory for targeted species required repeated visits to many sites and potential habitats at different seasons. Zoological surveys were conducted in 2006 at Taskinas Creek Reserve on July 26-27, August 16, and August 22-23.

Sampling methods employed included using sweep nets to collect Lepidoptera, Odonata, Coleoptera and other invertebrates found either flying or on vegetation in both marsh and upland habitats. Nocturnal lepidopterans and other invertebrates were captured using UV Light traps consisting of standard bucket traps equipped with a blacklight (= ultraviolet) powered by a 12-volt gel-cell battery. Ethyl acetate was used as a killing agent. Traps were setup to run overnight at Taskinas Creek during the 2006 survey from July 26-27 and August 22-23 (Figure 7). Other collections were made by hand and additional observations (sight or sound) were recorded.

All specimens collected during the study were preserved using standard methods (Martin 1977). Some specimens may be deposited in the National Museum of Natural History and the reference collection (primarily Lepidoptera and Odonata) of DCR-DNH.

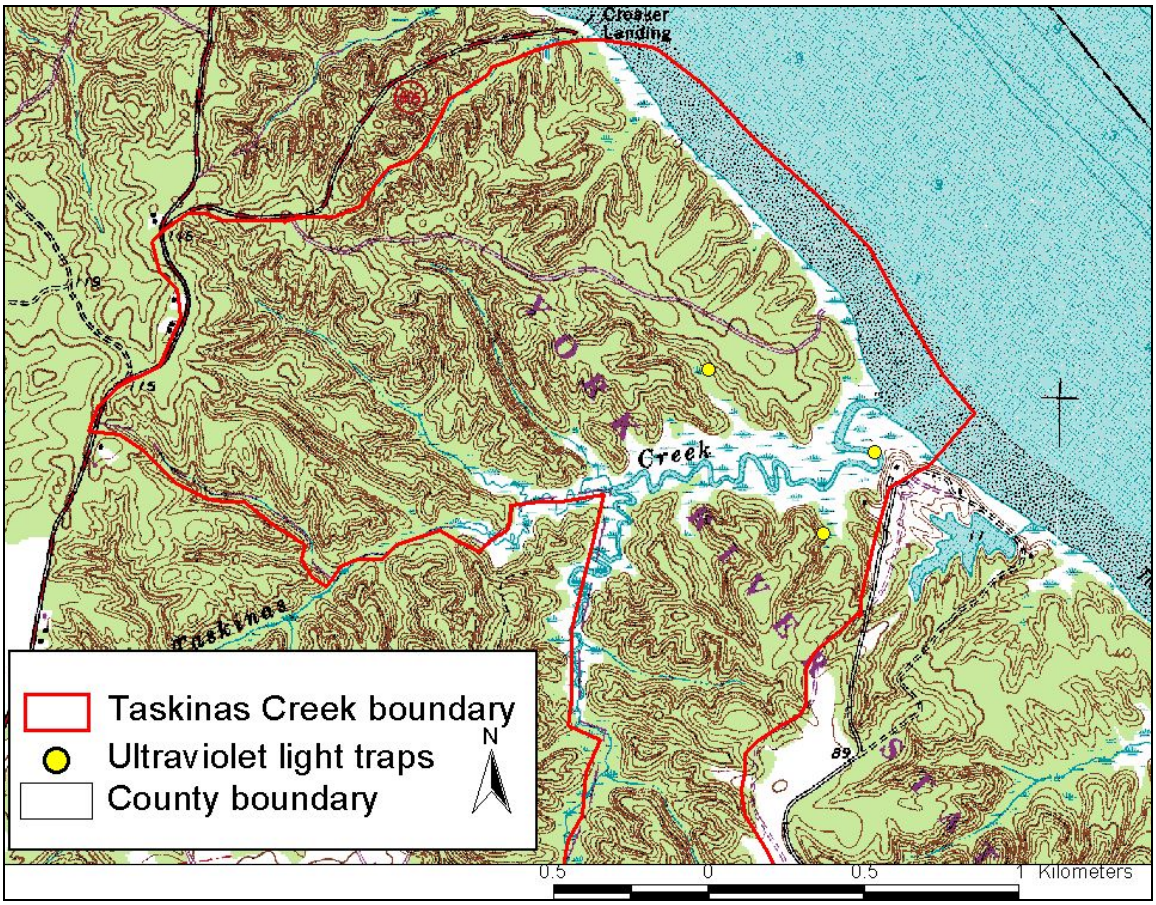

Figure 7. Locations of UV light trap stations during zoological survey of Taskinas Creek.

Zoology Survey Results. Prior to the survey, certain animals were 'targeted' as rarities that either had been known from Taskinas Creek or there was a probability of being on the property. To date, most of the Odonata (dragonflies and damselflies) and Lepidoptera (butterflies and moths), and groups of Coleoptera (beetles) of interest (e.g., tiger beetles) have been identified. Some identification is still pending confirmation from experts; however, surveys for other readily identifiable groups (e.g. birds, amphibians and reptiles) found no rare species during the 2006 inventories conducted by DCR-DNH staff.

One Bald Eagle nesting location is known just outside the boundary of YRSP and the Taskinas Creek Reserve (VDGIF 2004) (Figure 8). Eagles use both the water and upland resources within the Reserve boundary for fishing and nesting and are therefore considered in this management plan. Guidelines for Bald Eagle primary or secondary management zones should be adhered to where they intersect with the NERRS boundaries (USFWS and VDGIF 2000). Based on data provided by VDGIF (2004), both primary and secondary management zones intersect the Taskinas Creek Reserve boundary (Figure 8). Results of the most recent annual survey for Bald Eagle nest sites conducted by the Center for Conservation Biology have determined that no additional breeding pairs have moved within or near the Reserve boundaries (Watts and Byrd, 2007).

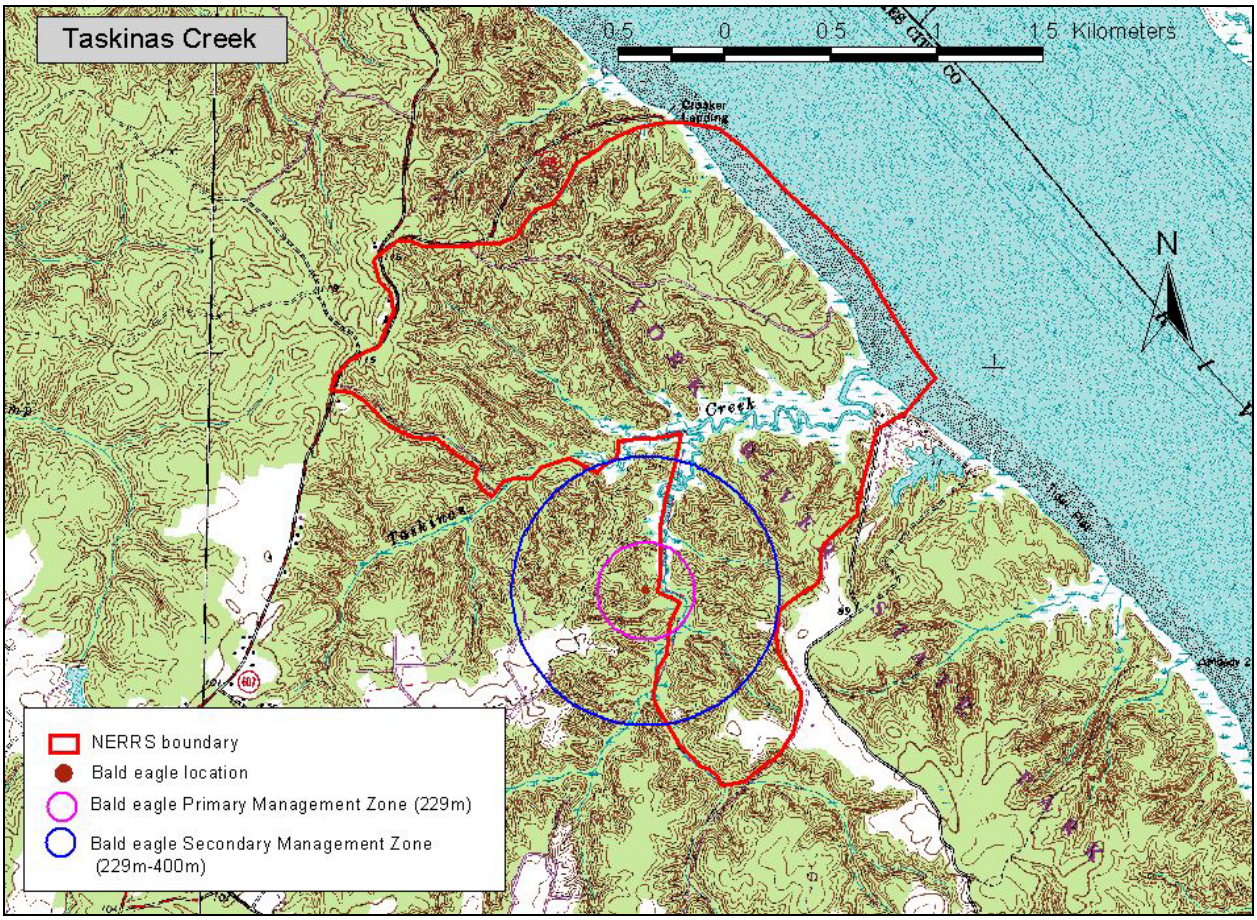

Figure 8. Bald Eagle nest location (2004 VDGIF data) and management zones at Taskinas Creek Reserve and York River State Park.

Potential Natural Heritage Resources

Extensive inventories have been conducted by DCR-DNH staff and other specialists over several decades at YRSP including the Taskinas Creek Reserve. It is currently believed that all species of state rare (S1, S2) plants and exemplary natural community types that could potentially occur at the Reserve are known. Although none are currently known, rare animals include diverse and in some cases incompletely described species groups (e.g. insects). One potential rare animal species (based on available habitat) includes Mabbee's salamander (*Ambystoma mabeei*)(G4/ S1S2). Therefore, it is possible that new species could be discovered at the Reserve in the future, pending additional survey efforts.

Watchlist Species

Plants. Two *watchlist* plants have been reported from Taskinas Creek Reserve. A third *watchlist* species has been reported from YRSP outside of the reserve boundary but which has potential to occur within the reserve (Table 3).

A population of *Malaxis spicata* (Florida adder's-mouth, G4/S3), originally found by Barry Ensley in 1984, was re-discovered by Donna M.E. Ware (The College of William and Mary) on July 17, 1990. At that time, the population consisted of 42 plants in a ravine bottom located

about 0.13 mi SSW of the YRSP visitor's center within the Reserve. About 20 percent of these plants were flowering on the survey date. An additional location for this species is known from YRSP outside the Reserve.

DCR-DNH staff ecologists located *Scirpus lineatus* (drooping bulrush, G4/S3) in a ravine bottom north of Taskinas Creek in 2006. Two additional stations for this species were reported from ravine bottoms south of the creek by Ware in 1990. All three of these locations are within the boundaries of Taskinas Creek Reserve. Additional stations for this species, which inhabits Coastal Plain / Piedmont Basic Seepage Bog communities, are known from elsewhere in YRSP.

Ponthieva racemosa (shadow-witch orchid, G4G5/S3) was reported in 1990 by Ware from two stations in YRSP, both of which are outside the reserve boundary. One of these stations is located in the ravine just NW of Route 605 in the northern end of the Park. The other station is located at the southern end of the Park. DCR-DNH ecologists also found this plant in a different ravine system near the southern end of the Park in 2006. Potential habitat for this species exists within Taskinas Creek Reserve.

All three of these *watchlist* plant species are found in habitats where *Microstegium vimineum* (Japanese stilt-grass) is a serious or potentially serious problem. *Malaxis spicata* and *Ponthieva racemosa* are believed to be particularly susceptible, as they are small plants that could easily be overtopped and crowded out by this highly invasive non-native grass. Deer browse is also considered to be a serious threat to *Ponthieva racemosa*.

Table 3. Plant *watchlist* species within/near Taskinas Creek Reserve and 2006 status.

Species	Observation Year	Location(s)	Notes
Florida adder's-mouth *(Malaxis spicata)*	1984, 1990	0.13 mi SSW of the YRSP Visitor Center	Not seen since 1990
drooping bulrush (*Scirpus lineatus*)	2006	Two ravine bottoms within the Reserve	Inhabits Coastal Plain Basic Seepage Bog communities
shadow-witch orchid (*Ponthieva racemosa*)	1990	Two stations in YRSP	Potential habitat exists at TCR

Animals. Although no records exist in the DCR *Biotics* database, Northern diamond-backed terrapin (*Malaclemys terrapin terrapin*) (G4T4/S4) has some potential to occur at Taskinas Creek Reserve due to the presence of tidal saltmarsh habitat where typical food items (fiddler crabs / periwinkle snails) are in good abundance. Terrapins prefer open and sandy shore habitat for breeding, where they lay eggs in sandy soils above the high tide line. Substrate such as this is not in great abundance at the reserve; thus, Taskinas Creek may be a good feeding area for diamond-backed terrapins but is unlikely to support breeding activity for this *watchlist* species.

Invasive Species

One small patch of non-native Phragmites existed within the Reserve along Taskinas Creek in 2006. At that time, the patch covered less than 1/8th acre (Figure 6).

The highly invasive non-native grass *Microstegium vimineum* (Japanese stilt-grass) is present at Taskinas Creek Reserve in various locations (Figure 9). Of greatest concern are occurrences within the drier microhabitats of some Coastal Plain / Piedmont Basic Seepage Swamp communities. Continued invasion by *Microstegium* is the greatest threat to the future viability of existing good occurrences of this community type. This species also occurs along roads and trails within the Reserve and is likely spreading as a result of colonization opportunities afforded by the creation of light gaps and tree windfall mounds during Hurricane Isabel in 2003.

Figure 9. Japanese stilt-grass (*Microstegium vimineum*) occurs at Taskinas Creek Reserve and the surrounding area. Common locations are along disturbed areas such as trails and old woods roads. This problematic invasive non-native species invades and degrades Coastal Plain / Piedmont Basic Seepage Swamp communities at the Reserve.

RESOURCE STEWARDSHIP

Goals and Objectives

The primary stewardship goal at Taskinas Creek Reserve is to maintain a functioning ecosystem with a matrix of natural communities that will provide the research community with a long-term site for habitat-focused research opportunities. The management approach and policy direction for CBNERRVA components is outlined in Appendix C. Reserve-level management and monitoring actions, as well as cooperative management initiatives and protection strategies are planned based on the best current information and available resources.

Management objectives for Taskinas Creek:

- Maintaining and restoring natural communities;
- Fostering research to accomplish conservation goals and contribute to the body of knowledge on flora, fauna, and natural communities of Virginia;
- Managing habitat to benefit and provide for protection of natural resources, scenic resources, and historic resources;
- Evaluating effects of management on plants, animals, and natural communities.
- Monitoring marsh communities along Taskinas Creek for long-term vegetation changes and marsh movement due to sea level rise and other climatic factors.

Management Issues at Taskinas Creek Reserve:

Actions must sometimes be taken in natural areas to maintain natural conditions and to return human-altered land or vegetation to a condition that supports continued existence of rare species and/or natural communities. General threats to biodiversity include habitat degradation and loss, invasive non-native species, pollution, overexploitation, disease, land conversion, water development, some agricultural practices, livestock grazing, off-road vehicles, pollutants, infrastructure development, disruption of fire regimes, logging, and mining activities (Wilcove et al. 1998). After habitat loss, invasive non-native species are the greatest threat to terrestrial species. For aquatic species, water pollution is the most significant threat after habitat loss (Richter et al. 1997). Because of these threats to biodiversity, active management is often needed to restore and maintain natural resources (Wilcove and Chen 1998).

- One ongoing management issue of high concern will be the need for CBNERRVA staff to interact closely with DCR-DSP staff in order to achieve an optimal balance between the primary recreation objective of DCR and the primary research and education objectives of VIMS.
- Another management issue of high concern and likely to cause negative impacts to natural resources at Taskinas Creek Reserve is invasive non-native plants. While, *Phragmites australis* is one known threat, a currently more abundant and difficult to control species present at the Reserve is Japanese stilt-grass.

Interactions with York River State Park Staff. A key aspect for successful management at Taskinas Creek Reserve will be for CBNERRVA staff to maintain open and positive communications with the landowner – in this case, DCR-DSP staff at YRSP. To facilitate this communication, it is recommended that DCR and VIMS staff conduct an annual meeting prior to March 1 of each year to review activities of the previous year, discuss relevant and upcoming issues, and share concerns regarding the administration and management of Taskinas Creek

Reserve within YRSP. Contact information for current DCR-DSP staff associated with resource management at the Reserve and Park are as follows:

Virginia State Park Staff – Contact Information

District 1 Resource Specialist:	Erik Molleen
Phone:	757-412-2311
Fax:	757-412-2315
Email:	erik.molleen@dcr.virginia.gov
Office location:	First Landing State Park, Virginia Beach
York River State Park Manager:	Russell Johnson
Phone:	757-566-3036
Fax:	757-566-4013
Email:	russell.johnson@dcr.virginia.gov
Office location:	York River State Park
State Parks Resource Manager:	Theresa Layman
Phone:	804-786-9025
Fax:	804-786-9294
Email:	theresa.layman@dcr.virginia.gov
Office location:	Richmond

Invasive non-native plants. Nationwide, invasive species have been identified as the second highest threat to biological diversity, second only to loss of species and habitat from development and urban sprawl (Stein et al. 2000). Control of invasive non-native plants is expensive, resources are limited, and management efforts must be prioritized (Hiebert and Stubbendieck 1993). The goal of management is to prevent the worst invasive species from becoming established in high-quality natural communities. Control efforts will focus on reducing abundance of the most problematic invasive plants in the highest quality natural communities.

At Taskinas Creek Reserve, the following invasive species have been documented: Phragmites (*Phragmites australis*), Japanese stilt-grass (*Microstegium vimineum*), Japanese honeysuckle (*Lonicera japonica*) and Tree-of-heaven (*Ailanthus altissima*). The Nature Conservancy has compiled natural history, impacts/threats, management, monitoring, research, and extensive bibliographies for many invasive non-native species into Element Stewardship Abstracts (ESAs). ESAs for three of the species mentioned above are provided in Appendix E.

Phragmites or common reed (*Phragmites australis*). Phragmites is a non-native invasive grass which has become one of the most problematic invasive plant species affecting wetlands (Marks et al. 1993; Norris et al. 2002). Phragmites is found in every U.S. State and is well-established and increasing in coastal habitats of Virginia. This fast-spreading plant grows up to four meters tall and forms dense monotypic stands, crowding out other native marsh plants. Phragmites is long-lived and spreads rapidly due to its ability to reproduce both by seed and dispersed rhizome fragments, establishing readily in disturbed areas. As a result, marsh plant species diversity and habitat quality is drastically reduced for many kinds of marsh-dependant wildlife.

Phragmites is now considered to exist in North America, including Virginia, in two genotypic forms. One form is native to the U.S. and appears to have been a non-dominant component of diverse mid-Atlantic and northeastern marsh communities for millennia. Recent DNA studies provide strong evidence that a distinct, non-native Phragmites genotype is also present in the U.S. (Saltonstall 2002). This supports an existing theory that an introduced variety of Phragmites has for decades been aggressively invading and dominating coastal marshes and other wetland communities, in part due to a lack of natural biological control mechanisms. Cryptic invasion by a non-native variety of Phragmites is a plausible explanation for how and why this species has rapidly become dominant over thousands of acres of wetland communities during the last two decades in the Northeast and mid-Atlantic regions. The Virginia portion of the Chesapeake Bay and its tidal tributaries are currently experiencing high rates of invasion by non-native Phragmites. Disturbances that expose mineral substrate, such as dredging and placing spoil or natural disturbances such as wildfire and hurricanes, can heighten both the risk and rate of Phragmites colonization and/or spread.

Appendix F describes an aerial survey conducted in summer 2006 to document distribution and abundance of Phragmites at Taskinas Creek Reserve and YRSP. Fortunately, only one small patch of this species currently exists within the boundaries of the Reserve. Additionally, much of the Phragmites that once occurred within Park boundaries has been successfully controlled by DCR over the past five years, thus reducing the risk for new invasions at the Reserve.

Japanese honeysuckle (*Lonicera japonica*). Japanese honeysuckle is a semi-evergreen vine of the Caprifoliaceae family. A serious pest throughout eastern North America, it outcompetes native vegetation for both soil nutrients and light (Nuzzo and Randall 1997). Japanese honeysuckle was the most frequently observed non-native species in a study of almost 2000 DCR-DNH ecological community classification plots located across the state of Virginia (Heffernan et al. 2001). Japanese honeysuckle was found scattered in some of the upland forested areas surveyed at Taskinas Creek and is considered to be occasionally common to locally abundant. However, unless this common species is discovered to be posing a direct or imminent threat to natural heritage resources, DCR does not recommend control actions.

Japanese stilt-grass (*Microstegium vimineum*). A native of Asia, Japanese stilt-grass is now widespread east of the Mississippi (Hunt and Zaremba 1992; Miller 2003; Merhoff et al. 2003). In 2006, stilt-grass was seen at Taskinas Creek Reserve. This species spreads rapidly into disturbed areas but can invade undisturbed upland areas by forming satellite populations from seed introduced by animals, flooding, or surface run-off following heavy rains. It is generally slow to invade undisturbed areas, but rapidly fills disturbed areas such as flood-scoured stream sides, tip-up mounds, and along roads and trails (Tu 2000). Highly shade tolerant, it forms a dense monotypic ground layer and produces numerous seed that may persist for many years (Merhoff et al. 2003). Deer also avoid browsing on some invasive non-native plants including Japanese stilt-grass (Tu 2000), further exacerbating the nefarious effects of these weeds on native flora.

An individual plant of Japanese stilt-grass can produce up to 1000 seeds, which can remain viable in the soil for three to five years. Once established, stilt-grass is able to crowd out native

herbaceous vegetation in wetlands and forests within three to five years (Barden 1987; Hunt and Zaremba 1992).

Manual/mechanical, environmental/cultural, and chemical methods have all been used with some success for control of Japanese stilt-grass. Prescribed burns have not been successful in controlling this species so far, but fall burns may have the potential for partial control. If controlled during the early stages of invasion, the potential for successful management is high. The potential for large-scale restoration of wildlands where Japanese stilt-grass has become established is probably moderate (Tu 2000). Grass-specific herbicides may need to be used to control Japanese stilt-grass at the cost of sacrificing some native grass species populations. The best combination of control for Japanese stilt-grass will likely involve mowing/cutting in late summer prior to seed set and spot treatments of herbicide in early summer, along with the use of pre-emergent herbicides in late winter.

Tree-of-heaven (*Ailanthus altissima*). This highly invasive tree species is currently present at YRSP near the Visitor Center and in other areas of the Park. While currently not widespread or abundant within the Reserve, tree-of-heaven is likely present in locations such as along forest edges and within tree fall gaps. This species invades quickly into disturbed, sunny areas including interior forest locations where wind-thrown trees create canopy openings. These settings are highly suitable for its colonization.

Native problem species. Due to overabundance, certain native species of animals have become problematic – from both ecological and economic perspectives. While these species are native to Virginia, their recent population increases have resulted in negative effects on habitat. Overabundance of some species is often incompatible with a broad array of resource management objectives. For ecological and or economic reasons, natural resource managers must often control burgeoning populations of native animals.

White-tailed deer (*Odocoileus virginianus*). A large body of research (Russell et al. 2001) presents evidence that dense populations of deer in many eastern U.S. ecosystems can negatively impact tree and herb regeneration, recruitment and composition (Alverson and Waller 1997, Horsley et al. 2003), alter natural community composition (Rooney and Dress 1997), eliminate certain plant species from areas (Augustine and Frelich 1998), and disrupt bird populations (deCalesta 1994; McShea and Rappole 1997). Deer also avoid browsing on the invasive non-native plants, such as Japanese stilt grass (Tu 2000) further exacerbating the nefarious effects of these weeds on native flora. Of particular concern for natural areas management are negative effects of high deer densities on herbaceous plants (Balgooyen and Waller 1995; Augustine and Frelich 1998) and rare plants (Miller et al. 1992). At the end of the 19th century, deer were over-hunted to the point of near extirpation from Virginia. Since then, implementation of strict game laws, elimination of natural predators, and the changing landscape (with more edge habitat) has given rise to a burgeoning deer population that today, in most areas of the state, exceeds estimated presettlement deer densities (Knox 1997). Monitoring programs can be designed to estimate and track deer population densities and deer impacts in order to guide management actions. Additional information on white-tailed deer monitoring and control can be found in Appendix E.

Fire management. Fire management activities include planning, prescribed burning, and wildfire suppression. Historically, lightning-induced wildfires as well as fires started by Native Americans would have occurred along the uplands of the Lower Peninsula, shaping natural communities and species habitats. Although prescribed burning is not currently recommended as a management practice at the Reserve, a fire management plan would help coordinate the wildfire suppression response among various state and/or federal agencies in the event of a future fire. This plan would explore the past role of fire on the Reserve and surrounding area, discuss positive and negative effects of fire on resources present at the site, outline the management objectives of both VIMS and DCR-DSP, and provide a set of management options should a wildfire occur. The potential uses and effects of prescribed burning should also be explored. Development and implementation of a fire management plan will best be accomplished by VIMS staff working closely with DCR, the Virginia Department of Forestry (DOF), and local fire departments. DCR is currently developing fire management guidelines pertaining to all prescribed burning on DCR lands. Prescribed fire, if used at the Reserve, will be conducted in accordance with these guidelines.

Post-hurricane clean-up. Hurricane Isabel in September 2003 heavily affected YRSP including Taskinas Creek Reserve, where extensive areas of forest experienced canopy disturbance when trees were blown down or broken off by the strong winds. In particular, trails and access roads were blocked by literally thousands of individual tree falls. Park staff, three years after the storm, continue to clear remaining blocked trails.

Federal and state natural resource laws. Laws and other regulations that may affect management of Taskinas Creek Reserve are noted in Appendix G. While management at CBNERRVA components is such that VIMS staff would rarely engage in land or water modifications subject to regulation, some future restoration actions could involve the regulatory process. Permitted fishing and/or hunting activities will comply with federal and state laws. At all CBNERRVA components, efforts to control invasive species, protect rare and endangered species, and protect existing natural and historic resources will fulfill the requirements of several natural resource laws.

Operations management. Operations management issues are those that relate to the non-biological aspects of resource management and protection. Especially on public lands where recreational uses may conflict with the other management objectives, protecting natural resources from inappropriate use and abuse is of key importance. Operations issues include the design, placement, and maintenance of infrastructure such as signs to protect resources from adverse human effects. Operations management actions include boundary line monitoring and maintenance, trails monitoring and maintenance, access control, visitor safety, and law enforcement.

Visitor management. Taskinas Creek Reserve is within the boundaries of YRSP – an increasingly popular day-use state park situated mid-way between two large and growing metropolitan areas. Recreational use of the Reserve by the public is allowed under the existing MOU between VIMS/CBNERRVA and DCR (Appendix A). While the Reserve's primary purposes are for research and environmental education, designation of the Reserve is not intended to restrict passive recreational activities, especially in the eastern portion which

includes the present location of the park's visitor center. Access to the western portion of the Reserve is generally not encouraged; however, currently there is a hiking/access trail in this area that is open for hiking/wildlife watching. (Appendix B).

Primitive camping for scout groups was provided at Croaker Landing in the bluff area of York River State Park for a couple of years, but was closed in 2005 due to health department issues regarding Port-A-John availability. Boy Scout leaders have recently approached a local delegate about reopening this camping area which is located near the reserve boundary but is not on the reserve. In addition, the current YRSP Master Plan calls for "canoe-in camping" to be provided within the park in the future.

Potential inappropriate public uses include illegal artifact collection, unauthorized hunting, and non-permitted collection of plants and minerals. These activities threaten resources directly, have potential to threaten resources in the future, and raise concern regarding visitor and researcher safety and application of state and federal regulations.

Appropriate uses. The reserve is available for research, teaching, and environmental education by permit from YRSP and CBNERRVA. Hiking on designated trails within the Reserve portion of YRSP is also permitted. Deer hunting within YRSP and Taskinas Creek Reserve is currently (2007) managed by DCR under controlled conditions (reservation hunts) to meet specific resource management objectives (Appendix G). In 2007, managed hunts at the park were conducted on November 5-6 and 26-27. A maximum of 40 hunters per day participate in these hunts. Weapons are restricted to archery, muzzleloaders, and shotguns – high powered rifles are not permitted. DCR requires that all participating hunters show proof of completing a Hunter Education Course. The park is closed to other visitors while such managed hunts are in progress Hunting for species other than deer is not allowed at YRSP. The following DCR website has additional information: http://www.dcr.virginia.gov/state_parks/hunting.shtml

Inappropriate uses. Deterring inappropriate public uses at Taskinas Creek Reserve will require some level of site operations work; e.g., boundary marking, on-site staff presence, public contact, outreach efforts, and law enforcement. Specific examples of inappropriate uses include:

- *Non-permitted collection of plants and animals*. Any and all collection of plant and animal specimens is for research and educational purposes only and requires a permit issued and approved by both DCR and VIMS staff. Unauthorized collection of plants, animals, or minerals directly impacts the natural resources at a site and can quickly decimate populations of rare plants or animals. Therefore, such collection is prohibited.

- *Artifact collection* degrades cultural and historic sites, and disrupts substrates and vegetation. Artifacts are occasionally found on and around Taskinas Creek. To protect historic resources within the Taskinas Creek Reserve, such collection is prohibited.

- *Unleashed dogs and feral cats* disrupt or prey on ground-nesting birds (Yalden and Yalden 1990; Mitchell and Beck 1992) and terrestrial fauna. Feral cats, dogs, or livestock that become established at Taskinas Creek Reserve should be trapped and removed.

Data Gaps and Research Needs
A variety of data gaps and research needs exist in regard to management issues at Taskinas Creek. Further monitoring, research, and management actions will be required to address these questions, which include:

- Are there new or more effective ways to combat Japanese stilt-grass and other invasive species?
- What aquatic communities exist on the Reserve?
  - What aquatic invertebrate species are present?
  - Are there management concerns for these communities/species?
- What is the breeding bird use and capacity at Taskinas Creek?
- What is the magnitude and extent of habitat change in the Taskinas Creek reserve (both in the short and long term)
  - How are these changes linked to watershed land use practices?
- What is the forest disturbance history within Taskinas Creek Reserve and York River State Park?
  - How have land clearing, timbering, wildfire, fire suppression, wind storms, and ice storms affected the development of vegetative communities over the last 300 years?
- What are the effects of sea level rise and shoreline erosion at Taskinas Creek Reserve and York River State Park.
  - What are the implications for long-term resource management?
- What is the historical/archaeological significance of the Reserve?
  - Where are the archaeological sites where artifacts occur and how should they be managed?

Monitoring.
General Overiew: A wide variety of monitoring techniques are used to assess change in natural community composition and rare species population status. Monitoring can determine if natural processes essential to natural heritage resources health are occurring and whether or not management actions have been effective. Monitoring is also needed to document effects of human visitation and public use patterns on natural heritage resources and other natural features protected within natural areas. The term "monitoring" describes several different types of data collection related to resource management and includes inventory, natural history study, research, implementation monitoring, trend measurement, baseline measurement, and long-term ecological studies. Monitoring in a strict sense is "the collection and analysis of repeated observations or measurements to evaluate changes in condition and progress towards meeting a management objective." (Elzinga et al. 1998). This strictly defined mode of monitoring is most useful for rigorously measuring change.

NERRS System-Wide Monitoring Program (SWMP): The goal of the NERR System Wide Monitoring Program is to "Identify and track short-term variability and long-term changes in the integrity and biodiversity of representative estuarine ecosystem and coastal watersheds for the purpose of contributing to effective national, regional, and site-specific coastal zone management". Three broad categories have been identified for monitoring under SWMP:

- Phase I: Abiotic parameters (water quality, weather, nutrients)
- Phase II: Biological parameters (communities and habitats)

- Phase III. Watershed parameters (land use and land cover changes)

Current and Future Monitoring at Taskinas Creek Reserve: Since its initiation in 1995, CBNERRVA has fully participated in the NOAA/NERRS System-Wide Monitoring Program at the Taskinas Creek Reserve. Within the Reserve and York River State Park, CBNERRVA currently maintains long-term, year-round continuous water quality (1995 to present) and meteorological stations (2000-present) as well as collects monthly and monthly diel nutrient (nitrate, nitrite, ammonium, phosphate) samples near the water quality station (2002-present). CBNERRVA will also be examining the overall spatial distribution (Tier 1 Analysis) and patterns of inter-annual and long-term variability within selected areas of emergent vegetation (Tier II Analysis) within the Taskinas Creek Reserve as funds become available. At the Taskinas Creek Reserve, CBNERRVA has started work on the Tier II monitoring through funds from the NOAA Restoration Center to establish long-term reference sites within undisturbed tidal marsh habitats for evaluating the success of near-by restoration efforts. Starting in the spring of 2008, CBNERRVA will be establishing vegetations transects, groundwater wells, sediment elevation tables, and vertical control (through geodetic and water level datum reference systems) at the Taskinas Creek Reserve to accurately describe reference conditions and better understand habitat change. This work is also related to and will become part of the NERR SWMP Phase III effort of tracking and evaluating changes in estuarine habitats and ecological conditions as related to anthropogenic influences from the watershed and environmental stressors from climate change.

Research. Research to improve understanding of natural history, biology, and population dynamics of rare species and ecosystem functions is needed for sound management planning and on which to base defensible management actions. Numerous data gaps (see above) need to be addressed in order to improve management strategies at the Reserve. Studies conducted by VIMS or sponsored through funding support will answer basic natural history questions and inform management decisions and actions. An annotated bibliography of prior research conducted within the Reserves boundaries including the Taskinas Creek Reserve can be found at: http://www.vims.edu/cbnerr/research/26February2006_research_biblio.PDF

Studies conducted on all CBNERRVA components require submission of an application, which must be reviewed and subsequently approved by VIMS staff. Likewise, DCR receives requests from colleges and universities, state agencies, and private individuals to conduct research studies on state parks. These require completion of a DCR Research and Collecting Permit application, which is reviewed by the DCR-DSP Resource Management Section. A follow-up report of study results is required for each approved research permit issued by DCR. Effective communication and coordination should occur between VIMS and DCR to keep each organization informed on current research permit requests and approvals. These actions will help avert project overlap, head off misunderstandings, and prevent one research project from negatively impacting another.

Therefore, it is recommended that:

1. In addition to a VIMS research permit application, any proposed research at Taskinas Creek Reserve also will require the submission of a DCR Research/Collection permit application;
2. All DCR permit applications proposing research activities on the Reserve will be required to be reviewed by VIMS-CBNERRS staff for their input and approval.

Management Recommendations

Rare plant populations. The *Stewartia ovata* population is located in a remote area of the reserve with little human visitation. No invasive species were observed in the vicinity of the plants, and no other threats to the population were discerned. Monitoring is recommended every five years to reevaluate the health of the population. Invasive species monitoring at the *Stewartia* subpopulation locations should be conducted every two to three years for the purposes of early detection of new invasive plant invasions. In particular, monitors should be on the lookout for new infestations of Japanese stilt-grass and tree-of-heaven (*Ailanthus altissima*).

Bald Eagle nest protection. Bald eagles nest at one known location in YRSP very near the Taskinas Creek Reserve boundary. Guidelines for Bald Eagle primary or secondary management zones should be adhered to where they intersect with the Reserve boundaries (USFWS and VDGIF 2000). Based on data provided by VDGIF (2004), the secondary management zone of one bald eagle nest intersects with the Taskinas Creek boundary (Figure 8). It is recommended that the existing Bald Eagle nest within YRSP be monitored at least annually, and that signs warning against disturbance and harassment be posted. Additional management assistance may be available from staff at the College of William and Mary's Center for Conservation Biology or from VDGIF – Wildlife Diversity Division.

***Phragmites* control.** Prior to 2005, numerous (6 – 7) small patches of *Phragmites* were located along Taskinas Creek within the Reserve. Herbicide treatments by DCR staff during summer/fall of 2005 resulted in apparent effective control of these areas, as aerial mapping during summer 2006 indicated the presence of just one small (0.125 ac) remaining patch (Figure 6). However, some very small patches may have gone undetected during this census.

It is recommended that existing patches of *Phragmites* at the Reserve be treated with Habitat herbicide as soon as is possible. Staff from CBNERRVA should contact the DCR-DSP District 1 Resource Specialist or the York River State Park manager to discuss how best to accomplish this action. DCR-DSP and DCR-DNH have worked closely in recent past years to control *Phragmites* at YRSP. It is possible that DCR-DNH staff using boat-based spray equipment could treat Taskinas Creek *Phragmites* either in 2007 or 2008.

CBNERRS and/or DCR staff should continue to monitor Taskinas Creek Reserve during the growing season following any *Phragmites* control treatments to assess control effectiveness. Annual monitoring is also recommended for early detection purposes because of the likelihood that additional *Phragmites* patches will develop in the future. Ground-based control actions should be conducted in a timely manner to treat all known *Phragmites* patches detected during routine monitoring.

Japanese stilt-grass. Stilt-grass is known from disturbed areas in the Reserve, such as along trails and road sides. Most significantly, this species is currently found only in some of the significant community occurrences of Coastal Plain / Piedmont Basic Seepage Swamps. These communities should be monitored annually for stilt-grass presence/absence and control measures should be considered in those communities where the species is present. Grass-specific herbicides such as Poast are one potential tool for controlling this problematic weed, which likely is introduced within local watersheds via water flow from upstream sources.

It is probably inevitable that currently weed free natural community occurrences at the Reserve will become infested, which reinforces the need for periodic monitoring. Early detection of new stilt-grass invasions greatly increases the likelihood of successful control efforts. It is recommended that monitoring for this species be conducted at least once every two years within mapped occurrences of Basic Seepage Swamp communities. Additionally, attempts should be made to map and control stilt-grass within the Reserve along trails and roads.

Japanese honeysuckle. Honeysuckle was expectedly common in some forest communities visited at Taskinas Creek in 2006. Although various management strategies for controlling Japanese honeysuckle have been documented in an earlier section of this natural resource plan (please see page 27), no management actions are recommended for this species at this time. Japanese honeysuckle is too ubiquitous for management to be feasible and natural heritage resources are not directly threatened.

Tree-of-heaven. One species that is known to occur at YRSP and the Reserve, and which has strong potential for future increases, is tree-of-heaven (*Ailanthus altissima*). In particular, this invasive tree species is likely to take advantage of the light gaps and soil disturbance created by Hurricane Isabel to begin invading the otherwise mostly intact forest communities at the Reserve. It is recommended that known locations of tree-of-heaven at the Reserve be mapped and monitored periodically. Young seedlings can be pulled, while established saplings and larger trees can be controlled by cutting/girdling and treating freshly cut stem surfaces with an approved herbicide.

Invasive species – general. On-going periodic surveys for the above-named as well as additional potential invasive plant species are recommended throughout the reserve.

Native problem species. It is recommended that forest community groundcover at Taskinas Creek Reserve be monitored biennially for impacts from the effects of deer overbrowsing. Should overly negative effects be demonstrated to be occurring, staff at DCR-DSP should be informed and strategies developed to increase annual deer harvests as part of the existing deer management program at the park.

Relocation of YRSP visitor center. At one time, CBNERRVA proposed relocating the current visitor center location to the recently purchased Harrison Tract, a location away from the river edge. Relocating this facility would reduce the amount of vehicle traffic and reduce parking lot runoff to ecologically sensitive riparian areas. Relocation would also reduce the need for DCR to consider shoreline stabilization and/or river bluff engineering in order to protect the state's investment in buildings located along an eroding shoreline.

Discussions between DCR and VIMS to determine the feasibility and effectiveness of relocating the park visitor's center should continue to occur in the future.

Public Access to Taskinas Creek Reserve. York River State Park and CBNERRVA will continue to work out arrangement for the use of existing nature trails and public access areas within the Taskinas Creek Reserve. In addition, CBNERRVA will periodically monitor resource

conditions along these areas of public access to insure resource degradation does not occur as a result of excessive visitor use. Camping can cause long-term concentrated impacts on soils and vegetation from trampling and fire rings and is an inappropriate use at all Reserve components.

Cultural resources survey north of Taskinas Creek. It is recommended that the work conducted by Traver (2003) to discover and characterize both historic and prehistoric artifacts within YRSP south of Taskinas Creek be extended to include samples and excavations in the upland areas along the York River north of Taskinas Creek. These portions of the Reserve appear to hold good potential for additional discovery of cultural resources. It is recommended that VIMS staff work with DHR and the College of William and Mary - Center for Archaelogical Research to determine the extent of historical sites and to better determine protection needs and focus conservation efforts.

Unauthorized artifact collection. DHR and land managers with experience in protecting cultural resources can assist with developing and locating signs to discourage trespass and subsequent illegal artifact collection. DHR may also provide assistance with developing effective outreach programs. VMRC could be requested to increase patrols in the area in an effort to further discourage this activity.

Surface and groundwater protection. Residents and landowners living or managing property within the Chesapeake Bay Preservation Area should be encouraged to adhere to provisions set forth by the Bay Act, as well as to agricultural and silvicultural BMPs designed to reduce sedimentation and run-off. In particular, past problems with high fecal coliform bacteria levels within the Taskinas Creek watershed may be alleviated if upstream landowners change the way in which they manage their affairs. It is recommended that CBNERRS staff contact some or all of these landowners and assess specific situations. Possible follow-up actions would include providing information that may help modify landowner activities and result in decreased nutrient and/or sediment runoff and groundwater inputs.

Spill contingency plan. It is recommended that VIMS work closely with the U.S. Coast Guard, the Virginia Department of Environmental Quality (DEQ), and other appropriate agencies and organizations with expertise in petroleum or toxic materials spills to develop a contingency and response plan to protect Taskinas Creek resources in the event of an incident in the York River. Potential sources of leaks or spills include the Cheatham Annex and Exxon piers to the east of the Reserve.

Improve communication between VIMS and DCR. It is recommended that DCR and VIMS staff meet at least once per year, twice if possible, to discuss relevant issues and share concerns regarding the administration and management of Taskinas Creek Reserve within YRSP. At least one of these meeting should occur prior to March 1 of each year to review activities of the previous year and identify upcoming research, education, resource protection, and restoration needs for the Taskinas Creek Research Reserve as well as funding sources to address these needs,.

ADDITIONAL PROTECTION NEEDS

To adequately protect and conserve resources located at Taskinas Creek Reserve, it may be necessary that additional land be purchased or conservation easements be acquired. Purchasing additional lands for a new park visitor center is one specific strategy to increase resource protection and reduce visitor impacts at the Reserve. Protecting water quality in Taskinas Creek by influencing land uses in the upper creek watershed, currently in private ownership, is another reason for additional land protection initiatives. Habitat fragmentation is increasingly threatening nearby lands. To mitigate some of these impacts, VIMS and DCR should consider pursuit of conservation and open-space easements and management agreements on key tracts near the park and Reserve.

Towards that end, the Virginia Institute of Marine Science, in partnership with DCR, has identified the Stieffen tract as a high priority land acquisition property. Given its natural resources, large tract size (>200 ha; >500 ac), and location immediately adjacent to YRSP, the Stieffen tract will serve as a buffer area for Taskinas Creek Reserve. This buffer area is designed to protect the long-term integrity of the core area of the Reserve and provide additional protection for key habitats and species. In addition, the possibility exists for the expansion of the core area of the Reserve within the present park boundaries with the acquisition of the Stieffen tract. The threat of land use conversion from forested to residential development is high. The acquisition of the Stieffen tract and its subsequent management by DCR supports the Reserve mission and is consistent with the Land Acquisition Inventory Plan of the NERRS and the Reserve's Boundary and Acquisition Plan.

SUMMARY

Management to protect and maintain natural resources and biological diversity at Taskinas Creek Reserve will require ongoing actions and assessments to ensure that resources are conserved. The complexity of ecosystems and a shortfall of staff time and funds usually precludes a full understanding of the effects of ongoing biological change and a sufficiency of management actions to direct and monitor that change. By taking an active and adaptive management approach at Taskinas Creek, by using and building on an existing baseline of inventory data, and by monitoring trends in natural communities and/or species populations following management actions it is likely that successful stewardship of natural resources will be attained.

Future Improvements to Taskinas Creek Natural Resource Plan (in 2013)

1) Updating Information on Hydrologic and Water Quality Conditions
   - Continue to update hydrologic and water quality conditions in the York River subestuary data collected through the U.S. EPA Chesapeake Bay Shallow Water Monitoring Program, currently administered by CBNERRVA.
   - This program combines the use of high resolution surface water quality mapping (Dataflow) with continuous, fixed water quality stations to provide accurate measurements of the temporal and spatial variability in water quality constituents as well as assessing water quality criteria within the York River subestuary.
   - This water quality information is compiled thorugh the Virginia Estuarine and Coastal Observing Sytem website: http://www2.vims.edu/vecos/

2) Updating Informaiton on Potential Impacts to Water Quality at Taskinas Creek Reserve
   - Documenting Land Use/Land Cover Changes in Taskinas Creek Watershed.
     - The Coastal Change Analysis Program (C-CAP) is a nationally standardized database of land cover and land change information, developed using remotely sensed imagery, for the coastal regions of the U.S. C-CAP products inventory coastal intertidal areas, wetlands, and adjacent uplands with the goal of monitoring these habitats by updating the land cover maps every five years. Data for Virginia exists for 1996, 2001, and 2005.
       - http://www.csc.noaa.gov/crs/lca/ccap.html
   - GIS Based Tools or Products to Assess Water Quality Impacts Related to Anthropogenic Activities in the Watershed.
     - N-SPECT is a complex yet user-friendly geographic information system (GIS) extension that helps coastal managers and local decision makers predict potential water-quality impacts from nonpoint source pollution and erosion. Users enter information about their area (land cover, elevation, precipitation, and soil characteristics) to create the baseline information. Users then add different land cover change scenarios (such as a development) to get information about potential changes in surface water runoff, nonpoint source pollution, and erosion
       - http://www.csc.noaa.gov/crs/cwq/nspect.html

3) Update on Current and Future Biomonitoring and Habitat Change Studies
   - As the NERRS monitor environmental parameters in a coordinated and consistent manner, reserves are valuable sites for developing an in-depth understanding of the past, present, and future status in the extent and quality of coastal habitat.
     - Use historical aerial photography and other remotely sensed products to calculate erosion rates and habitat conversion/loss over long-term temporal scales and/or resulting from episodic events (i.e. large storms, hurricanes).
     - Document the current spatial distribution and future changes (through Reserve-level mapping) of estuarine habitats within the Taskinas Creek Reserve according to the NERRS classification system.
     - Document patterns of inter-annual and long-term variability within selected areas of emergent vegetation as they relate to anthropogenic (i.e. watershed development) and environmental (i.e. storms, sea level rise) factors.

4) Update on Establishing Vertical Control at Taskinas Creek Reserve (NERRS HMC Plan)
   - Specific objectives are to establish a vertical control reference system at Taskinas Creek Reserve of high level accuracy elevation (cm/mm).
   - Make an assessment of gaps in vertical control points at Taskinas Creek Reserve and identify the infrastructure or steps to fill in those gaps.
   - Install and tie geodetic benchmarks to the current tidal datum.
   - Develop a network of sediment elevation tables (SETs) and feldspar marker horizons at Taskinas Creek Reserve to measure marsh vertical accretion, marsh-surface elevation change (at micro-topographic acales), and shallow and deep soil subsidence on shorter-term time scales in response to sea level rise and storm impacts.

5) Updating Information on Avian Populations in Taskinas Creek Reserve
   - Work with the Center for Conservation Biology (CCB) to target avian species which have the potential to occur within our reserve sites based on their geographic locations and habitat types. http://www.ccb.wm.edu/
     - Especially those species of "conservation concern" identified by CCB or VaDGIF through their Wildlife Action Plan.
   - Determine if Taskinas Creek Reserve falls within any identified Important Bird Areas (IBAs's) in Virginia. http://iba.audubon.org/iba/viewState.do?state=US-VA
     - The IBA program is a science-based initiative designed to identify, conserve, and monitor sites that provide essential habitat for bird populations. Under this initiative, sites that are critical for the long-term survival of bird populations have been identified across the globe using internationally agreed upon criteria.
     - The CCB joined forces with the IBA program with funds from the Coastal Program to provide the information resources and expertise needed to identify and establish a network of conservation sites in coastal Virginia.

6) Incorporation of Wildlife Action Plan Information (Virgina DGIF)
   - The Virginia Wildlife Action Plan provides a blueprint and vision for effective and efficient wildlife conservation in the Commonwealth.
     - http://bewildvirginia.org/wildlifeplan/
   - The Virginia Wildlife Action Plan identifies 925 species of greatest conservation need, 60% of which are aquatic and 70% of which are invertebrates.
     - The species are grouped into four tiers of relative conservation need: critical, very high, high, and moderate which allow for prioritization of conservation actions.
     - In making this assessment, Virginia DGIF focused on species that demonstrated some level of rarity or risk of imperilment (e.g. subject to habitat loss, impacted by pollutioin, currently at low population levels).
   - Using information in this document and the Map Wild! Website (a GIS applicaton under development allowing users to query information from the Wildlife Action Plan), CBNERRVA may identify additional species (known to exist within the habitats at the Taksinas Creek Reserve) for future monitoring or management actions.
   - *This information will supplement those species already identified by the Natural Heritage Division of DCR within this Natural Resource Plan.*

7) Monitor Lespedeza cuneata (http://www.invasive.org/eastern/eppc/LECU.html)
   - Lespedeza cuneata, called the Chinese bushclover, is considered an invasive weed of open areas, roadsides, and fields. This plant has spread throughout the eastern United States and is a significant threat to native prairies and rangelands.
   - This species probably occurs at York River State Park along roads, wide open trails, and in fields. It is not known to invade woodlands, even ones with lots of windthrow or other canopy disturbance as it requires really needs a lot of sunlight.
   - This species was not mentioned in this Natural Resource Plan because Taskinas Creek Reserve has so little of the habitat this species requires. However, if additional hiking or nature trails are developed in or near the Reserve, periodic surveys should be conducted to monitor the status of this species.

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LIST OF APPENDICES

Appendix A.
MOU between VIMS/W&M and VaDCR for the Administration of the Taskinas Creek component of CBNERRVA.

MEMORANDUM OF UNDERSTANDING
BETWEEN
THE VIRGINIA INSTITUTE OF MARINE SCIENCE
AND
THE DEPARTMENT OF CONSERVATION AND RECREATION
CONCERNING THE MANAGEMENT
OF THE
TASKINAS CREEK COMPONENT
OF THE
CHESAPEAKE BAY NATIONAL ESTUARINE RESEARCH RESERVE IN VIRGINIA

WHEREAS, the Commonwealth of Virginia, acting through the Virginia Institute of Marine Science (VIMS), has determined that the designation of Taskinas Creek within the York River State Park as a Chesapeake Bay National Estuarine Research Reserve (CBNERR) under the National Estuarine Research Reserve Program as provided for in the Coastal Zone Management Act of 1972, as amended, would provide for beneficial long-term research and public education to improve coastal management capabilities of the Commonwealth; and

WHEREAS, the Virginia Department of Conservation and Recreation (DCR) owns and manages the property known as Taskinas Creek within York River State Park; and

WHEREAS, the DCR is willing to make a long-term commitment to the Reserve program by making a substantial portion of the Taskinas Creek watershed within York River State Park, along with adjacent state waters, designated as a National Estuarine Research Reserve for the purposes and in the manner set forth below and in the Natural Resource Management Plan for York River State Park and the Management Plan for the CBNERR in Virginia; and

WHEREAS, VIMS and DCR recognize that the designation of Taskinas Creek within York River State Park as a research reserve is an acknowledgement that the area within the reserve is a natural field laboratory to be used, in consonance with current uses, to study and gather data on natural and human processes occurring within the watershed of this York River tributary to the lower Chesapeake Bay, and further to provide a basis for increased public awareness and understanding of the complex nature of estuarine systems, their values and benefits to man and nature, and the problems that confront them, all of which are reflective of the goals of the CBNERR Program which are preservation, research and education; and

WHEREAS, the establishment of the Taskinas Creek Research Reserve will augment the present management, educational, and research functions of the DCR within York River State Park, but shall not be used as a substitute for the present management, education, or research functions of DCR; and

NOW, THEREFORE, for and in consideration of mutual covenants herein contained, it is agreed by and between the parties the following:

ARTICLE I. - Research Reserve Boundary

The CBNERR at Taskinas Creek will include:

Land owned by the DCR within York River State Park, as delineated in the Management Plan for CBNERR in Virginia (Appendix A). DCR and VIMS will develop a conservation plan and a land protection strategy for land adjacent to the reserve within a fifty foot contour.

ARTICLE II. - Ownership and Management of Taskinas Creek Area

The real and personal property within the boundaries of the Taskinas Creek Research Reserve shall continue to be owned and managed by DCR except as specifically provided below or by a separate MOU developed for a specific facility. The use of the York River State Park property within the boundaries of the Research Reserve shall be in accordance with the purposes for which the Research Reserve is established.

The Research Reserve will be cooperatively managed and operated by the DCR and VIMS in accordance with the Natural Resource Management Plan for York River State Park and the Management Plan for the CBNERR in Virginia.

The parties agree to coordinate fully their programs and activities conducted in the Research Reserve at Taskinas Creek. Disputes concerning such activities and programs shall be resolved at the appropriate level of management.

ARTICLE III. Uses of the Reserve at Taskinas Creek

That portion of the York River State Park designated as the Research Reserve at Taskinas Creek will be used primarily for ecological research and public education. Natural resource management activities carried out in the Research Reserve under the York River State Park resource management plan will be compatible with the site's designation as an open/sensitive undeveloped zone. Manipulative research and management within the Reserve will be permitted only with the concurrence of the parties to this agreement on a case-by-case basis.

Research will be directed towards but not limited to: (1) a better understanding of the ecological relationships within the estuarine environment; (2) baseline ecological measurements; (3) monitoring significant changes in the estuarine environment; and (4) assessment and prediction of the effects of man's activities on the estuarine environment.

Educational programs will be designed to increase public knowledge and awareness of estuarine systems and their uses to man, and may serve as a model for similar programs elsewhere in the Bay area and in other estuarine systems.

Designation of the Research Reserve will not restrict passive recreational activities within the core area nor fishing and water-oriented recreational and other wildlife oriented activities which have been traditionally conducted in York River State Park, nor to contravene the manner in which these activities are regulated by appropriate law. The designation of the Research Reserve at Taskinas Creek is in no way meant to obstruct the achievement of the goals and objectives of the DCR as they pertain to the York River State Park. Resource conditions within the Research Reserve will be monitored to insure that resource degradation does not occur as a result of excessive visitor use. Appropriate measures will be taken to minimize any damages observed as a result of monitoring.

York River State Park and CBNERR shall work out arrangements for the use of existing nature trails and facilities for Research Reserve programs. DCR and VIMS will jointly plan and pursue, if necessary, the creation of any new trails, boardwalks, exhibits, docks, parking areas, facilities, equipment, etc., that enhance the management, research and education goals of the Park and the Research Reserve. It is understood that these additional facilities wil be developed to protect the environment in the area by locating administrative facilities and public access in appropriate sites. Either VIMS or DCR financial assistance award monies may be used for these purposes.

Ownership of scientific and education instruments and equipment purchased by VIMS and located at York River State Park will remain with VIMS. Siting and placement of such equipment will be jointly agreed upon by CBNERR and York River State Park staff.

Personnel engaged in Research Reserve sponsored research and education projects will be afforded access to York River State Park on the same basis with regard to the payment of parking and other fees as personnel engaged in York River State Park or DCR sponsored activities. Such individuals will be identified by presentation of the approved Research Reserve permit or by a permit issued by York River State Park.

ARTICLE IV. Administration of the Reserve

The DCR will have primary mangement responsibilities for day to day administration, operations, and maintenance of the Taskinas Creek component of the Research Reserve system in cooperation and consultation with VIMS. Other cooperative projects between DCR and VIMS and other academic institutions or other organizations which are designed specifically to address Research Reserve goals of education, research and preservation shall also require cooperation and consultation.

DCR and VIMS further agree to cooperate on the following Reserve management functions:

a. DCR and VIMS will review activities of the previous year, and prepare an annual list of research, education, resource protection, and restoration needs for Taskinas Creek prior to March 1; VIMS and DCR will help seek funding to fulfill these identified needs;

b. DCR will enforce Park rules and regulations and Research Reserve management policies within Taskinas Creek Reserve site; VIMS will insure compliance among participants in VIMS sponsored activities within the reserves; DCR will notify VIMS of non compliance of personnel engaged in Research Reserve sponsored activites;

c. VIMS will conduct a peer review process for research projects wishing to use the Taskinas Creek NERR component. DCR will provide review comments as part of this process;

d. VIMS will assist the DCR in reviewing applications for permits for sponsored and unsponsored education, monitoring and research projects involving Taskinas Creek Research Reserve site from other parties;

e. DCR will issue permits for approved research, education, and resource protection/restoration projects as required;

f. DCR and VIMS will review reports prepared under education and research monitoring grants concerning the Taskinas Creek Research Reserve site. At least 2 weeks will be allowed for the review. Investigators wil be required to deposit final reports with VIMS and DCR;

g. DCR and VIMS will cooperate in the design , training, and supervision of volunteer programs for the Taskinas Creek Research Reserve site;

h. DCR will involve VIMS in the review and update of the York River State Park natural resource management plan and assist VIMS in the review and update of the Research Reserve management plan; and

I. DCR and VIMS will monitor the impact of visitor use and reserve activities and take steps to mitigate impacts.

ARTICLE V. - Research Reserve Management Plan

This MOU shall be incorporated into the Research Reserve Management Plan.

ARTICLE VI. - Advisory Committees

DCR and York River State Park personnel will be appointed to all CBNERRVA Advisory Committees that oversee activities utilizing Taskinas Creek.

ARTICLE VII. - Termination of the MOU

This MOU shall be in effect until superceeded.

If VIMS ceases to operate the Research Reserve at Taskinas Creek as a designated Research Reserve, or Research Reserve designation is withdrawn or otherwise terminated, this MOU and the VIMS' interest shall be terminated and the DCR shall again have the full and exclusive control of the property.

For purposes of this Article, the parties agree that a decision to terminate this Agreement shall be made jointly by the parties, with two years advance notice given.

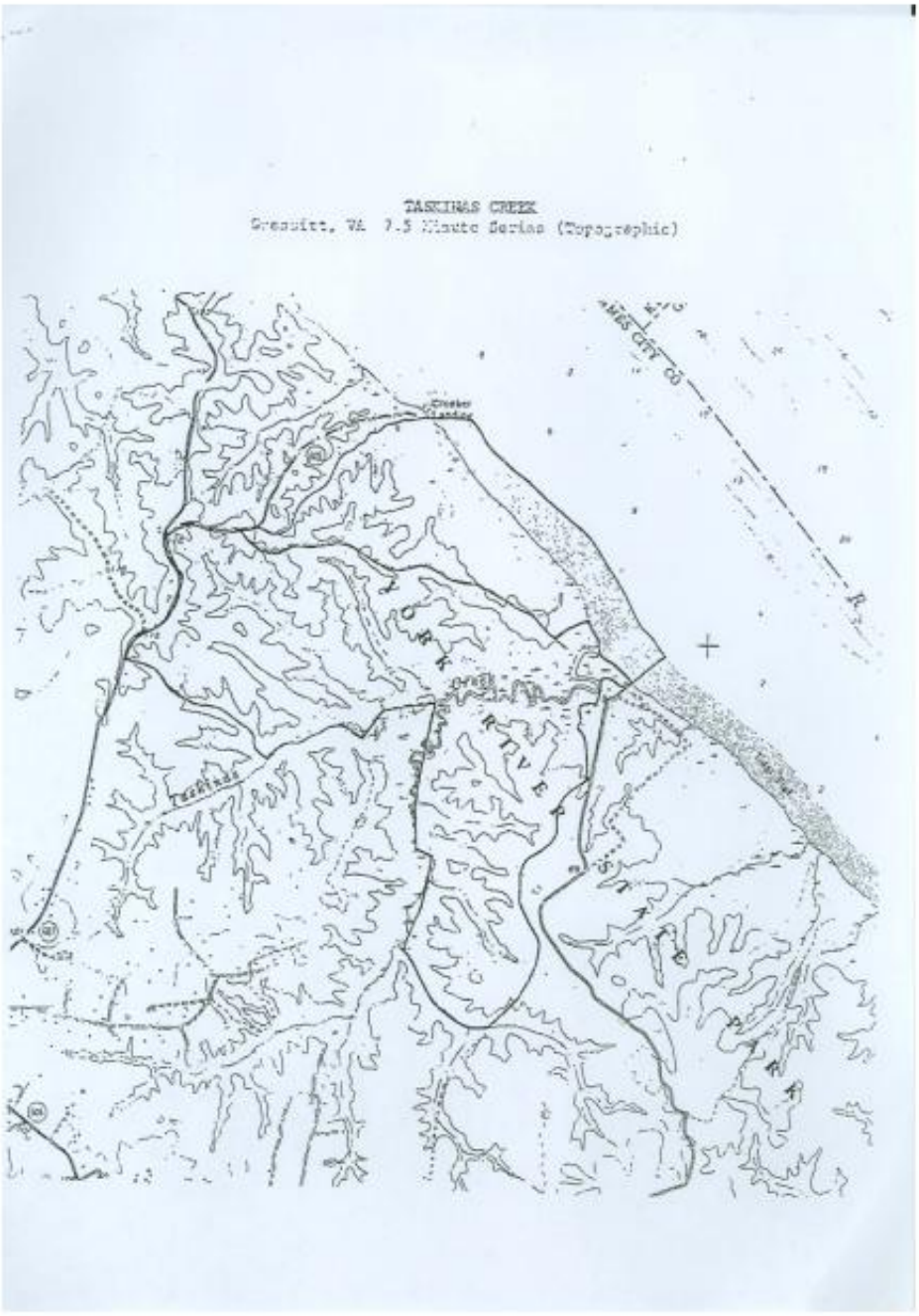
IN WITNESS WHEREOF, the parties hererto have caused this Memorandum of Understand to be executed on this date 13. May, 1997.

WITNESS

Kathleen W. Lawrence, Director
Department of Conservation and Recreation

WITNESS

L. Donelson Wright, Dean and Director
Virginia Institute of Marine Science
College of William and Mary


TASKINAS CREEK
Greenbelt, VA 7.5 Minute Series (Topographic)
JAMES CITY CO
LOWER
RIVER
Taskinas

Appendix B.
General Public Access Plan for Chesapeake Bay National Estuarine Research Reserve Sites
(*Last Modified: September 12, 2004)*

A. Mission and Goals

CBNERRVA is responsible for the long-term management of its reserve components in order to protect the ecological integrity of the natural system and provide a stable environment to support research, monitoring and education missions. In some cases, the reserve component can be managed to meet this objective while still supporting some level of public use.

B. General Policy

Public access to the four CBNERRVA components is regulated on a site-specific basis. The objectives of regulated access are to maintain each site's integrity for research and education while permitting traditional uses which do not conflict with reserve goals or agreements with private landowners. CBNERRVA and site property owners reserve the right to impose additional restrictions to curtail any activity threatening to disturb natural conditions or ongoing research and education activities. It should be noted that specific public uses are not compatible, for example bird and wildlife watching is not compatible with concurrent waterfowl hunting. In such cases, CBNERRVA will strive to minimize conflicts through spatial and temporal separation strategies. If negative impacts are observed, the causative public use(s) will be determined and re-evaluated. When warranted, the assistance of local and state law enforcement agencies may be called upon to enforce access regulations. Prosecution of violators will serve as a deterrent against vandalism, littering and arson.

C. Public Access Rules and Schedules

Goodwin Islands
The College of William and Mary maintains a limited-use public access policy for the Goodwin Islands. In accordance with that policy, Goodwin Islands are managed exclusively for research and education. Goodwin Islands are only accessible by shallow draft boats. There are no docking facilities or designated trails on Goodwin Islands. The following access rules apply to Goodwin Islands:

- Public access is limited from dawn to dusk and therefore overnight camping is prohibited.
- Beach areas can be used for picnicking, beachcombing and other non-destructive activities if visitors do not willingly or negligently disturb the environment or scientific experiments/equipment.
- Bicycles, off-road vehicles, and horses are prohibited.
- Building of any type of fire is prohibited.
- Waterfowl hunting from floating blinds is allowed, however, a reserve issued permit is required. No stationary blinds are allowed. Upland and wetland hunting activities are not permitted.
- Fishing, crabbing and collection of shellfish is allowed if in accordance with applicable state laws and regulations.

- Collection of plants, animals (other than that allowed by applicable state laws and regulations), minerals, or artifacts is prohibited.
- Dogs or other domestic animals accompanying visitors must be kept on a leash at all times.

Catlett Islands
With the exception of a single tract acquired by VIMS, the Catlett Islands are privately owned. Visitation is controlled by the property owner(s) and general public access is not permitted on the Catlett Islands. The islands are posted against trespass. Hunting, trapping and oyster gathering are the exclusive rights of the property owners and their assigns. In waters around Catlett Islands, commercial and recreational harvest of fish and crabs is allowed if in accordance with applicable state laws and regulations.

Taskinas Creek
Taskinas Creek reserve is within the boundaries of York River State Park. Access is controlled by park regulations. The park is open year-round from 8am to dusk. The eastern portion of Taskinas Creek within park boundaries is used for passive recreation and nature study. This region contains the park's Visitor Center and outdoor amphitheater, which are open seasonally (closed in the winter) to provide opportunities to learn about coastal environments and local history. Visitors are encouraged to use more than 25 miles of self-guided hiking, biking and equestrian trails. The park and/or park concessionaire charges a nominal park entrance fee and rental fee for picnic shelters, canoes and other recreational items. Picnic tables are available throughout the park on a first-come, first-served basis. Playground equipment, horseshoe pits and volleyball courts are also available. Many of the facilities and trails are ADA compliant.

Croaker Landing, which provides access to the York River, includes a parking area, a boat launch and dock on the York River, and restrooms, is open twenty-four hours a day for boating and has a 10 p.m. closing time posted for non-boating activities. Overnight facilities, in terms of limited primitive group tent camping, are available. Fishing and boating opportunities exist within an upland freshwater pond, Taskinas Creek and the York River proper. Boat (pond only) and canoe rentals are available seasonally. Croaker Landing provides access to the York River and includes a newly constructed fishing pier, a parking area, a boat launch and dock, and restrooms; parking and launch fees are required at all times. Hunting is only allowed in season (November/December) during special controlled hunts. During the hunts, the park is closed to all other visitors. Access to the western portion of Taskinas Creek, which incorporates the reserve, is generally not encouraged.

Sweet Hall Marsh
Sweet Hall Marsh is privately owned. Visitation is controlled by the property owner(s) and general public access is not permitted. Hunting and trapping are the exclusive rights of the property owners and their assigns. In waters around Sweet Hall Marsh, commercial and recreational harvest of fish and crabs is allowed if in accordance with applicable state laws and regulations.

Appendix C.
Management Policies for Chesapeake Bay National Estuarine Research Reserve Sites from 1991 CBNERRVA Management Plan

APPENDIX B
MANAGEMENT POLICIES FOR YORK RIVER SITES

Designated Research Reserves shall be managed to maintain its aesthetic, topographical, and biological integrity. The Reserve shall be maintained as open space, fish and wildlife habitat, and natural field laboratory for nonmanipulative research. The following policies will apply.

Geology

Surface and subsurface features possessing unique geological characteristics shall be maintained and protected so as to preserve those characteristics from unwarranted disturbance and/or destruction. Visitor access to these features will be limited to insure protection of the features and the safety of the visitor. VIMS will work with the Department of Mines, Minerals and Energy to have a geological survey conducted at each reserve site. Surveys must be conducted by a qualified geologist, recognized in the areas of field investigation.

Pertinent statutes, regulations and guidelines
Virginia Cave Protection Act
Coastal Primary Sand Dune Protection Act

Soils

Excavation, mining, or removal of loam, gravel, rock, sand, coal, petroleum, or minerals or alteration of topography shall not be permitted except as related to the collection of geological and geophysical data. Areas devoted to agricultural use or areas subject to user impact, such as trails, should be developed and/or maintained to minimize damage to and loss of existing soils. Soil maps and soil suitabilities shall be obtained or developed for each research reserve.

Pertinent statutes, regulations and guidelines
Virginia Erosion and Sediment Control Law
Agriculture—Best Management Practices
Guidelines on Construction and Maintenance of Trails (to be developed)

Shorelines

Shorelines shall be preserved in their natural state and existing condition. Restoration of severely eroding shorelines by planting native vegetation may be allowed with approval on an individual basis as an applied research. Opposition to existing and/or proposed off-site activities will be considered if such activities may adversely affect existing shoreline and/or water resources along or within reserve boundaries.

Pertinent statutes, regulations and guidelines
Virginia Erosion and Sediment Control Law
Hydrologic Modifications—Best Management Practices
Subaqueous Guidelines
Coastal Primary Sand Dune Protection Act
Federal Clean Water Act, Section 401
Federal Coastal Zone Management Act

Stream Beds and Channels

Stream beds and channels shall be preserved in their natural state and existing condition. There shall be no manipulation or alteration of natural water courses, channels, or other water bodies, nor shall there be conducted activities on or around the reserve site that could alter natural water level, flow, or both except in conjunction with applied research projects where the impact will be temporary and nondestructive. Opposition to existing and/or proposed off-site activities will be considered if such activities may adversely affect natural water courses, channels, levels, flow, or other resources within the reserve boundaries.

Pertinent statutes, regulations and guidelines
Hydrologic Modifications—Best Management Practices
Watercourses Generally
Minimum Instream Flow Generally
Subaqueous Guidelines
Federal Clean Water Act, Section 401

Water Quality

There shall be no human activities or uses of the reserve site that are detrimental or

adverse to the maintenance, improvement or conservation of existing surface and ground water supplies and quality. All activities within a reserve must be conducted so as to avoid violation of established State Water Control Board Water Quality Standards.

Pertinent statutes, regulations and guidelines

Waters of the State, Ports and Harbors
Federal Clean Water Act
Standards of Water Quality (established by State Water Control Board)
Minimum Instream Flow Generally
Sources Affecting Ground Water—Best Management Practices
Hazardous Waste Management Reglations

Air Quality

No activities shall be permitted in the reserve that have the potential to cause air pollution which exceeds acceptable air quality standards. Air quality will be monitored at appropriate sites.

Pertinent statutes, regulations and guidelines

Federal Clean Air Act
Virginia Air Pollution Control Law
Regulations for the Control and Abatement of Air Pollution

Wetlands

All tidal and nontidal wetlands located within or along reserve boundaries shall be protected in a natural condition. Wetlands include bogs, swamps, freshwater and tidal vegetated marshes, and unvegetated flats.

Pertinent statutes, regulations and guidelines

Virginia Wetlands Act
Federal Clean Water Act, Section 404 and Section 401

Forests

Timber management within the core area of reserve lands should be directed toward the development and preservation of significant old growth stands, except where selective harvesting of mature trees is a traditional use of the property. Disease, insect, or exotic plant control, facility development, and/or stand improvement considerations in the buffer zones shall be the controlling or motivating factors behind decisions to harvest or treat timber. Any harvesting of timber will be conducted in accordance with guidelines established by VDOF. The research reserve program shall work with the Virginia Department of Forestry to develop an inventory and evaluation of standing timber at each site. VIMS will work with the Virginia Department of Agriculture and Consumer Affairs to survey timber stands for forest pests, disease, and exotic and rare/endangered plant species and to develop appropriate pest/disease management procedures.

Pertinent statutes, regulations and guidelines

Forestry—Best Management Practices
Gypsy Moth Control Guidelines (to be developed)

Fish and Wildlife

Game and nongame species shall be managed to preserve the overall health of the various populations within the reserve and to maintain fish and wildlife habitat. Traditional hunting, fishing, oystering, and trapping will be allowed, consistent with applicable laws. VIMS will work cooperatively with the Virginia Department of Game and Inland Fisheries to establish reserve-specific wildlife management plans.

Pertinent statutes, regulations and guidelines

Forestry—Best Management Practices
Agriculture—Best Management Practices
Game and Inland Fisheries Hunting Regulation
Virginia Marine Resources Commission Fishing Regulations

Rare, Threatened or Endangered Species

Areas identified as possessing rare, threatened or endangered species shall be managed, according to recommended regulations and guidelines, to preserve and protect the

species. The presence of an endangered or threatened species shall not necessarily preclude continued or proposed uses of an area. The flora and fauna on research reserves will be surveyed, identified and classified with the assistance of the Virginia Natural Heritage Program and Department of Game and Inland Fisheries.

Pertinent statutes, regulations and guidelines

Federal and State Endangered Species Act
Virginia Endangered Plan and Insect Species Act

Traditional Uses

Traditional hunting, trapping, oystering, and fishing activities will be allowed in accordance with applicable laws. Private landowners may place noncommercial blinds on the reserve for personal use or use by assigns. Agricultural and silvicultural activities within the buffer areas of research lands will be conducted in accordance with environmentally sound practices (BMPs).

Pertinent statutes, regulations and guidelines

Game and Inland Fisheries Hunting Regulations
Virginia Marine Resources Commission Fishing Regulations
Virginia Erosion and Sediment Control Law
Virginia Pesticide Law
Agriculture—Best Management Practices

Structures, Roads and Trails

No new buildings, facilities, structures, piers, roads or trails shall be constructed on the reserve site, except those designed, constructed, utilized in, and accessary to research, education, hunting and naturalistic uses of the reserve site. Such construction shall only be permissable only after the environmental impact of any such construction is fully assessed and approved. Similarly, removal of existing structures shall be assessed for potential environmental impact. There shall be no compulsion to remove existing structures.

Signs and Billboards

Display of signs, billboards, or other advertisements shall not be permitted on or over the reserve sites, except to state the name and/or address of the owner, to provide notice of the designation as a Chesapeake Bay National Estuarine Research Reserve, and/or to post the property against trespass or littering.

Fire

A proactive fire plan to consider wildland fire prevention and supression will be developed in cooperation with the Department of Forestry. A two-phased approach to the prevention, management, and suppression of fire will be encouraged. The plan will take into consideration that fire is a natural process in forest ecology and will not seek to control all fires. However, proactive plans to protect structures, and other significant resources which are sensitive to fire damage and to protect human safety will also be developed. Any prescribed burns to be used for resource management purposes will be conducted only under the supervision of a qualified master burner.

Pertinent statutes, regulations and guidelines

Forest Wardens and Fires

Trash, Rubbish and Waste

No soil, trash, ashes, garbage, hazardous waste, or offensive materials shall be dumped or deposited on the research reserve site. No wetland, pond, or waterway shall be filled.

Off-Road Vehicles

No motor vehicles, trail bikes, or all-terrain vehicles shall be operated at the reserve site, except in designated buffer areas and/or for official reserve management operations.

Archaeological and Historical Sites and Objects

Reserve sites shall be inventoried to locate sites and objects possessing prehistoric and/

or historic significance and plans to protect such sites and objects shall be prepared. Activities which may in some way affect significant sites or objects shall require review and/or permitting by the Division of Historic Landmarks and approved by reserve manager.

Pertinent statutes, regulations and guidelines
Virginia Antiquities Act
Virginia Cave Protection Act
1986 Appropriations Act
National Historic Preservation Act

Historic Buildings, Structures and Objects

Historic structures shall be protected and preserved and the history of such structures shall be incorporated in the reserve's interpretive offerings where appropriate. Eligible structures shall be surveyed and evaluated for nomination to the Virginia Landmarks Register and the National Register of Historic Places. Buildings and structures possessing historic significance shall be protected by established statutes and regulations. Plans for the alteration, remodeling, or redecoration of historic structures on the Virginia Landmarks Register must be submitted to the Division of Historic Landmarks for review and comment to insure that the historic and/or architectural integrity of these properties is maintained.

Pertinent statutes, regulations and guidelines
1986 Appropriations Act
Division of Engineering and Buildings Directive No. 1
National Historic Preservation Act

Collection of Natural, Historical or Cultural Resources

All collecting of plant, animal, mineral, or fossil specimens shall require the prior issuance of a collecting permit by VIMS and the Division of State Parks, where appropriate. The collection of historic or archaeological artifacts will be allowed only with collecting permits approved by the Division of Historic Landmarks. Use of metal detectors by public visitors is prohibited.

Pertinent statutes, regulations and guidelines
Division of Parks and Recreation Regulation No. 5
Virginia Antiquities Act
Virginia Cave Protection Act

Manipulative Research

In order to protect the natural integrity of the research reserve, no manipulative research activities with a significant or long-term adverse impact on reserve resources shall be allowed. Habitat manipulation for resource management purpose shall not be allowed, except as allowed under policies for shorelines, timber, fish, wildlife, and fire management. If waivers of certain policies or portions of policies are determined to benefit the overall management of the research reserve system, they could be considered on an individual basis.

Industrial and Commercial Activities

No industrial or commercial activities shall be conducted in the research reserve core area, with the exception of commercial fishing.

RELEVANT STATE STATUTES AND REGULATIONS AFFECTING PROPOSED RESERVE SITES

Endangered Plant and Insect Species Act

The Endangered Plant and Insect Species Act (Va. Code Ann. Sec. 3.1-1020 et seq.) makes it unlawful for any person to dig, take, cut, process, or otherwise collect, remove, transport, possess, sell, offer for sale, or give away any species native to or occuring in the wild in Virginia that are listed as threatened or endangered.

A license is required to cut or collect any threatened species and records of purchases must be kept. Any person who violates the

provisions will be found guilty of a Class 4 misdemeanor.

Erosion and Sediment Control Law

The Erosion and Sediment Control Law (Va. Code Ann. Sec. 10.1-560 et seq.) states that the Board of Agriculture and Consumer Services shall create regulations for the effective control of soil erosion, sediment deposition and nonagricultural runoff to prevent unreasonable degradation of properties, stream channels, waters and other natural resources.

Land-disturbing activities are regulated by the Act as well. No person may engage in any land-disturbing activity until an erosion and sediment control plan for the land-disturbing activity has been reviewed and approved. Violations or noncompliance will result in the stopping of all or part of the land-disturbing activities. Penalties, injunctions, and other legal actions are outlined in the Act for those found in noncompliance or violation.

Stormwater Management

The Erosion and Sediment Control Law also provides for the establishment of stormwater management programs. The Department of Agriculture and Consumer Services is authorized to promulgate regulations which specify minimum criteria and administrative procedures for stormwater management programs in Virginia. A local government which has adopted a stormwater management program must grant written approval of a plan, the conditions for approval, etc. within a specified time period. Any person who violates any provision of a local ordinance or program shall be guilty of a misdemeanor.

Air Pollution Control Board

The State Air Pollution Control Board is created by this chapter (Va. Code Ann. Sec. 10.1-1300 et seq.) and shall be composed of five members appointed by the Governor for four-year terms. The Board has the power to promulgate regulations, including emergency regulations, abating, controlling and prohibiting air pollution. The Board may create local air pollution control districts to assist the Department in its air monitoring programs, to initiate and make studies relating to air pollution and make recommendations to the Board. Any owner violating this law shall be guilty of a misdemeanor and shall be subject to a fine of not more than $1000 for each violation within the discretion of the court. Each day of continued violation after conviction shall constitute a separate offense.

Virginia Waste Management Act

The Virginia Waste Management Act (Va. Code Ann. Sec. 10.1-1400 et seq.) allows for the creation of the Virginia Waste Management Board which shall consist of seven Virginia residents appointed by the Governor. The Department of Waste Management is continued and also has the power to administer the policies and regulations established by the Board. The Act provides for the requirement of a permit to operate a sanitary landfill or other facility for the disposal, treatment or storage of nonhazardous solid waste. Open dumps are prohibited. Revocation of permits is outlined and the Board is given the power to promulgate regulations. Any person may submit to the Board a notice of intent to file an application for a certification of site approval. The applicant shall submit to the Board a draft impact analysis for the proposed facility within ninety days after the initial briefing meeting. Any person who violates any provision of this Act or regulation shall be assessed a civil penalty of not more than $10,000 for each day of such violation.

Historic Resources Act

The Department of Historic Resources is created in the Act (Va. Code Ann. Sec. 10.1-2200 et seq.) and shall be headed by a Director. The Virginia Historic Landmarks Board is continued as the Board of Historic Resources with seven members appointed by the Governor. The Board may promulgate regulations necessary to carry out the provisions of the Act. Underwater historic property shall be preserved and protected and shall be the exclusive property of the Commonwealth. Any

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person violating the provisions of this section shall be guilty of a Class 1 misdemeanor and, in addition, shall forfeit to the Commonwealth any objects recovered.

Endangered Species Act

In this section the General Assembly declares that certain species of fish or wildlife are threatened with extinction and are entitled to preservation and protection as a matter of general state concern (Va. Code Ann. Sec. 29-230 et seq.). The Commission of Game and Inland Fisheries is authorized to issue regulations to implement the provisions of this section. Any person who violates the provisions of this section shall be punished by a fine of not more than $1000, or imprisonment not to exceed six months, or both. The Commission may permit the taking, exportation, transportation or possession of any fish or wildlife which is listed by the provisions of this chapter for zoological, educational, or scientific purposes, wherever such activities are permitted under federal law, regulation, or permit.

Watercourses and Subaqueous Beds

In Section 62.1-1 of the Annotated Virginia Code and its associated sections, all the beds of the bays, rivers, creeks and the shores of the sea within the jurisdiction of the Commonwealth not conveyed by special grant or compact will continue to remain the property of the Commonwealth of Virginia. The Marine Resources Commission is given the authority to issue permits for all other reasonable uses of state-owned bottomlands. A fee of $25 shall be paid for issuing each permit, but if the cost of the project or facility is more than $10,000, the fee paid shall be $100. A fee of $25 shall be paid for recovery of underwater historic property. All royalties or funds that are collected from such agreements or contracts shall be paid into the state treasury to the credit of the Special Public Oyster Rocks Replenishment Fund.

Tidal Wetlands Act

Standards apply for the use and development of wetlands and shall be considered in the determination of whether applications required by this chapter should be granted or denied. The provisions of the guidelines promulgated by the Commissioner of Marine Resources shall be considered in applying the foregoing standards. No person may conduct any activity which would require a permit under a wetlands zoning ordinance unless he has such permit. The person must apply directly to the Marine Resources Commission for a permit. Any person who knowingly, intentionally, negligently or continually violates any order, rule or regulation will be guilty of a misdemeanor. Following conviction, every day the violation continues shall be deemed a separate offense.

Coastal Primary Sand Dune Act

In order to implement the policy in this chapter, the Commission promulgates guidelines which set forth the consequences of the use of these dunes. No person shall conduct any activity which would require a permit under a coastal primary sand dune ordinance unless he has such permit. In the Coastal Primary Sand Dune Protection Act or an ordinance adopted pursuant to it, all the duties and responsibilities and procedures specified in the Wetlands Act will be followed.

Fish, Oysters, Shellfish, etc.

In Section 28.1-1 et seq. of the Annotated Virginia Code, the Marine Resources Commission jurisdiction extends to the fall line of all tidal rivers and streams and the Commission shall have the jurisdiction over all commercial fishing and all marine fish, marine shellfish, and marine organisms below the fall line on all tidal waters of the Commonwealth. It is unlawful for any person to remove from the waters of this state under the jurisdiction of the Commission any marine fish, marine shellfish, or marine organisms without having first a collection permit. The Commission shall have the power to establish a license commensurate with other

licenses in the amount not to exceed $100 for any device used for the taking and catching of seafood in the waters of the Commonwealth. The Commission, after ten days' notice to any person having a license issued to it may revoke such license for violations of any provisions of this title.

Groundwater Act of 1973

The administration and enforcement of the provisions of this chapter lie with the State Water Control Board and The Department of Health jointly (Va. Code Ann. Sec. 62.1-44.83). No certificate of groundwater right, permit or registration statement authorized by this chapter will be required for any water withdrawal of less than 300,000 gallons a month for groundwater withdrawn for agricultural and livestock purposes. The Board may require persons who withdraw more than 300,000 gallons of water per month in a groundwater management area for the same purposes to report the amount of withdrawal. Whenever, after a public hearing, the Board finds that the permit holder is wilfully violating any provision of a permit the Board may cancel or suspend such certificate or impose conditions on the use therof in order to prevent future violations. Any person adjudged to have violated provisions of this chapter shall be guilty of a misdemeanor.

Scenic Rivers Act

In the Scenic Rivers Act (Va. Code Ann. Sec. 10.1-400 et seq.) the Director of the Department of Conservation and Recreation is empowered to identify rivers or sections of rivers that should be considered for designation because of their scenic, recreational and historic attributes. The agency designated by the General Assembly shall administer the scenic river or section to preserve and protect its use and enjoyment, periodically survey the scenic river and its immediate environs and monitor all existing and proposed uses.

Chesapeake Bay Preservation Act

The Act (Va. Code Ann. Sec. 10-313 et seq.) establishes the Chesapeake Bay Local Assistance Board. The Board is authorized to provide land use and development and water quality protection information. The Board shall also promulgate regulations which establish criteria for use by local governments to determine the ecological and geographic extent of Chesapeake Bay Preservation Areas. Local governments will employ the criteria to ensure that the use and development of land in Chesapeake Bay Preservation Areas shall be accomplished in a manner that protects the quality of the state's waters. The Board adopted regulations on September 20, 1989. These regulations give Tidewater local governments until September 20, 1990 to designate Chesapeake Bay Preservation Areas and employ performance criteria within them.

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Appendix D.
Natural Heritage Rarity Ranks and Status Explanation

Natural Heritage Rarity Ranks and Status Explanation

Each of the significant natural features (species, community type, etc.) monitored by DCR-DNH is considered an element of natural diversity, or simply an element. Each element is assigned a rank that indicates its relative rarity on a five-point scale (1 = extremely rare; 5 = abundant; Table 1). The primary criterion for ranking elements is the number of occurrences, i.e., the number of known distinct localities or populations. Also of great importance is the number of individuals at each locality or, for highly mobile organisms, the total number of individuals. Other considerations include the condition of the occurrences, the number of protected occurrences, and threats. However, the emphasis remains on the number of occurrences, so that ranks essentially are an index of known biological rarity. These ranks are assigned in terms of the element's rarity within Virginia (its State or S-rank), the element's rarity within a Nation (its National or N-rank), and the element's rarity across its entire range (its Global or G-rank). Subspecies and varieties are assigned a Taxonomic (T-) rank in addition to their G-rank. A Q indicates taxonomic uncertainty. Taken together, these ranks give an instant picture of an element's rarity. For example, a designated rank of G5S1 indicates an element which is abundant and secure range-wide, but rare in Virginia. In some cases, ranks are provisional or lacking, due to ongoing efforts by the Natural Heritage network to classify community syntaxa and cryptic plants or animals. Rarity ranks used by DCR-DNH are not legal designations, and they are continuously updated to reflect new information.

Table D-1. Definition of Natural Heritage state rarity ranks. Global ranks are similar to state ranks, but refer to a species' range-wide status. Note that GA and GN are not used and GX means extinct. GM and GW are ranks used only for communities, and refer to highly modified (GM) and ruderal (GW) vegetation respectively. National ranks are similar as well, and refer to a species' rarity within a nation, such as the United States or Canada. Sometimes ranks are combined (e.g., S1S2) to indicate intermediate or somewhat unclear status. Elements with uncertain taxonomic validity are denoted by the letter Q, after the global rank. These ranks should not be interpreted as legal designations.

S1	Extremely rare; usually 5 or fewer occurrences in the state, or in the case of communities, covering less than 50 hectares in aggregate; or may have a few remaining individuals; often especially vulnerable to extirpation.
S2	Very rare; usually between 5 and 20 occurrences, or in the case of communities, covering less than 250 hectares in aggregate; or few occurrences with many individuals; often susceptible to becoming endangered.
S3	Rare to uncommon; usually between 20 and 100 occurrences; may have fewer occurrences, but with a large number of individuals in some populations; may be susceptible to large-scale disturbances.
S4	Common; usually more than 100 occurrences, but may be fewer with many large populations; may be restricted to only a portion of the state; usually not susceptible to immediate threats.
S5	Very common; demonstrably secure under present conditions.
SA	Accidental in the state.
SH	Historically known from the state, but not verified for an extended period, usually more than 15 years; this rank is used primarily when inventory has been attempted recently.

SM Applied to vegetation extensively modified by disturbance but considered recoverable by management, time, or restoration of ecological processes.

SN Regularly occurring migrants or transient species which are non-breeding, seasonal residents. (Note that congregation and staging areas are monitored separately).

SU Status uncertain, often because of low search effort or cryptic nature of the element.

SW Applied to vegetation dominated by ruderal or exotic species.

SX Apparently extirpated from the state.

The spot on the landscape that supports a natural heritage resource is an element occurrence. DCR-DNH has mapped over 7,500 element occurrences in Virginia. Information on the location and quality of these element occurrences is computerized within the Division's BCD system, and additional information is recorded on maps and in manual files.

In addition to ranking each element's rarity, each element occurrence is ranked to differentiate large, outstanding occurrences from small, vulnerable ones. In this way, protection efforts can be aimed not only at the rarest elements, but at the best examples of each. Species occurrences are ranked in terms of quality (size, vigor, etc.) of the population; the condition (pristine to disturbed) of the habitat; the viability of the population; and the defensibility (ease or difficulty of protecting) of the occurrence. Community occurrences are ranked according to their size and overall natural condition. These element occurrence ranks range from A (excellent) to D (poor). Sometimes these ranks are combined to indicate intermediate or somewhat unclear status, (e.g., AB or CD). In a few cases, especially those involving cryptic animal elements, field data may not be sufficient to reliably rank an occurrence. In such cases a rank of E (extant) may be given. A rank of H (historical) is used to indicate an historical occurrence that could not be relocated by recent survey. Element occurrence ranks reflect the current condition of the species' population or community. A poorly-ranked element occurrence can, with time, become highly-ranked as a result of successful management or restoration.

Element ranks and element occurrence ranks form the basis for ranking the overall significance of sites. Site biodiversity ranks (B-ranks) are used to prioritize protection efforts, and are defined in Table D-2.

Table D-2. Biodiversity ranks used to indicate site significance.

B1 Outstanding Significance: only site known for an element; an excellent occurrence of a G1 species; or the world's best example of a community type.

B2 Very High Significance: excellent example of a rare community type; good occurrence of a G1 species; or excellent occurrence of a G2 or G3 species.

B3 High Significance: excellent example of any community type; good occurrence of a G3 species.

B4 Moderate Significance: good example of a community type; excellent or good occurrence of state-rare species.

B5 General Biodiversity Significance: good or marginal occurrence of a community type or state-rare species.

The U.S. Fish and Wildlife Service (USFWS) is responsible for the listing of endangered and threatened species under the Endangered Species Act of 1973, as amended. Federally listed species (including subspecific taxa) are afforded a degree of legal protection under the Act, and therefore sites supporting these species need to be highlighted. USFWS also maintains a review listing of potential endangered and threatened taxa known as candidate species. Table D-3 illustrates the various status categories used by USFWS and followed in this report. The status category of candidate species is based largely on the Service's current knowledge about the biological vulnerability and threats to a species.

As of February 27, 1996, species formerly referred to as Category 2 (C2) candidates for listing as threatened or endangered are no longer considered "candidates" under the Endangered Species Act. The USFWS no longer maintains a formal, comprehensive list of such species. However, the Virginia Field Office of the USFWS intends to maintain an informal list of these and other "Species of Concern" that may warrant future consideration as candidates. These "Species of Concern" can be regarded as species for which the Service has insufficient scientific information to support a listing proposal. Former Category 1 (C1) species are now considered "candidates" (C) for listing. "Candidate" species are species for which the USFWS has enough scientific information to warrant a proposal for listing. The designation of Category 3 species (3A, 3B, 3C) has been discontinued. However, the USFWS will continue to maintain its files on these species in case new information indicates a need for reevaluation.

Table D-3. U.S. Fish and Wildlife Service species status codes, with abbreviated definitions

LE	Listed endangered
LT	Listed threatened
PE	Proposed to be listed as endangered
PT	Proposed to the listed as threatened
C	Candidate: status data supports listing of taxon as endangered or threatened
SOC	Species of Concern: no official status, evidence of vulnerability, but insufficient data exists.

In Virginia, two acts have authorized the creation of official state endangered and threatened species lists. One act (Code of Virginia ' 29.1-563 through 570), administered by the Virginia Department of Game and Inland Fisheries (DGIF), authorizes listing of fish and wildlife species, not including insects. The other act (Code of Virginia ' 3.1-1020 through 1030), administered by the Virginia Department of Agriculture and Consumer Services (VDACS), allows for listing of plant and insect species. In general, these acts prohibit or regulate taking, possessing, buying, selling, transporting, exporting, or shipping of any endangered or threatened species appearing on the official lists. Species protected by these acts are indicated as either listed endangered (LE) or listed threatened (LT). Species under consideration for listing are indicated as candidates (C).

(November 2000)

Appendix E.
Invasive Non-native Species and Problem Native Species Information

Element Stewardship Abstract – *Phragmites australis*

Element Stewardship Abstract – *Microstegium vimineum*

Element Stewardship Abstract – *Lonicera japonica*

White-tailed deer and Virginia Natural Area Preserves – Mike Leahy, former Mountain Regional Steward, Department of Conservation and Recreation, Division of Natural Heritage, Roanoke, VA.

Impacts and Economic Costs of Deer in Suburban Landscapes – Dr. Paul D. Curtis, Extension Wildlife Specialist, Department of Natural Resources, Cornell University, Ithaca, NY.

ELEMENT STEWARDSHIP ABSTRACT
for

Phragmites australis

Common Reed

To the User:

Element Stewardship Abstracts (ESAs) are prepared to provide The Nature Conservancy's Stewardship staff and other land managers with current management-related information on those species and communities that are most important to protect, or most important to control. The abstracts organize and summarize data from numerous sources including literature and researchers and managers actively working with the species or community.

We hope, by providing this abstract free of charge, to encourage users to contribute their information to the abstract. This sharing of information will benefit all land managers by ensuring the availability of an abstract that contains up-to-date information on management techniques and knowledgeable contacts. Contributors of information will be acknowledged within the abstract and receive updated editions. To contribute information, contact the editor whose address is listed at the end of the document.

For ease of update and retrievability, the abstracts are stored on computer at the national office of The Nature Conservancy. This abstract is a compilation of available information and is not an endorsement of particular practices or products.

Please do not remove this cover statement from the attached abstract.

Authors of this Abstract:
Marianne Marks (original version), Beth Lapin & John Randall

The Nature Conservancy
Element Stewardship Abstract
For *Phragmites australis*

I. IDENTIFIERS

Common Name: COMMON REED Global Rank: G5

General Description:
Phragmites australis is a large perennial rhizomatous grass, or reed. The name Phragmites is derived from the Greek word for fence, phragma, in reference to its fence-like growth along streams.

Diagnostic Characteristics:
Members of the genus Phragmites are superficially similar to Arundo. Sterile specimens of P. australis are sometimes misidentified as Arundo donax, a grass introduced to North America from Asia and now troublesome in natural areas, especially in California. The genera can be distinguished when in flower because the glumes of Phragmites are glabrous while those of Arundo are covered with soft, whitish hairs 6-8 mm long. In addition, the glumes are much shorter than the lemmas in Phragmites.

II. STEWARDSHIP SUMMARY

Communities that have stable Phragmites populations present but have been exposed to disturbance should be closely monitored. Management is necessary when evidence indicates that Phragmites has spread, or is spreading and threatening the integrity of rare communities, invading the habitat of rare plants or animals or interfering with the wildlife support function of refuges. Cutting, burning, application of herbicides (in particular Rodeo), or water management schemes are possible control measures. The measure(s) used will depend on a number of factors including the size and location of the infestation, the presence of sensitive rare species and the work-force available.

III. NATURAL HISTORY

Range:
Phragmites australis is found on every continent except Antarctica and may have the widest distribution of any flowering plant (Tucker 1990). It is common in and near freshwater, brackish and alkaline wetlands in the temperate zones world-wide. It may also be found in some tropical wetlands but is absent from the Amazon Basin and central Africa. It is widespread in the United states, typically growing in marshes, swamps, fens, and prairie potholes, usually inhabiting the marsh-upland interface where it may form continuous belts (Roman et al. 1984).

Because Phragmites has invaded and formed near-monotypic stands in some North American wetlands only in recent decades there has been some debate as to whether it is indigenous to this continent or not. Convincing evidence that it was here long before European contact is now available from at least two sources. Niering and Warren (1977) found remains of Phragmites in cores of 3000 year old peat from tidal marshes in Connecticut. Identifiable Phragmites remains dating from 600 to 900 A.D. and constituting parts of a twined mat and other woven objects were found during archaeological investigations of Anasazi sites in southwestern Colorado (Kane & Gross 1986; Breternitz et al. 1986).

There is some suspicion that although the species itself is indigenous to North America, new, more invasive genotype(s) were introduced from the Old World (Metzler and Rosza 1987). Hauber et al. (1991) found that invasive Phragmites populations in the Mississippi River Delta differed genetically from a more stable population near New Orleans. They also examined populations elsewhere on the Gulf coast,

from extreme southern Texas to the Florida panhandle, and found no genetic differences between those populations and the one near New Orleans (Hauber, pers. comm. 1992). This increased their suspicion that the invasive biotypes were introduced to the Delta from somewhere outside the Gulf relatively recently.

Phragmites is frequently regarded as an aggressive, unwanted invader in the East and Upper Midwest. It has also earned this reputation in the Mississippi River Delta of southern Louisiana, where over the last 50 years, it has displaced species that provided valuable forage for wildlife, particularly migratory waterfowl (Hauber 1991). In other parts of coastal Louisiana, however, it is feared that Phragmites is declining as a result of increasing saltwater intrusion in the brackish marshes it occupies. Phragmites is apparently decreasing in Texas as well due to invasion of its habitat by the alien grass ARUNDO DONAX (Poole, pers. comm. 1985). Similarly, Phragmites is present in the Pacific states but is not regarded as a problem there. In fact, throughout the western U.S. there is some concern over decreases in the species habitat and losses of populations.

Habitat:
Phragmites is especially common in alkaline and brackish (slightly saline) environments (Haslam 1972, 1971b), and can also thrive in highly acidic wetlands (Rawinski, pers. comm. 1985). However, Phragmites does not require, nor even prefer these habitats to freshwater areas. Its growth is greater in fresh water but it may be outcompeted in these areas by other species that cannot tolerate brackish, alkaline or acidic waters. It is often found in association with other wetland plants including species from the following genera: SPARTINA, CAREX, NYMPHAEA, TYPHA, GLYCERIA, JUNCUS, MYRICA, TRIGLOCHIN, CALAMAGROSTIS, GALIUM, and PHALARIS (Howard et al. 1978).

Phragmites occurs in disturbed areas as well as pristine sites. It is especially common along railroad tracks, roadside ditches, and piles of dredge spoil, wherever even slight depressions hold water (Ricciuti 1983). Penko (pers. comm. 1993) has observed stunted Phragmites growing on acidic tailings (Ph 2.9) from an abandoned copper mine in Vermont. Various types of human manipulation and/or disturbance are thought to promote Phragmites (Roman et al. 1984). For example, restriction of the tidal inundation of a marsh may result in a lowering of the water table, which may in turn favor Phragmites. Likewise, sedimentation may promote the spread of Phragmites by elevating a marsh's substrate surface and effectively reducing the frequency of tidal inundation (Klockner, pers. comm. 1985).

A number of explanations have been proposed to account for the recent dramatic increases in Phragmites populations in the northeastern and Great Lakes States. As noted above, habitat manipulations and disturbances caused by humans are thought to have a role. In some areas Phragmites may also have been promoted by the increases in soil salinity which result when de- icing salt washes off roads and into nearby ditches and wetlands (McNabb and Batterson 1991). On the other hand, bare patches of road sand washed into ditches and wetlands may be of greater importance. Phragmites seeds are shed from November through January and so may be among the first propagules to reach these sites. If the seeds germinate and become established the young plants will usually persist for at least two years in a small, rather inconspicuous stage, resembling many other grasses. Later, perhaps after the input of nutrients, they may take off and assume the tall growth form that makes the species easily identifiable . Increases in soil nutrient concentrations, may come from runoff from farms and urban areas. It has also been suggested increases in nutrient concentrations, especially nitrates, are primarily responsible for increases in Phragmites populations. Ironically, eutrophication and increases in nitrate levels are sometimes blamed for the decline of Phragmites populations in Europe (Den Hartog et al. 1989).

Ecology:
Salinity and depth to the water table are among the factors which control the distribution and performance of Phragmites. Maximum salinity tolerances vary from population to population; reported maxima range

from 12 ppt (1.2%) in Britain to 29 ppt in New York state to 40 ppt on the Red Sea coast (Hocking et al. 1983). Dense stands normally lose more water through evapotranspiration than is supplied by rain (Haslam 1970). However, rhizomes can reach down almost 2 meters below ground, their roots penetrating even deeper, allowing the plant to reach low lying ground water (Haslam 1970). Killing frosts may knock the plants back temporarily but can ultimately increase stand densities by stimulating bud development (Haslam 1968).

Phragmites has a low tolerance for wave and current action which can break its culms (vertical stems) and impede bud formation in the rhizomes (Haslam 1970). It can survive, and in fact thrive, in stagnant waters where the sediments are poorly aerated at best (Haslam 1970). Air spaces in the above-ground stems and in the rhizomes themselves assure the underground parts of the plant with a relatively fresh supply of air. This characteristic and the species' salinity tolerance allow it to grow where few others can survive (Haslam 1970). In addition the build up of litter from the aerial shoots within stands prevents or discourages other species from germinating and becoming established (Haslam 1971a). The rhizomes and adventitious roots themselves form dense mats that further discourage competitors. These characteristics are what enable Phragmites to spread, push other species out and form monotypic stands.

Such stands may alter the wetlands they colonize, eliminating habitat for valued animal species. On the other hand, the abundant cover of litter in Phragmites stands may provide habitat for some small mammals, insects and reptiles. The aerial stems provide nesting sites for several species of birds, and Song Sparrows have been seen eating Phragmites' seeds (Klockner, pers. comm. 1985). Muskrats (ONDATRA ZIBETHICUS) use Phragmites for emergency cover when low lying marshes are swept by storm tides and for food when better habitats are overpopulated (Lynch et al. 1947).

Studies conducted in Europe indicate that gall-forming and stem- boring insects may significantly reduce growth of Phragmites (Durska 1970; Pokorny 1971). Skuhravy (1978) estimated that roughly one-third of the stems in a stand may be damaged reducing stand productivity by 10-20%. Mook and van der Toorn (1982) found yields were reduced by 25 to 60% in stands heavily infested with lepidopteran stem- or rhizome-borers. Hayden (1947) suggested that aphids (HYALOPTERUS PRUNI) heavily damaged a Phragmites stand in Iowa. On the other hand work in Europe by Pintera (1971) indicated that although high densities of aphids may bring about reductions in Phragmites shoot height and leaf area they had little effect on shoot weight. Like other emergent macrophytes, Phragmites has tough leaves and appears to suffer little grazing by leaf-chewing insects (Penko 1985).

As mentioned above, there is great concern about recent declines in Phragmites in Europe where the species is still used for thatch. In fact, the journal Aquatic Botany devoted an entire issue (volume 35 no.1, September 1989) to this subject. Factors believed responsible for the declines include habitat destruction and manipulation of hydrologic regimes by humans, grazing, sedimentation and decreased water quality (eutrophication) (Ostendorp 1989).

Detailed reviews of the ecology and physiological ecology of Phragmites are provided by Haslam (1972; 1973) and Hocking et al. (1983) and an extensive bibliography is provided by van der Merff et al. (1987).

Reproduction:
Phragmites is typically the dominant species on areas that it occupies. It is capable of vigorous vegetative reproduction and often forms dense, virtually monospecific stands. Hara et al. (1993) classify sparse stands as those with densities of less than 100 culms m-2 and dense stands as those with densities of up to about 200 culms m-2 in wet areas or up to 300 culms m-2 in dry areas. Mammalian and avian numbers and diversity in the dense stands are typically low (Jones and Lehman 1987). Newly opened sites may be colonized by seed or by rhizome fragments carried to the area by humans in soils and on machinery during construction or naturally in floodwaters.

The plants generally flower and set seed between July and September and may produce great quantities of seed. In the northeast, seeds are dispersed between November and January. However, in some cases, most or all of the seed produced is not viable (Tucker 1990). The seeds are normally dispersed by wind but may be transported by birds such as red-winged blackbirds that nest among the reeds (Haslam 1972). Following seed set, nutrients are translocated down into the rhizomes and the above- ground portions of the plant die back for the season (Haslam 1968).

Temperature, salinity and water levels affect seed germination. Water depths of more than 5 cm and salinities above 20 ppt (2%) prevent germination (Kim et al. 1985; Tucker 1990). Germination is not affected by salinities below 10 ppt (1%) but declines at higher salinities. Percentage germination increases with increasing temperature from 16 to 25 oC while the time required to germinate decreases from 25 to 10 days over the same temperature range. Barry Truitt (pers. comm. 1992) has observed that areas covered by thick mats of wrack washed up during storms and high water events are frequently colonized by Phragmites on the Virginia Coast Reserve. It is not clear whether it establishes from rhizome pieces washed in with the wrack or from seed that blows in later.

Once a new stand of Phragmites takes hold it spreads, predominantly through vegetative reproduction. Individual rhizomes live for 3 to 6 years and buds develop at the base of the vertical type late in the summer each year. These buds mature and typically grow about 1 meter (up to 10 m in newly colonized, nutrient-rich areas) horizontally before terminating in an upward apex and going dormant until spring. The apex then grows upward into a vertical rhizome which in turn produces buds that will form more vertical rhizomes. Vertical rhizomes also produce horizontal rhizome buds, completing the vegetative cycle. These rhizomes provide the plant with a large absorbent surface that brings the plant nutrients from the aquatic medium (Chuchova and Arbuzoba 1970). The aerial shoots arise from the rhizomes. They are most vigorous at the periphery of a stand where they arise from horizontal rhizomes, as opposed to old verticals (Haslam 1972).

IV. CONDITION

Threats:

IMPACTS (THREATS POSED BY THIS SPECIES)
Phragmites can be regarded as a stable, natural component of a wetland community if the habitat is pristine and the population does not appear to be expanding. Many native populations of Phragmites are "benign" and pose little or no threat to other species and should be left intact. Examples of areas with stable, native populations include sea-level fens in Delaware and Virginia and along Mattagota Stream in Maine (Rawinski 1985, pers. comm. 1992). In Europe, a healthy reed belt is defined as a "homogeneous, dense or sparse stand with no gaps in its inner parts, with an evenly formed lakeside borderline without aisles, shaping a uniform fringe or large lobes, stalk length decreasing gradually at the lakeside border, but all stalks of one stand of similar height; at the landside edge the reeds are replaced by sedge or woodland communities or by unfertilized grasslands" (Ostendorp 1989).

Stable populations may be difficult to distinguish from invasive populations, but one should examine such factors as site disturbance and the earliest collection dates of the species to arrive at a determination. If available, old and recent aerial photos can be compared to determine whether stands in a given area are expanding or not (Klockner, pers. comm. 1985).

Phragmites is a problem when and where stands appear to be spreading while other species typical the of the community are diminishing. Disturbances or stresses such as pollution, alteration of the natural hydrologic regime, dredging, and increased sedimentation favor invasion and continued spread of

Phragmites (Roman et al. 1984). Other factors that may have favored recent invasion and spread of Phragmites include increases in soil salinity (from fresh to brackish) and/or nutrient concentrations, especially nitrate, and the introduction of a more invasive genotype(s) from the Old World (McNabb and Batterson 1991; Metzler and Rosza 1987, see GLOBAL RANGE section for further discussion).

Michael Lefor asserts that one reason for the general spread of Phragmites has been the destabilization of the landscape (pers. comm. 1993). In urban landscapes water is apt to collect in larger volumes and pass through more quickly (flashily) than formerly. This tends to destabilize substrates leaving bare soil open for colonization. Watersheds throughout eastern North America are flashier due to the proliferation of paved surfaces, lawns and roofs and the fact that upstream wetlands are largely filled with post-settlement/post agricultural sediments from initial land-clearing operations.

Many Atlantic coast wetland systems have been invaded by Phragmites as a result of tidal restrictions imposed by roads, water impoundments, dikes and tide gates. Tide gates have been installed in order to drain marshes to harvest salt hay, to control mosquito breeding and, most recently, to protect coastal development from flooding during storms. This alteration of marsh systems may favor Phragmites invasion by reducing tidal action and soil water salinity and lowering water tables.

Phragmites invasions may threaten wildlife because they alter the structure and function (wildlife support) of relatively diverse Spartina marshes (Roman et al. 1984). This is a problem on many of the eastern coastal National Fish and Wildlife Refuges including: Brigantine in NJ; Prime Hook and Bombay Hook in DE; Tinicum in PA; Chincoteague in VA; and Trustom Pond in RI.

Plant species and communities threatened by Phragmites are listed in the Monitoring section. Some of these instances are described below:

1. Massachusetts, a brackish pondlet near Horseneck Beach supports the state rare plant MYRIOPHYLLUM PINNATUM (Walter) BSP, which Phragmites is threatening by reducing the available open water and shading aquatic vegetation (Sorrie, pers. comm. 1985).

2. Maryland, at Nassawango Creek, a rare coastal plain peatland community is threatened by Phragmites (Klockner, pers. comm. 1985).

3. Ohio, at the Arcola Creek wetland, Phragmites is threatening the state endangered plant CAREX AQUATILIS Wahlenb. (Young, pers. comm. 1985).

Phragmites invasions also increase the potential for marsh fires during the winter when the above ground portions of the plant die and dry out (Reimer 1973). Dense congregations of redwing blackbirds, which nest in Phragmites stands preferentially, increase chances of airplane accidents nearby. The monitoring and control of mosquito breeding is nearly impossible in dense Phragmites stands (Hellings and Gallagher 1992). In addition, Phragmites invasions can also have adverse aesthetic impacts. In Boston's Back Bay Fens, dense stands have obscured vistas intended by the park's designer, Frederick Law Olmstead (Penko, pers. comm. 1993).

As noted above Phragmites is not considered a threat in the West or most areas in the Gulf states.

Restoration Potential:
Areas that have been invaded by Phragmites have excellent potential for recovery. Management programs have proven that Phragmites can be controlled, and natural vegetation will return. However, monitoring is imperative because Phragmites tends to reinvade and control techniques may need to be applied several times or, perhaps, in perpetuity. It is also important to note that some areas have been so heavily

manipulated and degraded that it may be impossible to eliminate Phragmites from them. For example, it may be especially difficult to control Phragmites in freshwater impoundments that were previously salt marshes.

V. MANAGEMENT/MONITORING

Management Requirements:
Invasive populations of Phragmites must be managed in order to protect rare plants that it might outcompete, valued animals whose habitat it might dominate and degrade, and healthy ecosystems that it might greatly alter.

Management Programs:
Cultural, mechanical and/or chemical methods can be used to control Phragmites. The factors that are believed responsible for the alarming decreases of Phragmites beds in Europe and Texas include habitat destruction, increased soil nitrate levels, and eutrophication (Boar, Crook and Moss 1989, Ostendorp 1989, Sukopp and Markstein 1989) are not appropriate as management tools in natural areas.

BIOLOGICAL CONTROL: Biological control does not appear to be an option at this time. No organisms which significantly damage Phragmites australis but do not feed on other plant species have been identified. Naturally occurring parasites have not proven to be successful controls (Tscharntke 1988, Mook and van der Toorn 1982, van der Toorn and Mook 1982). In addition, some of the arthropods that feed on Phragmites are killed by winter fires and thus would likely be eliminated from the systems where prescribed fires are used. Coots, nutria, and muskrats may feed on Phragmites but appear to have limited impacts on its populations (Cross and Fleming 1989).

BURNING: Prescribed burning does not reduce the growing ability of Phragmites unless root burn occurs. Root burn seldom occurs, however, because the rhizomes are usually covered by a layer of soil, mud and/or water. Fires in Phragmites stands are dangerous because this species can cause spot-fires over 100 feet away (Beall 1984). Burning does remove accumulated Phragmites leaf litter, giving the seeds of other species area to germinate. Prescribed burning has been used with success after chemical treatment for this purpose at The Brigantine National Wildlife Refuge, NJ (Beall 1984) and in Delaware (Lehman, pers. comm. 1992). Occasional burning has been used in Delaware in conjunction with intensive spraying and water level management. This helps remove old canes and allows other vegetation to grow (Daly, pers. comm. 1991)

At Wallops Island, Virginia, a small (100' x 400') brackish to saline to dry wetland was burned November 1990 to control Phragmites (M. Ailes, pers. comm. 1992). A variety of other species appeared in the year following the burn but they appeared leggy while the Phragmites remained vigorous. A second winter burn is planned and monitoring of transects will continue (there are no pre-treatment data).

At Wertheim National Wildlife Refuge in New York, a 20-30 acre freshwater impoundment was drained in the fall of 1989, burned the following winter and then reflooded (Parris, pers. comm. 1991). Phragmites was eliminated from the half of the marsh that was treated and the area remained free of the grass through 1992.

According to Cross and Fleming (1989), late summer burns may be effective, but winter and spring burning may in fact increase the densities of spring crops. Thompson and Shay (1985) performed experimental burn treatments on Delta Marsh, Manitoba. They found that spring, summer and fall burns resulted in higher total shoot densities and lower mean shoot weights than on controls primarily as a result of greater densities of shorter, thinner vegetative shoots. Shoot biomass was greater in spring-burned and fall-burned plots than in control areas but less on summer- burned plots. They also found that below-

ground production increased following spring and fall burns but not following summer burns. The increase in light availability following burns generally appears to benefit Phragmites. A variety of understory responses to these burns was noted. For example, summer burns increased species diversity, richness, and evenness, although certain species declined (Thompson and Shay 1985).

In Connecticut late spring burns followed by manual flooding with salt water was successful in reducing Phragmites height and density (Steinke, pers. comm. 1992). After three years, the fuel load was exhausted; the process was very expensive and self- regulating tide gates were installed instead (see MANIPULATION OF WATER LEVEL AND SALINITY).

In Europe, experimental removal of litter in winter resulted in doubling the above-ground biomass (Graneli 1989). Increased light availability at the soil surface and aeration of the soil around the rhizomes may have been responsible for this increase. Burning in the winter in an experimental field caused little damage, while burning during the emergence period led to the death of the majority of Phragmites shoots (van der Toorn and Mook 1982).

CHEMICAL: RodeoTM, a water solution of the isopropylamine salt of glyphosate is commonly used for Phragmites control. This herbicide is not, however, selective and will kill grasses and broadleaved plants alike. Toxicity tests indicate that it is virtually non-toxic to all aquatic animals tested. It should be noted that many of these tests were performed by or for Monsanto, the company which manufactures Rodeo. Bioconcentration values for glyphosate in fish tissues were insignificant. Glyphosate biodegrades quickly and completely in the environment into natural products including carbon dioxide, nitrogen, phosphate and water. Finally, since glyphosate does not volatilize, it will not vaporize from a treated site and move to a non-target area (Brandt 1983; Comes, Bruns and Kelly 1976; Folmar, Sanders and Julin 1979; Monsanto 1985).

Rodeo must be mixed with water and a surfactant which allows it to stick to and subsequently be absorbed by the plant (Beall 1984). Instructions for application, amounts needed per acre, the approved surfactants and ratios for mixing, are on the Rodeo label. Glyphosate must be mixed with clean or, if possible, distilled water because it binds tightly to sediments and is thus rendered non-toxic to plants (Lefor, pers. Comm. 1992). This limits its effectiveness but also may help prevent it from acting on plants that were not originally targeted. Rodeo should not by applied in windy conditions, as the spray will drift (I. Ailes, pers. comm. 1985). It also should not be applied if rain is forecast within 12 hours because it will wash away before it has a chance to act (Daly 1984). Application rates may vary but, as one example, effective control of Phragmites in a Delaware marsh was achieved with 4 pints/acre of concentrate (Lehman, pers. comm. 1992).

Application of Rodeo must take place after the tasseling stage when the plant is supplying nutrients to the rhizome. At this time, when Rodeo is sprayed onto the foliage of aquatic weeds, it translocates into the roots. Rodeo interferes with essential plant growth processes, causing gradual wilting, yellowing, browning and deterioration of the plant. Studies on tasseling at the Augustine Tidal area, in Port Penn Delaware, indicated that tasseling in a stand is never 100% but that it is possible to spray when 94% of the plants are tasseling. In dense stands, subdominant plants are protected by the thick canopy and thus may not receive adequate herbicide. For these reasons, touch up work will be necessary (Lehman 1984).

At Brigantine National Wildlife Refuge, Rodeo was applied aerially after the plants tasseled in late August. The application resulted in a 90% success. The following February, a fast moving prescribed burn was carried out to remove litter, exposing the seed bed for re-establishment of marsh vegetation. However funding was not available for several years and Phragmites has returned to 90% of the previously treated areas (Beall, pers. comm. 1991). Treatment was resumed in fall 1991.

In September, 1983, at the Prime Hook Wildlife Refuge in Delaware, 500 acres of freshwater impoundments were sprayed with Rodeo from a helicopter for Phragmites control. The plants yellowed within 10 days. The following May aerial and ground evaluations of the sprayed area revealed a 98% kill of Phragmites (Daly 1984). In addition to applying herbicide, Prime Hook manipulates water levels with a stop log to stress Phragmites; winter water levels are held at an elevation of 2.8' msl until June, when water would otherwise be held at 2.2 msl. The combined spraying and water management approach was successful and many aquatic plants returned. A regime of spraying in August-September for two years followed by flooding has been used through 1991 (Daly, pers. comm. 1991). Annual costs of Phragmites control are $20K annual at Prime Hook (1,000 acres) and $3K at Bombay Hook (20-60 acres); monitoring costs, which include reading vegetation transects for species presence and density each September are not included in the cost.

Aerial spraying has been used since 1983 in many Delaware state wildlife refuges (Lehman, pers. comm. 1992). Using Rodeo, the state sprays freshwater and brackish impoundments, brackish marshes, and salt marshes from early September to early October; this is combined with winter burns between the first and second year of spraying. Areas will be spot-treated whenever needed after that. The herbicide treatments consist of 4 pints/acre the first year and 2 pints/acre the second, with an average cost of $65/acre. The state is involved with cost-sharing programs with private landowners where the state pays half the spraying cost with a willing owner. Desirable native vegetation usually returns after spraying; no revegetation is done. Occasionally become open mud flats that are eventually repopulated by Phragmites.

At Chincoteague National Wildlife refuge, an aerial spraying program initiated in 1986 in an 18-mile long freshwater impoundment was terminated due to budget cuts. Phragmites quickly reclaimed the area, estimated to be 100-150 acres total in small scattered stands (I. Ailes, pers. comm. 1991). In September 1991, spraying with Rodeo began again; it is expected that the entire area will be sprayed again in 1992, and that small areas of re-growth will be sprayed in 1993. Because the area is impounded, the water level usually is lower in the spring, which helps prevent Phragmites regrowth.

Herbicides are used at Tinicum Environmental Center, because other control options are limited. Unplanned burns do occur, but prescribed burns are not allowed due to the proximity to the highway and airport. Tinicum was recently granted $2M to restore a 18-acre site. Here they will be altering the elevation of the marsh, seeding with native plants, and monitoring the results (Nugent, pers. comm. 1991).

At Parker National Wildlife Refuge, an aerial spraying program (annual budget $5K) for 50 acres of a 100-acre freshwater impoundment began in mid-August 1991. A winter burn is anticipated and a second year of spraying planned. Results will be monitored by using aerial photos to delineate the boundaries of the Phragmites clones. A nearby tower also provides a suitable viewing point to observe progress (Healey, pers. comm. 1992).

In more fragile situations where Phragmites is threatening a rare plant or community, aerial spray techniques are inappropriate because such large-scale application could kill the community that the entire operation was designed to protect. Glyphosate can be applied to specific plants and areas by hand with a backpack sprayer. Wayne Klockner of The Nature Conservancy's Maryland Field Office has been successful in eliminating most Phragmites at the Nassawango preserve by applying glyphosate by hand with a backpack sprayer (Klockner, pers. comm. 1985). The control program there began in 1983; actual spraying is conducted along the power line ROW by Delmarva Power (Droege, pers. comm. 1991). Delmarva Power generally sprays with trucks, backpacks or helicopter, depending on the accessibility of the area and presence of rare plants nearby (Johnstone, pers. comm. 1991). They use Rodeo in tidal areas, and AccordTM (another glyphosate product) in non-tidal areas from mid-August to mid-October, when the plants are going to seed. They spray intensively the first year, and conduct touch-up spraying the

second year which eliminates 90-95% of the plants. They then return every three years to eliminate any new plants. They do not spray if the plants are not tasselling and are short.

Rodeo was used at Cape May Meadows in 1989, 1990, and 1991. It was applied with a 30 gallon gas-powered tank with spray nozzle mounted on a truck, Indian pump sprayers, 2.5 gallon hand-held sprayers, and wick applicators (Johnson, pers. comm. 1991). This appeared to kill most, if not all, of the treated Phragmites in this 20-acre area; plants found in the area following treatment were shorter and the stand was less dense (determined visually). However the dead stalks remained and blocked views from the trail.

In Connecticut a 5m x 23 m patch of Phragmites has been treated with a hand-held spray of Rodeo (1988 and 1989) and Roundup (1990 and 1991) for four years in late August-early September. The Phragmites is shorter and less dense at the site but it is still present (Lapin pers. obs.). Actions to supplement and enhance herbicide applications including the removal of tassels (1991) and removal of dead stalks (planned 1992), have been and will be taken.

Other chemicals have been used on Phragmites and are described in Cross and Fleming (1989).

Also see CUTTING at Constitution Marsh for another method of application.

CUTTING: Cutting has been used successfully to control Phragmites. Since it is a grass, cutting several times during a season, at the wrong times, may increase stand density (Osterbrock 1984). However, if cut just before the end of July, most of the food reserves produced that season are removed with the aerial portion of the plant, reducing the plant's vigor. This regime may eliminate a colony if carried out annually for several years. Care must be taken to remove cut shoots to prevent their sprouting and forming stolons (Osterbrock 1984). In the Arcola Creek Preserve in Ohio, cutting reduced the vigor of the Phragmites colony. Also in Ohio, at Morgan Swamp, cutting began in mid to end of July (before tassel set) in 1989 around a gas well in a freshwater wetland (Seidel, pers. comm. 1991). The preferred tool was an old-fashioned hedge trimmer with an 8" flat blade with serrations manufactured by Union Fork and Hoe. The trimmers worked better than loppers and were safer than sickles; a circular blade on a weed whacker was also used and proved to be faster and good for staff but it was more dangerous for volunteers and detracted from the atmosphere of the work-day (Huffman, pers. comm. 1992).

Small patches (10' x 50') in a New York freshwater system were cut at the end of July or the beginning of August for two successive years with positive results (Schneider, pers. comm. 1990). The hand-cut material was removed from the site and thrown on a brush pile (unfortunately it was located too close to the water and returned to the system).
Massachusetts Audubon staff have cut the perimeter around a 0.25 acre Phragmites patch at the end of July since 1986 in a freshwater wetland at Daniel Webster Preserve in Marshfield, Massachussetts (Anderson, pers. comm. 1992). They have monitored their success in keeping it from spreading by using a map and hand compass.

Stands of Phragmites of less than 1 acre in extent that block views in Everglades National Park are cut just before the onset of the rainy season. The rise in water elevation from the rains that follow stresses the roots of the plant. This works to a degree but Phragmites returns (Dowlen, pers. comm. 1985).

In Quincy, Mass., the town used small Bobcats with lawnmower clippers mounted on the buckets with a flexible cable to cut an area with 75% cover of Phragmites and 20-25' of muck (Wheelwright, pers. comm. 1991; Dobberteen pers. comm. 1991). Cutting this 10-acre plot three times during the summer (April, June, August) cost $150K. The cut material was stockpiled nearby where it was to be burned in the winter when it was washed away in a severe storm. In winter 1992, the town plans to open the tide gate and allow flushing to prevent further return of Phragmites. Results are not yet known.

Cutting culms to 6" followed by addition of rock salt on a 10' x 10' patch appeared to have reduced the height and density of Phragmites in a salt marsh in Greenwich, CT (Jontos and Allan 1984). Continued observations indicated that this trend appeared to continue (Jontos, pers. comm. 1992).

Cutting an area 25' x 25' to waist height with a hedge clippers and the applying one drop of Roundup with a syringe with a large needle (horse size) into the top of the plant in a brackish- freshwater marsh was begun in Constitution Marsh in New York in 1991 (Keene, pers. comm. 1991). Initial results indicate 90% eradication.

In Connecticut, cutting below the first leaf at the end of July in 1986, 1989, 1990, 1991, and 1992 in a freshwater tidal wetland around the perimeter of a one-acre patch has prevented subsequent expansion of the patch. Monitoring using aerial photos taken at five-year intervals indicated the control success. Cutting was done with hand-held cutters and gas-powered hedge trimmers, which were very efficient. Cut material was removed from the site and allowed to decompose on upland areas. In a second area, similar efforts in a calcareous wetland 1990-1992 were monitored by placing red survey wires around the perimeter of the patch. Preliminary observations indicate a cessation of Phragmites expansion.

In Europe, Weisner and Graneli (1989) found that oxygen transport was reduced by cutting the culms above and below the water surface;cutting below the water in June almost totally inhibited regrowth of shoots the following summer, while cutting above water reduced regrowth of shoots. Cutting in August did not reduce growth the following summer. Cutting in sandy substrates was minimally effective, while cutting on calcareous muds caused decreases in oxygen levels.

Also see MANIPULATION OF WATER LEVEL AND SALINITY.

GRAZING, DREDGING, AND DRAINING: Grazing, dredging, and draining are other methods that have often been used to reduce stand vigor (Howard, Rhodes and Simmers 1978). However, draining and dredging are not appropriate for use on most preserves (Osterbrock, 1984).

Grazing may trample the rhizomes and reduce vigor but the results are limited (Cross and Fleming 1989). Van Deursen and Drost (1990) found that cattle consumed 67-98% of above-ground biomass; in a four year study, they found that reed populations may reach new equilibria under grazing regimes.

MANIPULATION OF WATER LEVEL AND SALINITY: A self-regulating tide gate which reintroduced saltwater tidal action was used to help restore a diked marsh in Fairfield, Connecticut (Thomas Steinke pers. comm. 1992; Bongiorno et al. 1984). A 1-3 foot reduction in stem height resulted over each of three years . In addition to reduced height, plant density declined dramatically from 11.3 plants m-2 in 1980 to 3.3 plants/ m-2 the following year. In following years, Phragmites continued to decline, although less dramatically. In addition to the decreased height and density of the Phragmites stands, typical marsh flora including SALICORNIA, DISTICHILIS, SPARTINA ALTERNIFLORA Loisel. and S. PATENS (Aiton) Muhl. returned. Depending on topography and elevation, Phragmites was eliminated in large areas and continues to remain short and sparse in other areas through 1992. Hence, reintroduced tidal action and salinity can reduce Phragmites vigor and restore the community's integrity. This has been implemented successfully in other degraded former salt marshes in Connecticut (Rozsa, pers. comm. 1992).

Flooding can be used to control Phragmites when 3 feet of water covers the rhizome for an extended period during the growing season, usually four months (Beall 1984). However, many areas can not be flooded to such depths. Furthermore, flooding could destroy the communities or plants targeted for protection.

Open Marsh Water Management (OMWM) has been used as a method to control Phragmites. Plugging of ditches and addition of culverts to raise the soil salinities appears to have caused Phragmites die-back over the last four growing seasons at Fireplace Neck, New York (Niniviaggi, pers. comm. 1991; Rozsa, pers. comm. 1992).

Hellings and Gallagher (1992) found that Phragmites was negatively impacted by increasing salinity and increased flooding. They also found that cutting and subsequent flooding also reduced growth and survival in outdoor experiments. They suggest that Phragmites may be controlled by increasing flooding and salinity levels. Matoh, Matsushita and Takahashi (1988) also found reduction in vigor with increased salinity. However death apparently occurred only when cutting was combined with brackish flooding (Hellings and Gallagher 1992).

In Europe, episodic freshwater flooding occurring early in the growing season has been suggested as one of the reasons for reed population declines (Ostendorp 1991). McKee et al. (1989) investigated root metabolic changes due to freshwater flooding and labelled Phragmites as a flood-tolerant species.

Also see Chincoteague NWR under CHEMICALS, Wertheim NWR under BURNING, and Town of Quincy under CUTTING for additional references.

MOWING, DISKING, AND PULLING: Beall (1984) discourages mowing and disking. Mowing only affects the above ground portion of the plant, so mowing would have to occur annually. To remove the rhizome, disking could be employed. However, discing could potentially result in an increase of Phragmites since pieces of the rhizome can produce new plants. Cross and Fleming (1989) describe successful mowing regimes of several year duration during the summer (August and September) and discing in summer or fall.

In Cape May Meadows, New Jersey, a brackish to freshwater non- tidal sandy area, an attempt was made to remove rhizomes by pulling to a depth of three feet (Johnson, pers. comm. 1991). This resulted in a very sparse Phragmites stand the following year. However it was very labor-intensive (using 130 people-hours to cover a 50 ft2 patch) and could be applied best to sandy soils.

In a private yard, Phragmites was mowed and a thin layer of soil and grass seed were added. This was mowed weekly over the course of the summer. In the second summer shoots of Phragmites occurred around the edges. The rhizomes were decomposing after this treatment (M. Ailes, pers. comm. 1992).

PLASTIC: Clear plastic six-mil thick, 12 x 17 m, weighing 51.8 kg, was carried into a North Carolina marsh by air and held in place by sandbags (Boone et al. 1987, 1988). Plants were initially cut to 6-8" with a hand-pushed bush hog (Boone, pers. comm. 1991) or a weedeater with blade, with an area of 20 x 20 m taking several days to cut. The cut material was left and the plastic put over the area. The high temperatures under the plastic caused die-off of Phragmites in 3-4 days. After 8-10 weeks, the plastic deteriorated. The rhizomes appeared to have died back, but the project was of short duration and the results were not monitored the following year (Boone, pers. comm. 1991). Turner (pers. comm. 1992) noted that follow-ups in subsequent years indicated Phragmites returned but not as densely. Plastic management in each 12 x 12 m plot took an average of 53 hours, compared with 17 hours to cut and three hours to burn (Boone et al. 1987).

Clear plastic in two narrow swaths (70 m x 20 m) was placed along the edge of a tidal brackish pond after hand-cutting the Phragmites at the end of July 1991 (Anderson, pers. comm. 1992). One plot, in total sun, had a complete kill of Phragmites in 10 days, while the plot in partial shade had a partial kill. It is unknown how the plastic was kept in place or what was done with the cut material.

Clear and black plastic were used on 50' circular areas at Constitution Marsh in New York in 1990 and 1991 (Keene, pers. comm. 1991). Although there was difficulty due to tidal influence, the plastic was weighted down with rocks and appeared to kill what is under it. Runners along the edge were treated with a syringe application of Roundup in August. In November 1991, a hole cut in the middle of the black plastic provided the opportunity for cattail shoots to germinate. After the first year there was viable Phragmites in the areas covered. It appeared that the black plastic was more effective, due to the higher heat levels attained (Rod, pers. comm. 1992).

Monitoring Requirements:
Phragmites populations require close monitoring in order to determine whether they are increasing in area or not. Populations that are growing may quickly threaten or even eliminate rare elements. Monitoring provides the data needed in order to decide if control measures are necessary. If and when a control program is begun it is important to monitor targeted populations so that the program's effectiveness can be determined. If it is possible to leave untreated control areas without jeopardizing the success of the control program these should be monitored as well for comparison. It is imperative to continue monitoring even if a control program succeeds initially because Phragmites may reinvade and the sooner this is detected the easier it will be to combat.

To assess if a Phragmites colony is spreading, quantitative measurements should be made of percentage of aerial cover, stem density and culm height, especially at the periphery of the stand. Annual data should be compared to detect if the colony is expanding and the stand gaining vigor. Inventories of the vegetation in and near the colony should also be carried out in order to determine whether declines in species diversity are occurring.

In Europe, reed declines have been documented by comparing areas covered by Phragmites colonies on up-to-date maps or aerial photographs with older sources, monitoring permanent quadrats within or at the border of the reed belt and mapping the stubble fields left after die-back (Ostendorp 1989). In lakes (Stark and Dienst 1989), wooden poles 5 m apart were connected with string and the numbers of reed stalks directly below the strings were counted each year in the spring.

Monitoring Programs:
The programs listed below used various methods to control Phragmites populations and are monitoring the success of these actions including the degree of recovery of native species and the longevity of the control.

CONNECTICUT Monitoring Phragmites reduction and replacement vegetation after reintroducing tidal flow, using transects and line intercept. Contact: Charles T. Roman, William Niering, Scott Warren Dept of Botany Connecticut College New London, CT 06320

Monitoring Phragmites reaction to reintroduction of tidal flow and salinity. Contact: Tom Steinke Fairfield Conservation Commission, Independence Hall 725 Old Post Road Fairfield, CT 06430 203-256-3071

Addition of rock salt and casual observation of reduction of Phragmites height and density; also potential impact of inadvertent spill of used fryerlator oil. Contact: Robert Jontos, Jr. Land-Tech Consultants, Inc. Playhouse Corner Suite 205 Southbury, CT 06488 203-264-8300

Reintroduction of salt water into degraded former salt marshes, removal of dredge material and restoration of tidal creek in several sites in CT with transect and line intercept monitoring of results.

Contact: Ron Rozsa Long Island Sound Program Department of Environmental Protection 165 Capitol Avenue Hartford, Ct 06106 203-566-7404

Annual cutting of perimeter of one-acre stand and monitoring with aerial photos on five-year basis; herbicide application on small patch at edge of salt marsh. Contact: Beth Lapin The Nature Conservancy 55 High Street Middletown, CT 06457 203-344-0716

DELAWARE Aerial spraying of RodeoTM (glyphosate) and water management plan using stoplogs and vegetation analyses (using transects that measure density and species of plants) of replacement species. Contact: Paul Daly Bombay Hook National Wildlife Refuge RD #1 Box 147 Smyrna, DE 19977 302-653-9345

Monitoring the ecological factors (water table level, PH, salinity) governing the growth of Phragmites in 4 habitats; 1) open high salt marsh, 2) open low salt marsh, 3) brackish water impoundment, 4) freshwater impoundment. Investigating Phragmites control with glyphosate. Contact: Wayne Lehman and Bill Jones Delaware Division of Fish and Wildlife P.O. Box 1401 Dover, DE 19903 302-653-2079

LOUISIANA See RESEARCH PROGRAMS section below.

MASSACHUSETTS Cutting three times in one season, followed by opening of tidal flood gate to restore natural water regime, with initial 1 m random quadrats to measure stem density and plant height Contact: Mike Wheelwright Department of Public Works Town of Quincy Quincy, MA 02169 617-773-1380 x210 Contact: Ross Dobberteen Lelito Environmental Consultants 2 Bourbon St. #102 Peabody, MA 01960 508-535-7861

Aerial spray of RodeoTM (glyphosate) two years in a row, with winter burning; aerial photos to determine decrease in affected boundaries. Contact: Joann Healey Parker National Wildlife Refuge Northern Blvd. Plum Island Newburyport, MA 01950 508-465-5753

Clear plastic over cut bands along edge of tidal pond and cutting around perimeter of 0.25 acre stand. Contact: Jeanne Anderson Massachusetts Audubon Society South Great Road Lincoln, MA 01773 617-259-9500

Plastic mulch experiments Contact: Edward Stashko Brookline Massachusetts Conservation Commission 617-730-2088

Restoration of saltmarshes now dominated by Phragmites Contact: Larry Oliver U.S. Army Corps of Engineers New England Division 424 Trapelo Road Waltham, MA 02254 617-647-8347

MARYLAND Nassawango Creek, A Nature Conservancy Preserve RodeoTM (glyphosate) applied with backpack sprayer. Monitoring site to determine both reaction of natural plant community and evidence of Phragmites re-invasion. Contact: Wayne Klockner The Nature Conservancy Chevy Chase Center Office Building 35 Wisconsin Circle, Suite 304 Chevy Chase Maryland 20815 301-656-8073

Spraying with RodeoTM (glyphosate), burning; monitoring vegetation and invertebrates, annual expansion of Phragmites in untreated areas. Contact: Steve Ailstock Environmental Center Anne Arundel Community College Arnold, MD

NEW JERSEY Aerial spraying with RodeoTM (glyphosate), prescribed burn to remove litter, evaluating success. Contact: David Beall Edwin B. Forsythe National Wildlife Refuge Brigantine Division PO Box 72, Great Creek RD Oceanville, NJ 08231 609-652-1665

Pulling rhizomes, chemical spray; visual monitoring of presence/absence, sense of height and density. Contact: Liz Johnson The Nature Conservancy 17 Fairmont Road Pottersville, NJ 07979 908-439-3007

NEW YORK Cutting (herbicide use would require a permit), using visual assessment for success. Contact: Kathy Schneider Department of Environmental Conservation 700 Troy-Schenectady Road Lathan, NY 12110-2400 518-783-3932

Cutting and covering with plastic (black and clear); dripping herbicide in cut stems with syringe at Constitution Marsh, New York. Contact: Chuck Keene Museum of Hudson Highlands The Boulevard P.O. Box 181 Cornwall-on-Hudson, NY 12520 914-534-7781 Contact: Jim Rod National Audubon Society RFD 2, Route 9D Garrison, NY 10524 914-265-2601

Open Marsh Water Management with GIS infrared aerial photos and black and white photos (1986 & 1990) to monitor success Contact: Dominick Niniviaggi New York DEC Building 40 SUNY Stony Brook, NY 11790-2356 516-751-7900 x379 516-751-2719

Using water level manipulation and burning and visual monitoring Contact: Bob Parris Wertheim NWR P.O. Box 21 Smith Road Shirley, NY 11967 516-286-0485

PENNSYLVANIA Tinicum National Environmental Center Chemical application, 18 acre restoration with seeding Contact: Dick Nugent Tinicum Environmental Center Scott Plaza 2 Philadelphia, PA 19113 215-521-0663

OHIO Arcola Creek Wetland, Morgan Marsh Controlling Phragmites by cutting when reserves are in the aerial portion of the plant (before nutrients are translocated into the rhizomes); using aerial photos to map extent of areas, small (1 x 1 m plots) to measure stem density. Contact: Terry Seidel The Nature Conservancy Ohio Field Office 1504 West 1st Ave. Columbus, Ohio 43212 614-486-6789

VIRGINIA RodeoTM (glyphosate) application and monitoring program, with transects (mainly used for changes in vegetation and not in Phragmites) and vegetation maps on "topo" scale. Contact: Irvin Ailes Chincoteague National Wildlife Refuge Chincoteague, VA 23336 804-336-6122

Winter burns, checking progress in summer with six 400 m transects perpendicular to the shore that measure % cover and list species in 0.1 m2 plots every ten meters; success marginal. Contact: Marilyn Ailes Public Works Office Building Q29 Aegis Combat System Center Wallops Island, VA 23337 804-824-2082

VI. RESEARCH

Management Research Programs:
LOUISIANA Aerial photographs of the Mississippi River Delta indicated that different stands of Phragmites had different infrared signatures. Isozyme analyses were performed on samples from these stands in order to determine whether they differed genetically and constituted different clones. Two distinct clones were found and both differed from stands elsewhere on the Gulf coast. Additional isozymal work is planned on populations from elsewhere on the Gulf coast and, if time allows, from populations in the eastern and Great Lakes states as well

For research on population biology and control methods refer to BIOLOGICAL MONITORING PROGRAMS section.

Research Needs (General):
What are the genetics of natural populations and how do stable and invasive populations differ?

Management Research Needs:
Research on the following facets of Phragmites invasions and basic biology are needed: 1. what types and levels of disturbance and stress induce Phragmites to invade and/or dominate an area?; 2. how effective are various control programs and what conditions promote or allow Phragmites to reinvade areas from which it has been removed?; 3. if Phragmites does reinvade how long does this process take?; 4. are there ways to alleviate or mitigate for the stresses that induce the spread of Phragmites?; 5. can the use of competitive plantings of TYPHA or other desirable species be used to control Phragmites.

VII. ADDITIONAL TOPICS

VIII. INFORMATION SOURCES

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IX. DOCUMENT PREPARATION & MAINTENANCE

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Contributing Author(s): Marianne Marks (original version), Beth Lapin & John Randall (1993 update)

ELEMENT STEWARDSHIP ABSTRACT

for

Microstegium vimineum

Japanese stilt grass, Nepalese browntop, Chinese packing grass

To the User:

Element Stewardship Abstracts (ESAs) are prepared to provide The Nature Conservancy's Stewardship staff and other land managers with current management related information on species and communities that are most important to protect or control. The abstracts organize and summarize data from many sources including literature and from researchers and managers actively working with the species or community.

We hope, by providing this abstract free of charge, to encourage users to contribute their information to the abstract. This sharing of information will benefit all land managers by ensuring the availability of an abstract that contains up-to-date information on management techniques and knowledgeable contacts. Contributors of information will be acknowledged within the abstract.

For ease of update and retrievability, the abstracts are stored on computer at The Nature Conservancy. Anyone with comments, questions, or information on current or past monitoring, research, or management programs for the species described in this abstract is encouraged to contact The Nature Conservancy's Wildland Invasive Species Program.

This abstract is a compilation of available information and is not an endorsement of particular practices or products.

Please do not remove this cover statement from the attached abstract.

Author of this Abstract: Mandy Tu, The Nature Conservancy's Wildland Invasive Species Program, Dept. of Vegetable Crops & Weed Sciences, University of California, Davis, CA 95616, phone: (530)754-8891

Abstract Written: 8/00

THE NATURE CONSERVANCY

4245 North Fairfax Drive, Arlington, Virginia 22203-1606 (703) 841-5300

SCIENTIFIC NAME

Microstegium vimineum (Trin.) A. Camus

SYNONYMS

Andropogon vimineus Trin.
Eulalia viminea (Trin.) Kuntze
Microstegium imberbe (Nees ex Steud.) Tzvelev
Microstegium willdenovianum Nees ex Lindl.
Pollinia imberbis Nees ex Steud.
Pollinia viminea (Trin.) Merr.
Pollinia willdenoviana (Nees ex Lindl.) Benth.

COMMON NAMES

Japanese stilt grass, Nepalese browntop, Chinese packing grass

DESCRIPTION AND DIAGNOSTIC CHARACTERISTICS

Microstegium vimineum is a shade tolerant, annual C_4 grass (family Poaceae). It is a straggling or decumbent plant, usually 6-10 dm in height, and the reclining stems can grow up to 1.0 m (40 in) long. Its culms (stems) are typically branched, rooting at the lower nodes, and the nodes and internodes are smooth and hairless. The lanceolate leaf blades are 5-8 cm long and 2-15 mm wide, sparsely pubescent on both surfaces, and distinctly tapered at both ends. The ligules are membranous, usually ciliate, and are 0.5-2.0 mm long (Radford et al. 1968).

The terminal or axillary inflorescence is a raceme, 2-7 cm long, with an elongate peduncle and an angled disarticulating rachis. The hirsute fertile spikelets are deciduous, and occur in pairs, with one spikelet sessile and the other pedicellate. The glumes are equal in length (4.5-5.0 mm) and awnless. The first glume is flat and 2-3 veined. The second glume is keeled and 3-veined. There are two lemmas per spikelet, with the lower one sterile and the upper, fertile one awnless or often with a slender awn 4-8 mm. Both cleistogamous (flowers closed at pollination) and chasmogamous (flowers open) conditions have been reported for *M. vimineum* in Japan, with the axillary flowers all being cleistogamous (Tanaka 1975, in Barden 1987).

The fruit or caryopsis (grain) of *M. vimineum* is yellowish to reddish, and ellipsoid (2.8-3.0 mm) in shape. Fruiting occurs in September and October in North America (Radford et al. 1968; Hitchcock 1971; Gleason & Cronquist 1991).

M. vimineum can be distinguished from other grasses by its thin, pale green, tapered leaf blades, and by its multiple spikelets that may be either terminal or arising from leaf axils. The alternate leaves have a silvery stripe of reflective hairs down the middle of the upper leaf surface. In the fall, identification becomes somewhat easier after the plant develops a slight purplish tinge (LaFleur 1996; Swearingen 2000).

While *M. vimineum* is an annual, there has been some confusion regarding whether *M. vimineum* also occurs as a rhizomatous, perennial (Ehrenfeld 1999; Mehrhoff 2000). According to Mehrhoff (2000), this confusion resulted when specimens of a native perennial, *Leersia virginica*, were incorrectly identified as *M. vimineum*. The annual *M. vimineum* can be distinguished *L. virginica* (which it frequently grows

alongside) by the former's ciliate leaf sheath collars and paired spikelets (versus *L. virginica*'s glabrous or pubescent leaf sheaths and 1-flowered spikelets).

STEWARDSHIP SUMMARY

M. vimineum is an annual C_4 grass native to Asia from India and Japan. It possesses characteristics typical of many invasive species: it grows quickly, fruits within a single season, produces abundant seed, and easily invades habitats that have been disturbed by natural (e.g., flood scouring) and anthropogenic (e.g., mowing, tilling) sources. *M. vimineum* was first discovered in the United States in 1919 (Fairbrothers & Gray 1972), and has since spread rapidly to all states east of the Mississippi, and south of and including Connecticut. *M. vimineum* is locally abundant, able to displace native wetland and forest understory vegetation with its dense, expanding monospecific patches. It is usually found under moderate to dense shade in moist conditions, but it does not persist in areas with periodic standing water, nor in full sunlight (Barden 1987, 1991). Once established, the removal of *M. vimineum* requires major eradication and restoration efforts (Bruce et al. 1995).

Manual or mechanical techniques may be the best method for controlling *M. vimineum*, since it is a shallowly-rooted annual. Hand pulling, however, is extremely labor-intensive, is feasible only for small infestations, and will need to be repeated and continued at least seven years to exhaust the seed supply in the seed bank (Virginia Native Plant Society 2000). Mowing or burning early in the season does not control the plant as the plants resprout and new seeds germinate. Following these treatments, plants can still set seed by the end of the season. Mowing may be an effective control method if carried out in late summer, when the plants are in peak bloom but before seed is produced (J. Ehrenfeld, pers. comm.). For extensive infestations, where mechanical methods are not practical, systemic herbicides such as imazameth (tradename Plateau) or glyphosate (tradename RoundUp, or Rodeo in wetland sites), or grass-specific herbicides like sethoxydim (tradenames Vantage or Poast) may be effective (Johnson 1997; Swearingen 2000). No biological controls are currently available for this plant.

RANGE

M. vimineum was introduced to North America from Asia, where it is native to India, Nepal, China, and Japan. It was first identified in the United States in 1919 in Tennessee, and by 1960 had spread (probably by hay and soil) to Ohio and Pennsylvania, and all Atlantic coastal states from Florida to New Jersey. It was widely used as a packing material for porcelain from China, and this was likely the means of its introduction into the U.S. *M. vimineum* occupies riparian habitats, lawns, woodland thickets, damp fields, and roadside ditches. Reported occurrences of *M. vimineum* in North America currently include: Alabama, Arkansas, Connecticut, Delaware, Florida, Georgia, Illinois, Indiana, Kentucky, Louisiana, Maryland, Mississippi, New Jersey, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Texas, Virginia, West Virginia, and Puerto Rico (USDA-NRCS 1999).

IMPACTS AND THREATS POSED BY *MICROSTEGIUM VIMINEUM*

M. vimineum is capable of invading wildland areas and swiftly replacing natural communities with nearly monospecific stands. It is generally slow to invade undisturbed areas, but rapidly fills disturbed areas such as flood-scoured stream sides and sewer line rights-of-way that are mowed once a year. An individual plants of *M. vimineum* can produce up to 1000 seeds, and the seeds remain viable in the soil for three to five years. Once established, *M. vimineum* is able to crowd out native herbaceous vegetation in wetlands and forests within three to five years (Hunt 1992; Barden 1987).

M. vimineum is a C_4 plant, and C_4 plants are typically adapted to high temperatures and high light regimes. However, unlike most C_4 plants, *M. vimineum* is adapted to low light levels and is able to grow

and produce seed in only 5% full sunlight (Winter et al. 1982). Additionally, *M. vimineum* may be responsible for altering natural soil conditions, creating an inhospitable environment for many native species. Kourtev et al. (1998) reported that in areas that have been invaded by *M. vimineum*, both litter and organic soil horizons were thinner than in uninvaded areas, and that the pH of soils in invaded sites was significantly higher than in uninvaded sites. There is no indication that *M. vimineum* produces allelopathic chemicals (Woods 1989).

Established populations of *M. vimineum* usurp quality nesting habitat from quail and other wildlife. In addition, it creates excellent habitat for rats, especially cotton rats (*Sigmodon* spp.), that often prey on the nests of native bobwhite quail and attract other predators as well (A. Houston, pers. comm.).

HABITAT

In North America, *M. vimineum* occurs in a variety of disturbed sites. It thrives in along mesic roadsides, ditches, woodland borders, floodplains, and streamsides (Fairbrothers & Gray1972; Hunt & Zaremba 1992). It can also be found in mesic upland sites, and is almost always found in moderate to dense shade (Redman 1995). It does not survive, however, in areas with periodic standing water, nor in areas with full sunlight.

BIOLOGY AND ECOLOGY

Light, Moisture, and Temperature

M. vimineum possesses characteristics typical of many invasive species: it grows quickly, fruits within a single season, produces abundant seed, and easily invades naturally (e.g., flood scouring) and artificially (e.g., mowing, tilling) disturbed habitats. Once established, the removal of *M. vimineum* requires major eradication and restoration efforts (Bruce et al. 1995).

M. vimineum is unusual in that although it is a C_4 plant, it is adapted to low light conditions (Winter et al. 1982; Barden 1991). It can grow and produce seeds at as little as 5% full sunlight, but maximum growth and seed production occurs at 25-50% full sunlight (Winter et al. 1982; Horton & Neufeld 1998).

Most sites invaded by *M. vimineum* in the United States, have acidic soils (pH 5.8 to 4.8), but some populations are on soils derived from limestone or marble with surficial soil that is neutral or only slightly acidic in reaction. Soils on which *M. vimineum* occurs are typically average in levels of potassium and phosphorus, and high in nitrogen (Redman 1995). The overall acidity of the soils, however, may limit nutrient availability. Soils are usually moist, and are often well-drained silty loams, sandy loams, or loams. Clay was not a significant component of the upper soil horizons in any of the soils invaded by *M. vimineum* at sites studied by Hunt & Zaremba (1992).

No information was found regarding the optimal growing temperatures or the temperature limits of this species. The coldest winter temperature at which invasive populations of *M. vimineum* occur is approximately -21° to -23° C (Redman 1995).

Seed Dispersal

M. vimineum fruits and seeds disperse by water, animals, and by humans. (It was originally introduced as packing material or for basket-weaving.) The floating fruits of *M. vimineum* can disperse throughout an entire wetland or alluvial floodplain during high-water events (Woods 1989; Mehrhoff 2000). Even though *M. vimineum* does not exhibit any special adaptations for seed/fruit dispersal such as hooks or

barbs, its seeds are small and often adhere to animal fur or clothing. Further, the fruits have been observed being transported on automobiles (Mehrhoff 2000).

M. vimineum relies entirely on its seed bank for its annual recruitment. Seeds of *M. vimineum* may need a period of stratification (cool temperatures and high moisture) before they will germinate (Woods 1989). *M. vimineum* seeds stored in the soil may remain viable as long as five years (Barden 1991). *M. vimineum* seeds may have low germination rates (Woods 1989), but many seeds are produced by each plant. Seeds of *M. vimineum* are also able to survive submersion in water for periods of up to 10 weeks. Barden (1991) reports that seeds can germinate while under water, but the plants do not grow. If standing water is removed, more seeds will germinate shortly afterwards.

ECONOMIC USES

In the early 1900s, *M. vimineum* was used extensively as a packing material for porcelain, especially fine China porcelain, which may have contributed to its invasion into the United States. Culms of this grass have also been used for basket weaving. *M. vimineum* has not been documented as being intentionally planted as an ornamental, for erosion control, or for forage.

MANAGEMENT

Potential for Restoration of Invaded Sites

Manual and mechanical, environmental/cultural, and chemical methods are all useful to varying degrees in controlling *M. vimineum*. Prescribed burns have not been successful in controlling this species so far, but fall burns may have the potential for partial control. *M. vimineum* produces a large number of viable seed that can remain in the soil seed bank for seven years or more. If controlled during the early stages of invasion, the potential for successful management is high. The potential for large-scale restoration of wildlands where *M. vimineum* has become established is probably moderate.

Manual and Mechanical Control

Hand pulling of *M. vimineum* is the preferred method of removal as it is highly specific and provides minimal impact (except trampling and soil disturbance) to the surrounding environment. Hand pulling is an effective method of control if it is thorough and timed correctly. It is, however, labor-intensive and time-consuming. Pulling late in the season (September-early November) before seed production reduces the unintentional spread of the current year's seeds. Pulling early in the season (before July), however, allows germination of new plants from the seed bank which will mature during the remaining season and produce seeds. In the northeast, August and late September are good times to pull plants by hand (LaFleur 1996). Yearly weeding is necessary because new plants can appear as a result of seed banking or re-infestation from new seed being dispersed into the area (G. Edinger, letter to J. Randall).

Mowing using a weed whacker (or a weed-eater) is an effective control method if carried out in late summer just before seeds are produced. Mowing at any other time is not useful as the plants have the ability to resprout and can produce seed heads in the axils of their lower leaves (Woods 1989; Barden 1991). Mowing can also be useful in reducing the amount of litter and plant biomass prior to herbicide application, making the herbicide more effective.

Grazing

Grazing is not a control option for *M. vimineum* since cattle, deer, and even goats avoid feeding on it (A. Houston, pers. comm.; Barden 1991).

Flooding

Flooding for more than three months, or intermittent flooding during the growing season, may be an effective control method for mature plants of *M. vimineum.* The seeds of *M. vimineum,* however, can survive periods of inundation of at least ten weeks (Barden 1991).

Prescribed Burning

Spring burns are ineffective at controlling *M. vimineum* because a new cohort of seeds will germinate soon after the burn. Burns in the late fall, however, may be useful in controlling this species (Barden 1991). Burning is also useful in reducing the amount of litter and plant biomass prior to herbicide applications.

Herbicides

For large infestations of *M. vimineum*, the use of herbicides may be the only viable option for good control. A series of control experiments using herbicides was carried out at the Ames Plantation (University of Tennessee), and the researchers reported that it is relatively easy to kill *M. vimineum*, but that managing for a desirable plant community is difficult. They found that the herbicide imazameth (tradename Plateau) was the herbicide of choice for controlling *M. vimineum*. This is because imazameth (applied at a rate of 6 ounces per acre) kills *M. vimineum*, but allows the development of (a.k.a., does not kill) the desirable native sedges, ragweeds, and legumes.

The grass-specific herbicide fluazifop-p (tradename Fusilade) applied at the rate of 1.2 liters per hectare (1 pint per acre) also controlled *M. vimineum*, but left a less desirable plant community. Glyphosate (tradename RoundUp) was also tested, but resulted in a complete kill of all plants, which could potentially lead to possible re-invasion by *M. vimineum* or other undesirable species. Barden (1991) also found glyphosate useful in killing *M. vimineum*. Formulations of glyphosate registered for use aquatic systems (Rodeo), has been effective for *M. vimineum* control in wetlands. Woods (1989) in Tennessee found that the grass-specific herbicide sethoxydim (tradenames Poast, Vantage), applied during late summer at rates of 1 pint per acre, also provided excellent (more than 95%) control of *M. vimineum* and released dicots from competition without injuring them. Pre-emergent herbicides such as diphenamid (tradename Enide) and benefin (tradename Balan) have also demonstrated excellent control of *M. viminium* seedlings under conditions of good herbicide-to-soil contact (Woods 1989), but do not encourage the germination of native species.

Allan Houston (pers. comm.) reports that if there is a heavy build-up of litter (dead plant material) in *M. vimineum* stands, burning the debris may first be necessary to get adequate herbicide coverage. He suggests applying herbicide when the plants reach a height of 5-10 centimeters (2-4 inches).

Biological Control

No biological controls are currently available for *M. vimineum.*

EXAMPLES OF *MICROSTEGIUM VIMINEUM* MANAGEMENT ON TNC PRESERVES

According to TNC's 1998 Weed Survey, *M. vimineum* has been reported from TNC preserves in New Jersey, North Carolina, Virginia, Georgia, Alabama, Arkansas, Maryland, and in Connecticut. Several preserves reported *M. vimineum* is one of their worst weed problems, but only a few had begun active control measures.

In Maryland, Donnelle Keech reported that burning is not effective in controlling *M. vimineum*. In North Carolina, Robert Merriam reported hand pulling was effective. Elizabeth Farnsworth in Connecticut, however, indicated that hand pulling may be effective in small populations, but seems futile for large populations since it is difficult to eliminate the seed sources. She added that it is important to attack small infestations as soon as possible, and to attack them vigorously!

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MONITORING

The distribution of *M. vimineum* should be monitored annually or biannually where there is a threat to protected species. Following all control treatments, further control efforts and monitoring is needed for at least seven years due to the viability of seeds in the seedbank or re-invasion from nearby propagule sources (Barden 1991).

Since *M. vimineum* usually occurs in dense, nearly monospecific stands, permanent line intercepts (or transects) across population borders are an easy technique for periodic monitoring of changes in *M. vimineum* distribution. Where it is less abundant, visual estimates of percent cover changes in permanent plots, or photographic documentation, carried out at the same (phenologic) time each year, may be for monitoring change over time. Additionally, new invasions of *M. vimineum* should be identified as soon as possible, since small populations are the easiest to eradicate.

Research Needs

The following research topics need attention: 1) What are the impacts of *M. vimineum* on native communities? 2) What are the mechanisms of *M. vimineum* invasion in a variety of landscapes? 3) Is

biological control by inoculation with fungal pathogens a possible control technique? 4) Which species replace *M. vimineum* when control succeeds? And 5) What is the most effective method (for each specific area) of *M. vimineum* control, and how can this method encourage the regeneration of native species?

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ELEMENT STEWARDSHIP ABSTRACT
for
Lonicera japonica

Japanese Honeysuckle

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The Nature Conservancy

Element Stewardship Abstract

For *Lonicera japonica*

SCIENTIFIC NAME (GNAME)
Lonicera japonica Thunb.

The common name "Japanese honeysuckle" refers to the species *Lonicera japonica* Thunb. including the more aggressive cultivar *Lonicera japonica* var. halliana, also known as Hall's honeysuckle and the less common *Lonicera japonica* var. chinensis (P.W. Wats.) Baker. The original Latin name of the species was *Nintooa japonica* (Gleason and Cronquist 1963), but the species has been referred to as *Lonicera japonica* since at least 1889 (Wood and Willis 1889).

The genus name *Lonicera* refers to German naturalist Adam Lonitzer (1528-1586), the species epithet *japonica* to Japan, and the variety name *halliana* to Dr. George Hall, who introduced the variety to the United States in 1862 (Coombes 1991).

COMMON NAME

JAPANESE HONEYSUCKLE is the name most commonly used to refer to *Lonicera japonica* and its varieties, *L. japonica* var. halliana (Hall's Japanese honeysuckle) and *L. japonica* var chinensis. Hall's Japanese Honeysuckle is more common and aggressive than the species. In old floras *Lonicera japonica* was occasionally referred to as "woodbine" (Lounsbury 1899) and "Chinese honeysuckle" (Wood and Willis 1889; probably *L. japonica* var. chinensis).

DESCRIPTION (DIAGNOSTIC CHARACTERISTICS)

Lonicera japonica is a perennial trailing or climbing woody vine of the honeysuckle family (Caprifoliaceae) that spreads by seeds, underground rhizomes, and aboveground runners (USDA 1971). It has opposite leaves that are ovate, entire (young leaves often lobed), 4-8 cm long, with a short petiole, and variable pubescence. In the southern part of the range the leaves are evergreen, while in more northern locales the leaves are semi-evergreen and fall off in midwinter (Fernald 1970). Young stems are reddish brown to light brown, usually pubescent, and about 3 mm in diameter. Older stems are glabrous, hollow, with brownish bark that peels in long strips. The woody stems are usually 2-3 m long, (less often to 10 m). *Lonicera japonica* creates dense tangled thickets by a combination of stem branching, nodal rooting, and vegetative spread from rhizomes.

Lonicera japonica (including the varieties) is easily distinguished from native honeysuckle vines by its upper leaves and by its berries. The uppermost pairs of leaves of *Lonicera japonica* are distinctly separate, while those of native honeysuckle vines are connate, or fused to form a single leaf through which the stem grows. *Lonicera japonica* has black berries, in contrast to the red to orange berries of native honeysuckle vines. The fruits are produced September through November. Each contains 2-3 ovate to oblong seeds that are 2-3 mm long, dark-brown to black, ridged on one side and flat to concave on the other.

The fragrant white (fading to yellow) flowers of *Lonicera japonica* are borne in pairs on solitary, axillary peduncles 5-10 mm long, supported by leaflike bracts. The species has white flowers tinged with pink and purple. Individual flowers are tubular, with a fused two-lipped corolla 3-4(-5) cm long, pubescent on the outside. Flowers are produced late April through July, and sometimes through October. *Lonicera japonica* var. halliana may be distinguished from the species by its pure white flowers (fading to yellow; Dirr 1983) and more vigorous growth. *Lonicera japonica* var. *chinensis* has purple, essentially glabrous leaves, red flowers, and a more limited range than the species, occurring north to New Jersey and Pennsylvania (Fernald 1970), with an outlier in southern Illinois (Mohlenbrock 1986).

This description was derived from Gleason and Cronquist (1991) and Fernald (1970). Excellent illustrations of *Lonicera japonica* are contained in USDA (1971).

STEWARDSHIP SUMMARY

Lonicera japonica invades fields, forest edges and openings, disturbed woods, and floodplains, in eastern North America, where it spreads rapidly and outcompetes native vegetation by vigorous above- and below-ground competition. Once established, the vine may literally engulf small trees and shrubs, which collapse under the weight, and few plants survive beneath the dense canopy. It has also escaped cultivation at scattered locations in California and in Hawaii where it has the potential to become a severe pest in mesic and wet forest areas.

Lonicera japonica has few natural enemies in North America and is difficult to control once established. Thus, the best and most effective control method is to prevent its establishment by surveying a site for its presence regularly and immediately destroying every plant located. Unfortunately *Lonicera japonica* is difficult to locate when small and without careful attention may go unnoticed until it is well established.

Because Japanese honeysuckle is so difficult to control once established, an appropriate control program goal is 100% kill of all plants in the target area. Removing above-ground stems by cutting pulling or burning will temporarily weaken, but not kill, *Lonicera japonica* as it will resprout from subterranean buds and roots, and from cut branchlets.

In northern states, *Lonicera japonica* retains some leaves through all or most of the winter (semi-evergreen or evergreen), when most native plants have dropped their leaves. This provides a windows of opportunity from mid-autumn through early spring when it is easier to spot and treat with herbicides, fire or other methods without damaging native species. The most effective treatment is a foliar application of glyphosate herbicide (trade names Roundup, Rodeo or Accord; 1.5 v/v), applied after native vegetation is dormant and when temperatures are near and preferably above freezing. Applications within 2 days of the first killing frost are more effective than applications later in the winter. *Lonicera japonica* is less susceptible to herbicides after the first hard frost (-4^{o}C). Combining fire and herbicides may prove to be more effective than either method by itself if late autumn or winter burns are used to reduce Japanese honeysuckle biomass and all resprouts are then treated with a foliar application of glyphosate about a month after they emerge. Prescribed burns may also be used to help prevent spread of Japanese honeysuckle because seedlings and young plants are most susceptible to fires. Soil disturbance should be avoided in infested areas to minimize germination of seed in the seedbank.

IMPACTS (THREATS POSED BY THIS SPECIES)

Lonicera japonica damages natural communities it invades by outcompeting native vegetation for both light (shoot competition [Thomas 1980, Bruner 1967]) and below-ground resources (root competition [Dillenburg et al. 1993a, 1993b, Whigham 1984]), and by changing forest structure (Sasek and Strain 1990, 1991). *Lonicera japonica* grows very rapidly, sending out numerous runners that give rise to still more runners. The vines overtop adjacent vegetation by twining about, and completely covering, small trees and shrubs. Dense Japanese honeysuckle growth can topple trees and shrubs due to its weight alone (Williams 1994, McLemore 1981). As Lonicera japonica becomes established in forest openings it forms a dense blanket that excludes most shrubs and herbs (Oosting 1956). Few tree seedlings can penetrate the mat and those that do are often quickly overgrown and bent down by the vine, and consequently die (Slezak 1976, Thomas 1980). Forests invaded by *Lonicera japonica* gradually lose their natural structure as canopy openings are invaded, and understory herbs shrubs and replacement trees suppressed and killed by thick mats of honeysuckle. This results in a simplified, increasingly open understory. *Lonicera*

japonica, in turn, becomes even more vigorous with the increased light (Thomas 1980). These openings also promote further invasion by other non-native species including aggressive vines like kudzu (*Pueraria lobata*) and English ivy (*Hedera helix*) (Miller 1985; Thomas 1980).

Shading under the extensive and rapid aerial growth of *Lonicera japonica* poses the most obvious threat to native species. However, Dillenburg et al. (1993a, 1993b) demonstrated that in the early stages of invasion, below-ground competition by *Lonicera japonica* reduced tree growth, particularly leaf size and expansion rate, significantly and more than above-ground competition. After two growing seasons, *Lonicera japonica* root competition significantly reduced growth of young sweetgum trees (*Liquidambar styraciflua*) and greatly exceeded root competition from the native vine *Parthenocissus quinquefolia* (Dillenburg et al. 1993b). The combined effects of above- and below-ground competition can suppress growth or result in direct mortality of trees and seedlings (Whigham 1984). Bruner (1967) documented that after five years of co-occurrence, 33% of yellow-poplar seedlings were dead, 22% were overwhelmed, and 45% were heavily draped with *Lonicera japonica* that germinated from seed in the first year.

Lonicera japonica has an additional competitive edge as it grows during part or all of the winter, when many native species are dormant (Carter and Teramura 1988a). This evergreen or semi-evergreen character allows *Lonicera japonica* to photosynthesize at winter temperatures and light levels. The shade it casts during early spring may inhibit ephemeral herbs that complete their life cycle in the six weeks prior to deciduous tree leaf-out.

Alteration of forest understory and overstory structure by *Lonicera japonica* may lead to a decline or alteration in songbird populations (Nyboer 1990). However, no studies have been conducted on interactions between *Lonicera japonica* and native animals, with the exception of white-tailed deer (*Odocoileus virginianus*) which favors *Lonicera japonica* leaves as food (Handley 1945, Harlow and Hooper 1971). In fact, wildlife managers in some states actively promoted growth of this aggressive vine to provide winter forage for deer (Dyess et al. 1994; Segelquist and Rogers 1975, Stransky 1984). Japanese honeysuckle foliage is most digestible and nutritious in spring, but it is still relatively high in nutritional value in winter (Blair et al 1983) when other food sources are less available to deer (Dyess et al. 1994). Seeds and leaves are eaten by cottontail rabbits, as well as birds (Dyess et al. 1994), and the tangled thickets provide cover for birds and small mammals.

Lonicera japonica is a severe threat in the southeastern and eastern states (Florida to Texas, north to Kansas, Missouri, central Illinois and New York), and a severe potential threat in northern states outside the current (1995) range. On the northern edge of the range, *Lonicera japonica* flower production is inhibited by winter temperatures (Swink and Wilhelm 1994), and the vine is thus a moderate threat. For example, in Illinois, *Lonicera japonica* is not a serious pest in the colder, northern third of the state, but is increasingly common in the central part of the state (Nyboer 1990). *Lonicera japonica* continues to spread gradually northward (Wagner 1986), possibly due to increasing cold tolerance, or to warm winters, or to other factors.

As of 1995 *Lonicera japonica* northern range was limited by winter temperatures, and its western range by drought-induced stress at the seedling stage (Sasek and Strain 1990). If atmospheric CO_2 concentrations increase as predicted, resulting in a 3^oC increase in average and minimum winter temperatures, the northern range of *Lonicera japonica* is predicted to shift up to 400 km north (Sasek and Strain 1990). Further westward expansion may be limited by decreased summer precipitation, although *Lonicera japonica* has improved water use efficiency and increased drought tolerance at higher CO_2 levels (Sasek and Strain 1990). *Lonicera japonica* is also predicted to become a more serious competitor

of native trees at higher CO_2 levels, as it experiences much greater growth rates at higher CO_2 levels than do native woody erect species (Sasek and Strain 1991).

Virginia and Illinois have produced honeysuckle control circulars (Williams 1994, Nyboer 1990). Minnesota ranks the species as a severe potential threat (MN DNR 1991).

GLOBAL RANGE

Lonicera japonica is native to east Asia, including Japan and Korea (Gleason and Cronquist 1991, Lee et al. 1990). From this native range it has spread to Hong Kong (Thrower 1976), England (Clapham et al. 1962), Wales (Martin 1982), Portugal (De Baceler et al. 1987), Corsica (Jeanmonod and Burdet 1992), Hawaii (Wagner et al. 1989), Brazil, (Bove 1993), Argentina (Bonaventura et al. 1991), possibly the Ukraine (Panova 1986), and the continental United States, primarily by way of horticultural introductions.

The species was introduced into the U.S. in 1806 on Long Island, NY (Leatherman 1955), and the similar but more aggressive variety halliana was introduced to the country in 1862 in Flushing, N.Y. As with many invasive species, Japanese honeysuckle initially had a very gradual rate of spread, primarily to the south and east. *Lonicera japonica* was not included in Chapman's Flora of the Southern States (1884; in Hardt 1986) but in 1889 Wood and Willis included the variety *chinensis* in their flora of the eastern United States and a decade later Britton and Brown (1898) reported that the species ranged from New York and Pennsylvania to North Carolina and West Virginia. In 1899 *Lonicera japonica* was described in a wildflower book as the most widely planted of the honeysuckles (Lounsbury 1899). *Lonicera japonica* was reported from Florida in 1903, and from Texas in 1918 (Hardt 1986). By 1912, it had "escaped from cultivation", and ranged from Connecticut to Florida (Atkinson 1912), and within a few years was identified as an invasive problem species from the Gulf of Mexico to Massachusetts, creating "a network of tangled cords that covers the ground wherever this ruthless invader gets a foot hold" (Andrews 1919).

Lonicera japonica now occurs throughout the eastern half of the United States, south of a line extending from Massachusetts west to Lake Michigan, Illinois, and Missouri, and then southwest through Texas to Mexico, an area encompassing 26 states (USDA 1971, Leatherman 1955). The northern range limit coincides with maximum 30-year winter temperatures of -25^{o}C (Sasek and Strain 1990). The area of greatest infestation is in the center of this range, where annual precipitation averages 100-120 cm, and 30 year low temperatures are -8^{o}C to -15^{o}C (Sasek and Strain 1990). *Lonicera japonica*'s range is limited to the north by severe winter temperatures, and to the west by insufficient precipitation and prolonged droughts which limit seedling establishment (Sasek and Strain 1990). At the northern edge of the range, plants have reduced growth due to a shorter growing season, and produce few or no flowers (Swink and Wilhelm 1994). *Lonicera japonica* continues to spread northward, however, possibly due to increasing cold tolerance or warmer winters (Wagner 1986). It may spread up to 400 km north if global temperature increases 3^{o}C (Sasek and Strain 1990).

Japanese honeysuckle sporadically escapes from cultivation in California where it is present in scattered locations, primarily below 1000 m elevation (Hickman 1993). It has also escaped cultivation in scattered locations in the Hawaiian islands, particularly in mesic to wet forest in Kokee State Park on Kauai and near Volcano on the island of Hawaii (Wagner et al. 1990). It apparently does not produce seed at most locations in Hawaii and will likely become a much more serious pest there if fertile strains develop. Unfortunately, most plants in an escaped population in Manoa Valley on Oahu reportedly set seed (Wagner et al. 1990). A recent report from Kauai also indicates the Japanese honeysuckle population there may be spreading and has potential to become a severe pest in the Kokee area (Flynn, personal communication).

HABITAT

Lonicera japonica is native to east Asia. In Korea, *Lonicera japonica* is part of the understory in later successional forests dominated *Carpinus cordata, Fraxinus rhynchophylla* and *Cornus controversa* (Lee et al. 1990).

In North America, *Lonicera japonica* primarily occurs in disturbed habitat, including successional fields, roadsides, forest edges, and fencerows (Williams 1994). It is common in dry-mesic to wet-mesic upland forest, floodplain forest, and southern pine stands, and particularly common in forest openings created by disturbance, such as treefall, logging, or disease. *Lonicera japonica* continues to be planted for landscape purposes in gardens and along highways.

Lonicera japonica grows most vigorously in full sun and on rich soil, but is shade and drought tolerant and therefore able to grow in a wide variety of habitats (Leatherman 1955). It develops high frequency and cover in young forests while densely shaded, mature forests support fewer, and smaller, colonies (Robertson et al. 1994). *Lonicera japonica* usually invades disturbed communities and rarely colonizes deeply shaded, mature forests unless canopy openings are created by human disturbances or natural processes (disease, wind throw, drought, etc.) (Slezak 1976; Thomas 1980). In Virginia *Lonicera japonica* quickly invaded a former forest site destroyed by avalanche (Hull and Scott 1982), and it grew vigorously in a forest opening in Arkansas (McLemore 1981). This species can persist in low numbers in relatively undisturbed forest and then "break out" following disturbances that open the canopy, e.g.; windthrow, ice storm, disease, scouring flood, or drought. Once established, *Lonicera japonica*'s dense canopy inhibits establishment of later successional species (Myster and Pickett 1992). *Lonicera japonica* rarely invades deeply shaded, mature forests unless the canopy is somehow opened (Robertson et al. 1994).

In Pennsylvania, *Lonicera japonica* is a major component of the third stage of succession in old fields, increasing after fields have been abandoned for four years (Keever 1989). In New Jersey *Lonicera japonica* invaded an oldfield 13 years after abandonment, and was present for at least 18 years (Myster and Pickett 1992). In Virginia *Lonicera japonica*, is most abundant in the piedmont and coastal plant forests (Williams 1994). In Illinois *Lonicera japonica* grows where overstory canopy provides filtered light, especially oak forests, cedar glades, and barrens, and along the banks of streams where the natural break in canopy creates a light opening (Nyboer 1990). Plants then spread into adjacent shaded forest. *Lonicera japonica* has been found on Michigan sand dunes (Wagner 1986), and persists near abandoned homesites in the Chicago region (Swink and Wilhelm 1994). In Indiana, *Lonicera japonica* is abundant in urban forest preserves, but is absent from woodlots isolated by agricultural fields and distant from urban areas (Brothers and Springarn 1992).

BIOLOGY-ECOLOGY

Lonicera japonica is a strong competitor due to wide seed dispersal, rapid growth rate, extended growing season, ability to capture resources both above- and below-ground, wide habitat adaptability, and lack of natural enemies. Some of these factors have received considerable study, while others have been given little or no attention.

Lonicera japonica blooms most prolifically in full sun (Leatherman 1955), and decreases flowering activity as light decreases; in 8% of full light no flowers are produced (Blair 1982, Robertson et al. 1994). The blooming period extends from April to December in Georgia (Andrews 1919), late May to October in Kentucky (Sather, personal communication), May to June in Illinois (Mohlenbrock 1986), and June in Michigan. Flowers open a few hours before sunset, and remain open for approximately three days

(Roberts 1979). In Wales, the majority of flowers are pollinated the day after opening by bumblebees (*Bombus lucorum* and *B. pascuorum*). Other bee species may be potential pollinators, as nectar is available to species with tongues ≥ 4 mm long (Roberts 1979). Flowers remain open at night, indicating the possibility for moth pollination (Roberts 1979). In the United States *Lonicera japonica* is probably pollinated by a variety of insects, due to its extended blooming season and wide geographical range.

Relatively few studies have documented seed production, seed viability, germination requirements, or seedling establishment.

The inconspicuous black berries contain 2-3 seeds (USDA 1971). Fruit production is much higher in full sun than in shade (average 222 vs. 11 g seeds per plant, respectively) in Texas (Halls 1977). Fruit production decreases as soil nitrogen increases (Segelquist and Rogers 1975). Seed viability is highly variable. Leatherman (1955) determined that 85% of seed were viable, and obtained 63% germination. Haywood (1994) attempted to study long-term seed viability, but seed was unsound when collected. This variation is typical of the *Lonicera* genus, which is characterized by having variable seedcoat dormancy, embryo dormancy, and/or no dormancy both within and among species (Hartmann and Kester 1968). Bruner (1967) reported rapid growth from seed in South Carolina, and Carter and Teramura (1988b) stated that *Lonicera japonica* reproduces abundantly from seed. Berries are consumed by a number of birds including robin, turkey, quail, bluebird, and goldfinch (Martin et al. 1951, Jackson and Cooper 1974), which then disseminate the seeds (Nyboer 1990).

Rate of growth from the seedling stage is not known; most researchers and nurseries propagate *Lonicera japonica* from stem cuttings, particularly the var. halliana, which forms roots "wherever the canes touch moist ground" (Hartmann and Kester 1968). Leatherman (1955) suggested that seedlings likely photosynthesize shortly after germination, due to the low food reserves in each seed. Seedlings are known to establish in shaded understories, which implies that light may not be necessary for seed germination. Seedling growth is apparently slow for the first two years (Little and Somes 1967). *Lonicera japonica* is drought sensitive, particularly at the seedling stage (Sasek and Strain 1990). Biomass appears to decline with summer drought (Faulkner et al. 1989).

Once established, *Lonicera japonica* is capable of extremely vigorous growth. In a moist bottomland forest vines overtopped a 4.5 m tree in one year (Bruner 1967), although growth rates of 1.5 m/year may be more typical (Leatherman 1955). Bell et al. (1988) recorded a maximum shoot elongation of 4.6 mm/day in Maryland. This rapid growth rate allows *Lonicera japonica* to outcompete native trees; In one year, *Lonicera japonica* overtopped three-year old sweetgum (*Liquidambar styraciflua*) trees (Dillenburg et al. 1993a). *Lonicera japonica* vines spread both vertically and horizontally (Williams 1994).

Individual vines have numerous long vegetative runners; the combined length of lateral and sublateral runners from one sprout in one year exceeded 15 m (Little 1961). Vines in high light have been recorded with ≥ 7 runners, each over 60 cm long (Slezak 1976). The runners develop roots at nodes in contact with soil, and thus form dense mats. If the above ground parts are severed, each new root system develops into a separate, but genetically identical, plant. The root system has been recorded at up to 3 m across and 1 m deep (Leatherman 1955). Roots are highly competitive with native species (Carter and Teramura 1988a, 1988b).

Lonicera japonica's climbing architecture is adapted to early successional forest (Carter and Teramura 1988a), which typically has small diameter trees and a dense understory. The vines twine about vegetation in closely spaced spirals, thus creating a strong support structure that permits them to remain upright after the host tree is killed. Individual shoots may be very long, but due to the numerous spirals, a vine's height above the ground may not be great. Japanese honeysuckle vines typically climb stems <15

cm diameter (Andrews 1919). Larger stems are rarely used as hosts, as *Lonicera japonica* cannot climb wide boles unless small branches or other vines are present to provide support (Andrews 1919).

Longevity of individual plants has not been measured. As *Lonicera japonica* reproduces vegetatively, life span of individual stems or roots is not a measure of genet longevity.

Lonicera japonica is adapted to growing in 25-100% of full light, and grows vigorously in full sun. Stem density is greatest in full light, and decreases with increasing shade: In Pennsylvania, Robertson et al. (1994) recorded mean stem densities of 25.4/m^2 in an oldfield, 15/m^2 in a thicket, 13.6/m^2 in a woodland, and 8.6/m^2 and 8.1/m^2 in riparian forest and upland mature forest, respectively. Stem density was similarly high in both oak and maple associations (Robertson et al. 1994). In Washington D.C. *Lonicera japonica* produced good growth at 47% of full sun (Thomas 1980). In this location winter light measurements in closed forest range from 49% to 86% of full light. *Lonicera japonica* is able to persist in deciduous forest at low summer light intensities, and put on growth in winter, or when canopy gaps occur.

Lonicera japonica tolerates low light conditions, and may spread vegetatively, but rarely produces flowers or fruits under low light (25% of full light; Robertson et al. 1994). Honeysuckle plants are severely stressed in low light, and lose substantial amounts of aboveground biomass after long periods of low light: Blair (1982) reported that leaf biomass declined 94% after two years at very low light (8% of full sunlight), and plants suffered stem dieback and leaf loss, but did not die. Leatherman (1955) similarly reported that half of her experimental cuttings survived at 10% of full light, and the majority survived at 25% of full light. Once established, *Lonicera japonica* can persist at low light levels with little or even negative growth, and respond to winter sun and canopy openings with more vigorous growth (Carter and Teramura 1988a). Interestingly, as a twining vine *Lonicera japonica* is less physiologically adapted to low light levels than native tendril climbing vines, such as *Parthenocissus quinquefolia* (Carter and Teramura 1988a), which can rapidly climb up supporting trees to reach higher light levels.

Lonicera japonica has a long photosynthetic season due to its evergreen nature and its ability to grow in cold temperatures. *Lonicera japonica* shoots grow until the first frost, apparently because they are able to lignify rapidly, which gives them greater cold-hardiness than more tender species (Panova 1986). In southern locales *Lonicera japonica* retains its old leaves over winter (Schierenbeck and Marshall 1993) permitting year-round photosynthesis. In these areas, *Lonicera japonica* leaves are physiologically active during the winter and can grow when minimum predawn air temperatures are at or above -3^{o}C. At these temperatures, net photosynthetic rates on warm winter days are comparable to those in summer (Carter and Teramura 1988b). The presence of old leaves during the period of new-leaf formation (January - March), combined with the higher photosynthetic rates in new leaves, increases total carbon gain and thereby growth rate and invasiveness (Schierenbeck and Marshall 1993). Shoots produce an early burst of growth in spring, before native species leaf out (Dillenburg et al. 1993a).

In the northern states *Lonicera japonica* retains its leaves until late December or January (semi-evergreen), while native trees lose their leaves in October. The vines continue to photosynthesize for several months after overstory trees have dropped their leaves, which allows them to maintain presence in low light communities (Robertson et al. 1994, Carter and Teramura 1988a). In Maryland, *Lonicera japonica* is physiologically active for 9 weeks after native deciduous vines have gone dormant (*Parthenocissus quinquefolia* and *Vitis vulpina*) (Bell et al. 1988). In spring *Lonicera japonica* begins growth some two months earlier than native species, from the period when temperatures are above freezing, until deciduous trees produce new leaves (Hardt 1986). Thomas (1980) calculated that in the Washington D.C. area there are an average of 52 days/year between first and last frost when temperature and light conditions in closed canopy forests are adequate for *Lonicera japonica* photosynthesis.

Lonicera japonica leaves are unaffected by minimum temperatures of -0.6°C, and continue to function, at lower efficiency, until temperatures drop below -3.0°C (Carter and Teramura 1988b). The relatively high rate of leaf gas exchange in autumn, winter, and spring indicates that carbon gain during this period may contribute substantially to *Lonicera japonica*'s rapid growth rate. Although *Lonicera japonica* leaves photosynthesize in winter, the lowered activity reduces effectiveness of foliar herbicides applied after the first frost (Regehr and Frey 1988). In Tennessee, defoliation occurred at -26°C, but plants were not apparently killed (Faulkner et al. 1989).

Lonicera japonica is spread primarily by birds, which consume the fruits and pass the seeds, carrying them from landscape plantings to natural areas and disseminating them in forest openings and disturbance zones. Once established, *Lonicera japonica* can develop a large seedbank that germinates when the soil is disturbed. This attribute led to a dramatic increase in southern states in the 1950's, when timber companies promoted intensive site preparations (discing, burning, bush-hogging) to facilitate tree regeneration after clearcutting (Prine and Starr 1971). Honeysuckle grew so rapidly from both seedbank and top-killed plants that tree seedlings were outcompeted (Prine and Starr 1971). Consequently, forest companies have conducted much of the research to identify herbicides that control *Lonicera japonica* (Edwards and Gonzalez 1986, McLemore 1981).

Originally introduced as a landscape plant, *Lonicera japonica* is still considered a desirable species by some landscapers, highway designers, and wildlife managers. Wildlife managers promote increased growth of *Lonicera japonica* to provide winter forage, particularly for deer (Dyess et al. 1994). Landscape architects plant *Lonicera japonica* for its fragrant flowers and rapid growth (Georges et al. 1993, Nam and Kwack 1992, Bradshaw 1991), and highway designers use the plant for erosion control and bank stabilization (Stadtherr 1982, Hardt 1986).

In China *Lonicera japonica* is a valued medicinal herb that contains anti-complementary polysaccharides (Shin et al. 1992). Polyphenolic compounds isolated from *Lonicera japonica* inhibit human platelet activation and provide protection from cellular injury, and thus help maintain human vascular homeostasis (Chang and Hsu 1992). Aden I, a mixture of *Lonicera japonica* flower buds and parts of other plants, has both antibiotic and antiviral effects, comparable to results produced by standard antibiotics (Houghton et al. 1993). Leaves and flowers are used in the therapy of chicken pox (Luo 1989), and may be used as a food additive to increase productivity of broiler chickens in Korea (Cho 1992).

CONTROL

Prevention/Legislation

In Illinois, the sale and distribution of *Lonicera japonica* is prohibited under the Illinois Exotic Weed Act (1988).

Biological control

The only technique that could control *Lonicera japonica* on a regional scale is biological control, but as of 1997 no formal program had been established. Interestingly, in China, a biocontrol program using *Sclerodermus* spp. was established to protect *Lonicera japonica* from the cerambycid *Xylotrechus grayi* (Tian et al. 1986). *Lonicera japonica* is utilized by some insects in its native habitat and the U.S. In Sichuan, China, *Lonicera japonica* growing near cottonfields is an early spring host for aphids that feed on crops later in the growing season (Li and Wen 1988). In North Carolina, the two-spotted spider mite (*Tetranychus urticae*), an agricultural pest in corn and peanut fields, overwinters on *Lonicera japonica* growing on field margins (Margolies and Kennedy 1985). *Lonicera japonica* is also a suitable host for the

cicadellid cotton pest (*Empoasca biguttula*) in Hunan, China (Chen et al. 1987), and may be a host for tobacco leaf curl virus, which was detected in the horticultural variety *Lonicera japonica* var. aureo-reticulata (Macintosh et al. 1992). The vine is susceptible to honeysuckle latent virus (Brunt et al. 1980), and to tobacco leaf curl bigeminivirus (TLCV) transmitted by whiteflies (MacIntosh et al. 1992).

Burning

Fire removes above-ground vegetation, and reduces new growth, but does not kill most *Lonicera japonica* roots, and surviving roots produce new sprouts that return to pre-burn levels of cover within a few years (Oosting and Livingstone 1964). A single spring fire reduced Japanese honeysuckle cover 50% in Illinois (Nyboer 1990). Two sequential fires topkilled *Lonicera japonica*, reducing crown volume (m^3/ha) by 80%, but new growth from root sprouts maintained *Lonicera japonica* as a dominant groundcover species in North Carolina (Barden and Matthews 1980). In Virginia burning is used to reduce abundance of *Lonicera japonica*, and inhibit spread for 1-2 growing seasons (Williams 1994). Prescribed burning significantly reduced *Lonicera japonica* biomass in Tennessee, by 93% when burned in October, and by 59% when burned January - March (Faulkner et al. 1989). Top-killed honeysuckle resprouted in spring (March - April), apparently from roots or runners just below the unburned litter layer. In this situation, follow-up application of 2% glyphosate in spring, 2 - 6 months after burning, appeared to control honeysuckle better on unburned than burned plots, possibly because tall herbaceous vegetation that grew up after the fire on the burned plots intercepted the herbicide before it could reach the shorter honeysuckle resprouts (Faulkner et al. 1989). In Texas, burning in February removed all above ground foliage, but did not kill plants (Stransky 1984). However, burned plants produced fewer and shorter runners than unburned plants, and fire therefore reduced total vegetative growth (Stransky 1984).

Combining fire and herbicides may prove to be more effective than either method by itself if late autumn or winter burns are used to reduce Japanese honeysuckle biomass when most native species are dormant and all resprouts are then treated with a foliar application of glyphosate about a month after they emerge (Johnson, personal communication). Prescribed burns may also be used to help prevent spread of Japanese honeysuckle because seedlings and young plants are most susceptible to fires (Richter, personal communication) .

Chemical

The evergreen and semi-evergreen nature of *Lonicera japonica* allows application of herbicides when many native species are dormant. Timing of application is critical to effectiveness; in general, applying herbicide shortly after the first killing frost, and before the first hard frost (ca. -4.0^{o}C) is most effective. Herbicide effectiveness can be reduced in areas where large stones or fallen logs protect root crowns from soil-active herbicides (Miller 1985) or where overtopping vegetation intercepts foliar herbicides (Faulkner et al. 1989). Many herbicides produce a short-term reduction in foliar coverage, but do not kill the plant and buds left undamaged by the herbicide can produce new growth that often exceeds growth from untreated plants within a year (Prine and Starr 1971). A foliar application of 1.5% glyphosate shortly after the first frost appears to be the most effective treatment. Treated plants should be re-examined at the end of the second growing season, as plants can recover from herbicide application (McLemore 1981).

GLYPHOSATE (brand names include: Roundup, Rodeo, Accord)

• October applications of 0.75% and 1.5% v/v glyphosate killed 99% of treated *Lonicera japonica* within six months in Delaware, and few plants resprouted within 30 months of treatment (Regehr and Frey 1988). The two application rates were equally effective. The same experiment conducted in December resulted in 68% mortality at the lower concentration, and 86% mortality at the higher concentration, and

regrowth from buds was much greater than in plants treated in October. The authors concluded that timing of application was critical; applying glyphosate within 2 days of the first frost resulted in very high mortality. After the first frost, higher concentrations of glyphosate were needed to achieve somewhat lower mortality. Defoliation after glyphosate treatment was very slow; only 5-15% of leaves were gone one month after treatment, although 78-90% of stems were dead.

• A mid-August application of 2.2 kg/ha glyphosate controlled 83% of actively growing *Lonicera japonica* in North Carolina; control was reduced under drought conditions (Younce and Skroch 1989). Glyphosate (2 lb active ingredient/gal) at 1 to 1.5 gallons/acre controlled "most" *Lonicera japonica* in Alabama (Miller 1985).

• In Arkansas, a 6.72 kg active ingredient/ha application resulted in 85% control after one growing season, and 80% control after two growing seasons (McLemore 1981). Lower application rates were less effective two years after treatment.

• Effectiveness of glyphosate increased linearly with increasing herbicide concentration (0.48-4.8% w/w), but no concentration gave complete control with one application; repeated treatment with 4.8% glyphosate produced complete shoot necrosis in only 50% of plants (Ahrens and Pill 1985).

• Efficacy of glyphosate was not increased by addition of surfactants (Younce and Skroch 1989, Regehr and Frey 1988).

DICHLORPROP + 2,4-D

• Dichlorprop mixed with 2,4-D at 3.6 grams active ingredient/liter (1.5% v/v) resulted in 94% mortality when applied within two days of the first frost in October, but only 46% mortality when applied in December. Thirty months after treatment, 14% of stems sprayed in October resprouted, and 75% of stems sprayed in December produced new growth (Regehr and Frey 1988).

2,4-D + PICLORAM (brand names include: Tordon)

• Picloram is a restricted use soil-active herbicide that is prohibited in California, as it is relatively persistent and subject to leaching.

• Tordon 101 (4:1 2,4-D amine + picloram, at 1 to 2 gal/acre) "reduced existing honeysuckle to a few surviving crowns" (Miller 1985). Tordon 10K at 50 lb/acre had similar effectiveness (Miller 1985).

• Tordon 101 at 10 gal acre reduced foliage by 72.5% one year after treatment; a second application of Tordon 101 reduced foliage by a total of 90% one year after re-treatment (Prine and Starr 1971)

• A foliar spray of Tordon 101 at 2.8-8.4 kg/ha gave 84-94% control in a pine stand (McLemore 1982), similar to control provided by amitrole at 2.24 and 4.48 kg/ha. (McLemore 1982).

TEBUTHIURON (brand names include: Spike)

• Spike 80W (80% tebuthiuron) and Spike 20p (20% tebuthiuron) provided very effective control when applied at 4-5 lbs active ingredient/acre, "resulting in essentially bare plots with yellowing sprigs of vegetation" (Miller 1985).

DICAMBA (brand names include: Banvel, Brushkiller)

• Banvel 720 (2 lb 2,4-D and 1 lb dicamba) was very effective when applied at 4 gal/acre, but had only partial effectiveness at 3 gallons/acre (Miller 1985).

• Lower rates of Dicamba, as in Brushkiller 4-41 and 10-51, resulted in limited or no mortality (Miller 1985). In fact, *Lonicera japonica* growth was stimulated by application of Brushkiller 10-51 (Miller 1985).

SULFOMETURON (brand names include: Oust)

• A February application of sulfometuron methyl in South Carolina at .25 lb/acre active ingredient, applied when vegetation is less than 30-45 cm high, is recommended for control of *Lonicera japonica* in loblolly pine stands (Michael 1985).

• In Georgia, *Lonicera japonica* was not controlled by a late application of Sulfometuron applied at 3 oz/acre (Withrow et al. 1983)

• *Lonicera japonica* was almost completely killed (99% mortality) by a May application of 2 oz metsulfuron-methyl + 0.25% surfactant in central Georgia (Edwards and Gonzalez 1986)

INEFFECTIVE

• In Illinois, herbicides that are not used by the Department of Conservation due to ineffectiveness or environmental persistence are: picloram; amitrole; aminotriazolel atrazine; dicamba; dicamba + 2,4-D; 2,4-D; DPX 5648; fenac; fenuron; simazine; and triclopyr (brand names for triclopyr include Garlon 3A, Garlon 4 and Brush-B-Gone) (Nyboer 1990).

• Hexazinone at 2.24 and 6.72 kg Active ingredient/ha was ineffective (McLemore 1981), as was application at 1 or 2 lb active ingredient/acre (Michael 1985). Hexazinone pellets at 8 lb active ingredient/acre reduced *Lonicera japonica* cover from 100% to 25% cover after three years, while a 2 lb/acre rate resulted in a decrease in cover from 100% to 52% over the same time period (Michael 1984).

• Oryzalin is apparently ineffective, as it is recommended for use in controlling weeds that threaten *Lonicera japonica* planted as a groundcover (Bowman 1983)

• Brushkiller 10-51 at 1.5 gal/acre "encouraged" growth of *Lonicera japonica* (Miller 1985). Brushkiller 170 resulted in a 45% decrease in foliar cover one year after June treatment (Prine and Starr 1971).

• June application of 2,4-D (4 lb active ingredient/acre at 10 gal/acre) increased foliar growth of *Lonicera japonica* by 48% one year after treatment (control plants increased by 0.9%) (Prine and Starr 1971).

• June application of Banvel resulted in increased foliar growth one year after treatment (Prine and Starr 1971).

• Triclopyr in both ester and salt formulations (3 and 4lb/gal, respectively) and as an ester combined with 2,4-D (1 and 2lb/gal respectively) failed to control *Lonicera japonica* one year after treatment (Dreyer 1988). However, in Illinois the latter formulation is reputedly effective (Nyboer 1990).

Mowing, Discing and Pulling

Removing the above-ground portion of *Lonicera japonica* reduces current-year growth but does not kill the plant, and generally stimulates dense regrowth. Cut material can take root and should therefore be removed from the site (not practical with most infestations).

Mowing is an ineffective control method, stimulating growth and encouraging formation of dense, albeit shorter, mats. Plants mowed in February formed a dense, 20 cm tall mat within two months, growing from cut stems and rooting from severed runners; by the following November (21 months later) mowed plants were 60 cm high (Stransky 1984). Twice-yearly mowing in Virginia slowed vegetative spread but increased stem density (Williams 1994).

Bush-hogging is an ineffective control, as *Lonicera japonica* re-invades within one growing season (McLemore 1985).

Discing is apparently an effective control method: McLemore (1985) reported that "control of the honeysuckle was still effective after two years". Discing depth was not indicated. Discing is a highly destructive procedure that destroys native groundlayer species, and may stimulate *Lonicera japonica* seed bank germination.

Hand-pulling is a time-consuming procedure with limited effectiveness, as the entire plant (roots and shoots) must be removed. Pulling may be a practical method to remove small patches of seedlings.

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White-tailed Deer and Virginia Natural Area Preserves: a Discussion

Mike Leahy (July 2003)

Background

A large body of research (Russell et al. 2001) presents evidence that dense populations of white-tailed deer (*Odocoileus virginianus*) in many eastern U.S. ecosystems can negatively impact tree regeneration, recruitment and composition (Alverson and Waller 1997, Horsley et al. 2003), alter natural community composition (Rooney and Dress 1997), eliminate certain plant species from areas (Augustine and Frelich 1998), and disrupt bird populations (McShea and Rappole 1997). Deer also avoid browsing on the invasive, exotic plants stilt grass (*Microstegium vimineum*; Tu 2000) and garlic mustard (*Alliaria petiolata*; Nuzzo 1991), further exacerbating the nefarious effects of these weeds on our native flora. Of particular concern for natural areas management are the negative effects of high deer densities on herbaceous plants (Anderson 1994, Balgooyen and Waller 1995, Augustine and Frelich 1998) and rare plants (Miller et al. 1992).

It is estimated that the presettlement deer density of the eastern U.S. was around 8-11 deer/mi^2 (McCabe and McCabe 1997). At the end of the 19th century deer were over hunted to the point of near extirpation from Virginia. Since then the implementation of strict game laws, the elimination of natural predators and the changing landscape of the state with more edge habitats has given rise to a burgeoning deer population today that in most areas of the state exceeds the estimated presettlement deer densities (Knox 1997). A number of studies have demonstrated that deer densities >20 deer/mi^2 can have negative impacts on tree regeneration, recruitment and composition (Tilghman 1989, Healy 1997, Horsley et al. 2003). Deer densities of 8-15 deer/mi^2 have well-stocked and diverse woody understories (Healy 1997) and abundant and flowering herbaceous populations of such deer sensitive species as *Trillium grandiflorum* (Anderson 1994) and *Laportea canadensis* (Augustine et al. 1998). It should be noted that the effects of deer on forest ecosystems depends on the landscape context in which they occur (Horsley et al. 2003). Forest stands in landscapes with a significant amount of agricultural row-crop land are less impacted by the same density of deer than a forest stand in a primarily forested landscape.

Deer on NAPs

The results of field observations from DNH biologists coupled with deer density data from DGIF (Table 1) in light of cited research above indicates that there are currently too many deer on many of our NAPs if the goal of managing the preserves is to sustain and restore natural communities and rare plants.

Detailed and replicated, labor-intensive exclosure studies are not practical for DNH at this time to prove that deer are a problem on NAPs. I recommend that small exclosures on the scale of 5-10m^2 plots could be used that are easily constructed and monitored. Research studies have effectively used plots of this size (Alverson and Waller 1997, Healy 1997). The goal would be to monitor trends in vegetation that should track trends in deer densities. Preserves in counties or landscapes where deer densities exceed > 20 deer/mi^2 are likely negatively influenced by deer herbivory.

Deer are a problem for many of our NAPs and a deer management program via regulated hunting needs to be enacted to reduce the local herd to a density that does not negatively impact the ecological communities on a preserve. Deer hunting is the most practical method of deer control currently available (DGIF 1999). Utilizing deer birth control, trapping and moving; or erecting a deer-proof fence around a preserve would be extremely costly. DNH needs to work with wildlife biologists from the Virginia Department of Game and Inland Fisheries through the deer management assistance program (DMAP) and or the deer damage control assistance program (DCAP) to develop a deer management plan for either each preserve and or a state-wide deer hunting plan for NAPs. These DGIF programs consist of:

- DMAP is a site-specific deer management program that increases a landowner's or hunt club's management options by allowing a more liberal harvest of antlerless deer than could be obtained

under the current system of county regulations. DMAP tags can only be used to harvest antlerless deer (does and male fawns) and are not valid for antlered bucks. The primary goal of DMAP is to allow landowners and hunt clubs to work together on a local level to manage their deer herds. Secondary objectives are to increase the Department's biological database and to improve communication between deer hunters, landowners, and the Department.

- Like DMAP, DCAP was started in 1988. DCAP is a site-specific deer damage management program that increases a landowner's management options by allowing a more liberal harvest of antlerless deer than could be obtained under the existing system of county regulations. DCAP permit tags can only be used to harvest antlerless deer (does and male fawns) and are not valid for antlered bucks. The primary objective of DCAP is to provide site-specific assistance in the control of crop depredation by deer or other property damage. Secondary objectives are to maximize hunter participation in the control effort and to shift closed-season kill permit deer harvest(s) into the open deer season.

More harvest of female deer (does) will undoubtedly be a needed step towards reducing the herds using the preserves. Hunting efforts should concentrate on thinning the herd in those ecological communities most negatively impacted by excessive deer herbivory. One solution to deer overpopulation on NAPs would be to open preserves in counties with deer densities greater than a certain threshold to hunting of antler-less deer only (mainly does). In addition to obtaining the ecological benefits of a reduced deer herd on the preserves, we will be allowing greater public use of the NAPs during a time of year (fall, winter) when human impacts on the biota will be minimized.

Depending on the state other state programs vary in their approach to hunting on state natural areas. Natural areas in Missouri and Wisconsin are generally open to hunting while other programs such as Minnesota, Michigan, Illinois, Indiana and Ohio have a mix of open and closed to hunting natural areas.

Deer population pressures can be measured in terms of deer densities and or deer impacts (Horsley et al. 2003). Deer density can be assessed via a number of techniques including deer harvest data (DGIF 1999), counts at dusk (Storm et al. 1992), the drive method (deCalesta 1994), pellet counts (Neff 1968, White 1992, Alverson and Waller 1997), winter aerial surveys (Augustine and Frelich 1998) and line-transect sampling (Burnham et al. 1980, Healy and Welsh 1992). Population data on sensitive or "indicator" herbaceous plants have been used as a relatively crude but quick method of gauging the impact of deer populations on natural communities (Anderson 1994, Balgooyen and Waller 1995, Augustine and Frelich 1998, Augustine et al. 1998, Webster and Parker 2000). It is recommended that a monitoring program to track deer population densities and deer impact be utilized to assess the success of a deer management (hunting) program. Monitoring trends of deer impact on exclosure plots and measurements of sensitive herbaceous ground flora plants is recommended.

Recommendations

- Establish simple exclosure plots in NAPs with evidence of excessive deer herbivory to track trends in ground flora and the understory.
- Work with DGIF to establish some efficient system of hunting on NAPs that effectively reduces the deer impacts to preserves.
- NAPs in counties with deer population densities > 20 deer/mi^2 need to incorporate a deer management plan into the overall resource management plan.

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Impacts and Economic Costs of Deer In Suburban Landscapes

by Paul D. Curtis

The past quarter-century has witnessed a period of major growth and spread of people, automobiles, suburban living, and ownership of nonfarm rural lands. At the same time, white-tailed deer (*Odocoileus virginianus*) numbers have increased to unprecedented levels, and populations have expanded into areas with suburban development (Flyger et al. 1983). Deer in suburban landscapes cause significant economic losses to residential landowners, present safety hazards to motorists, and are perceived as agents in the transmission of Lyme disease (Connelly et al. 1987, Decker and Gavin 1987). The purpose of this paper is to provide an overview of the economic impacts caused by deer in suburban landscapes. Much of the information was obtained from several studies conducted in New York State by the Human Dimensions Research Unit at Cornell University. However, trends in other northeastern states with growing deer populations and rapid urbanization are similar. The major economic losses caused by deer are divided into three sections: deer-related vehicle accidents, Lyme disease, and plant damage.

DEER-RELATED VEHICLE ACCIDENTS

Most states keep records of deer-related vehicle accidents (DRVAs) and/or dead deer found along state highways. Romin (1994) reported that 538,000 deer collided with vehicles during 1991 in 35 states. Conover et al. (1995) estimated that the total number of reported DRVAs nationwide would be approximately 726,000 if all states were included. These estimates exclude deer that die away from the highway, and unreported DRVAs (Romin 1994). The reported number of DRVAs ranges from approximately 20 percent (Decker and Loconti 1989, Decker et al. 1990) to 50 percent (Romin 1994) of the actual number of collisions. Consequently, a conservative estimate of the total number of DRVAs nationwide would be 1.5 million annually.

Vehicle repair bills following a DRVA (in 1993 dollars) ranged from $1,200 to $2,200 in several states, with an average value of $1,577 (Conover et al. 1995). Accounting for just the 726,000 reported accidents, total annual cost for DRVAs in the United States would be about $1.1 billion. Current estimates for the cost of DRVAs in New York State alone are $50 to $70 million each year (J.R. Palmateer, New York State Department of Environment Conservation, Delmar, unpublished report).

Stout et al. (1993) examined the relationship between the perceived risk of being involved in a DRVA and public preference for local deer densities. Managing deer with consideration of public perceptions of risk from DRVAs differs from managing deer based on the actual incidence of DRVAs. Lowering the actual number of DRVAs can be accomplished with barrier fencing or reducing the size of the deer herd. However, this approach ignores the many positive recreational, aesthetic, and economic benefits people derive from higher deer densities. Risk perception is a complex process that involves more than assessing the number of DRVAs, and provides wildlife managers with an understanding of how the public balances the benefits and costs in the preference of a specific density for a local deer herd.

Respondents to a mail survey ($\underline{n}$ = 397, 66 percent response rate) indicated their most frequent deer-related concerns were DRVAs (83 percent) and Lyme disease (57 percent) (Stout et al. 1993). Most residents (88 percent) in Tompkins County, New York, were aware of at least one DRVA in the county, usually by first-hand experience of witnessing DRVAs involving other people (22 percent), or seeing car-killed deer along the highway (76 percent). Also, many respondents (69 percent) knew someone who had been involved in a DRVA in the county. However, most people (63 percent) still believed their chances of being personally involved in a deer-car accident during the next 12 months was low. A relationship

existed between perceptions of higher risk and preferences for a decrease in herd size. In addition, perceptions of social benefits from deer, probability of DRVA occurrence, tolerance of other deer-related problems, and personal involvement with a DRVA, also influenced respondents' attitude towards decreasing the size of the deer herd.

LYME DISEASE

Lyme disease was first recognized in the United States in 1975, after an unusual outbreak of arthritis near Lyme, Connecticut. Lyme disease is spread by ticks in the genus *Ixodes* that are infected with the bacterial spirochete *Borrelia burgdorferi*. *Ixodes* ticks may also spread the disease human babesiosis (*Babesia microti*), which is caused by a malaria-like parasite (Spielman et al. 1985). A public information guide from the Center for Disease Control indicated that between 12,000 and 14,000 cases of Lyme disease have been reported annually in the United States since 1994.

Larval and nymphal black-legged ticks (*I. scapularis*) commonly feed on white-footed mice (*Peromyscus leucopus*) and white-tailed deer in the northeast, but can be found on many other mammals and birds. Adult ticks, however, feed primarily upon deer (Watson and Anderson 1976, Piesman et al. 1979, Anderson and Magnarelli 1980). Although adult ticks are occasionally found on medium-sized mammals, deer densities may be a primary factor determining tick abundance (Wilson et al. 1985). *I. scapularis* is not found in regions where deer are absent, and tick abundance is greatest in areas where deer exhibit their highest densities (Piesman and Spielman 1979).

For 13 islands off the coast of Massachusetts, the abundance of larval ticks on white-footed mice was associated with deer density (Wilson et al. 1985). However, this relationship was not apparent for nymphal ticks, and it was speculated that transport of nymphs by birds confounded the relationship. On Long Island, New York, the frequency of deer use of 0.25-ha quadrats in fall was positively correlated with immature tick numbers found on white-footed mice the following summer (Wilson et al. 1990). Consequently, it has been suggested that the risk of contracting tick-borne diseases may be decreased by reducing local deer densities (Wilson et al. 1990). This may be difficult to achieve given the lack of support for hunting in many suburban landscapes.

Control of ticks on deer has been attempted mostly by deer exclusion or population reductions (Wilson and Deblinger 1993). Both methods have reduced populations of *I. scapularis* from selected experimental areas (Wilson et al. 1988, Daniels et al. 1993, Deblinger et al. 1993, Stafford 1993). However, these techniques are expensive, may be incompatible with recreational uses, and may result in opposition from animal-welfare activists.

Consequently, self-treatment of deer with acaricides is being investigated. Food-baited tubes have successfully delivered acaricides to mice and voles (Sonenshine and Haines 1985). "Damminix" tubes containing cotton have been used to treat mice with acaricides (Mather et al. 1987, Spielman 1988). A self-medicating applicator for killing ticks on deer and goats (*Capra hircus*) has been field tested in Virginia and North Carolina (Sonenshine et al. 1996). A 1 percent permethrin solution was used on a ceramic column to treat deer feeding from a circular polyethylene bin (Norval et al. 1994). Both penned and free-ranging deer readily used the applicators. Hunter-killed deer from a treated site were infested with fewer black-legged ticks (= 3.4) than those from a control site (= 10.8). Chromatographic analyses of hair samples revealed traces of permethrin on 3 of 4 deer tested. Additional large-scale field studies with similar self-application devices are currently under way.

PLANT DAMAGE

Deer damage to ornamental plants is widespread in the Northeast, but is not evenly distributed across the landscape. Impacts are often most intense near the suburban-rural fringes of large metropolitan areas (Curtis and Richmond 1992). Conover (1997a) surveyed a random sample of 100 homeowners in 10 of the 100 largest metropolitan areas in the United States, and determined that most respondents (61 percent) had experienced wildlife-related problems during the previous year. When results were extrapolated to the 60 million households in these metropolitan areas, wildlife damage was estimated to cost $3.8 billion annually. Only 4 percent of respondents reported problems with deer (2.4 million households), indicating that deer damage may cost homeowners approximately $251 million each year (Conover 1997b).

More detailed mail surveys of nursery producers and homeowners in suburban areas of southeastern New York State indicated higher levels of deer damage to landscape plants. Approximately two-thirds of producers and one-third of homeowners reported deer browsing. Nursery producers ($\underline{n} = 24$) reported total losses of $519,000 in a 5-county area during 1988, with a median loss per producer of $3,000 (Sayre et al. 1992). However, 3 producers reported more than $150,000 in deer damage, and the average loss for all growers exceeded $20,000.

Homeowners with deer impacts ($\underline{n} = 26$) reported a median loss of $200 per household in southeastern New York, and about three-fourths of these respondents classified the damage as light to moderate. The average replacement costs for trees and shrubs was nearly $500 for households with deer damage, so losses were not evenly distributed across the landscape (Sayre and Decker 1990).

Results from a self-administered mail survey of 1,002 households (70 percent response rate) in Westchester County, New York, indicated 95 percent of residents had seen a deer in the past 5 years, and 49 percent perceived an increasing trend in deer numbers (Connelly et al. 1987). More than 40 percent of respondents reported plant damage caused by deer. Average cost of plant replacement for households with deer damage averaged $94 for vegetables, $102 for flowers, $156 for fruit trees, and $635 for shrubbery. Estimated total plant replacement costs for northern Westchester County ranged from $6.4 to $9.5 million in 1987.

Despite significant plant damage in southeastern New York, two-thirds of all respondents believed that prevention of deer-car collisions should be the most important consideration of deer managers (Sayre and Decker 1990). Also, three-fourths of homeowners supported regulated hunting as a tool to manage deer populations. Even in highly suburban Westchester County, 72 percent of respondents recognized the need for deer management, and 44 percent supported the use of firearms during a regulated hunting season (Connelly et al. 1987). Two to three times more respondents expressed concerns about DRVAs and Lyme disease than about plant damage in Westchester County. It is obvious that human health and safety concerns related to deer should be the highest priority for wildlife managers.

FUTURE TRENDS

Overabundant deer populations currently cause substantial economic losses in many parts of the United States. The problems are particularly severe in the northeastern states, where expanding metropolitan areas continue to encroach on high-quality agricultural and forest lands. The forage and cover available near exclusive wooded home sites, and protection from hunting in many residential areas, have provided an ideal situation for deer populations to rapidly expand. Deer numbers in local parks and suburban landscapes may continue to double every two to three years, as long as forage is available, unless some form of mortality or fertility control is implemented. Densities in some parks now exceed 100 deer per square mile, a level that would have been beyond the belief of most wildlife managers two decades ago.

I expect the situation will get worse in the near future. Deer numbers continue to grow at the fringes of several metropolitan areas in the northeast, and elected officials are receiving more calls concerning damage to ornamentals, deer-car collisions, and Lyme disease. The greatest difficulty will be managing the social or human-dimensions aspects of these problems, as a proposal to reduce deer numbers can become a very controversial issue for a community. People hold a wide range of attitudes and beliefs concerning human-wildlife relationships, and a variety of stakeholders groups now demand a voice in wildlife management decisions. Although many different stakeholders will agree that high deer densities in suburban areas can pose significant human health and safety risks, it can be difficult to achieve consensus on an appropriate deer density for a local area, and acceptable methods for removing deer. Wildlife managers with traditional biology training may be poorly equipped to facilitate meetings and handle the competing demands of these different interest groups.

The specialized management required for suburban deer herds may be quite different from traditional programs. Although hunting will continue to be a valuable management tool for many herds, experimental methods to reduce deer fertility will continue to be tested and refined. Several recent surveys have indicated strong public support for non-lethal control of problem wildlife species. However, these high-technology approaches are very expensive, and it is unclear how many communities will be willing to pay the long-term costs for developing alternative deer management techniques. Many policy and regulatory hurdles also need to be resolved before fertility control methods will become widely available for deer managers.

In summary, suburban deer herds will continue to pose a tremendous challenge for wildlife managers. There is no quick-fix or simple solution that will resolve deer-human conflicts. Deer will utilize the habitat created by residential development, and exhibit sustained high reproductive output. Rapid population growth will continue as long as communities limit mortality factors (i.e., hunting and/or predation), and suitable forage is available. If people choose not to take action early in the process as problems start to develop, then communities often must remove many more deer at much greater expense at some point in the future.

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Appendix F.
2006 *Phragmites* Aerial Survey Report for Taskinas Creek Reserve

Introduction
The objective of this project was to conduct an aerial inventory to map all *Phragmites* patches at Taskinas Creek Reserve. Effective strategies for controlling *Phragmites* requires reliable information for locating and prioritizing control targets. Thus, it was evident that a need existed for a current data on *Phragmites* distribution and abundance in order to guide long term conservation planning and management actions. Previous experience by DCR-DNH staff with GPS ground mapping of *Phragmites* indicate that aerial surveys are the most efficient and accurate for mapping *Phragmites* over relatively large areas.

Methods
Aircraft. The aerial survey was conducted using a Schweitzer 300 CBi two-seat helicopter (Figure F-1). Small, stable in flight, and highly fuel-efficient, the Schweitzer allowed the pilot and one passenger (the observer) up to three hours of flight time between fueling stops. The cockpit provided an excellent view as most construction material is clear Plexiglas. Most flights were conducted with the door removed on the passenger side, further enhancing the view for the observer.

Figure F-1. Schweitzer 300 CBi helicopter used in the 2006 *Phragmites* aerial census at Taskinas Creek Reserve.

The survey flight for Taskinas Creek was conducted on July 12, 2006. A flight log was kept with the following information recorded:

Flight date	Fuel stops
Time in	Flight area
Time out	GPS files
Total flight time	Notes

GPS equipment. The observer carried and operated a handheld GPS receiver (Trimble GeoExplorer 3) for collecting position data. A data dictionary was developed to support the census goals and provide some flexibility to meet a variety of field conditions. The following GPS rover unit settings were used during all census flights:

PDOP mask	4.0	Minimum satellites	4
SNR mask	6.0	Recording interval	1 second
Elevation mask	15 degrees		

Identification of vegetation. *Phragmites* was easily identified from the air during the survey period (Figures F-2 and F-3). The following characteristic features of *Phragmites* contributed to a highly distinct search image: tall stature, bluish green leaves, leaf shape and arrangement on stem, purple-red inflorescence, and dense stand formation. Native *Phragmites* exhibits slightly greener color, less cover density, and sparser florescence. However, the native form is still distinguishable from *Spartina cynosauroides* and other tall native marsh species.

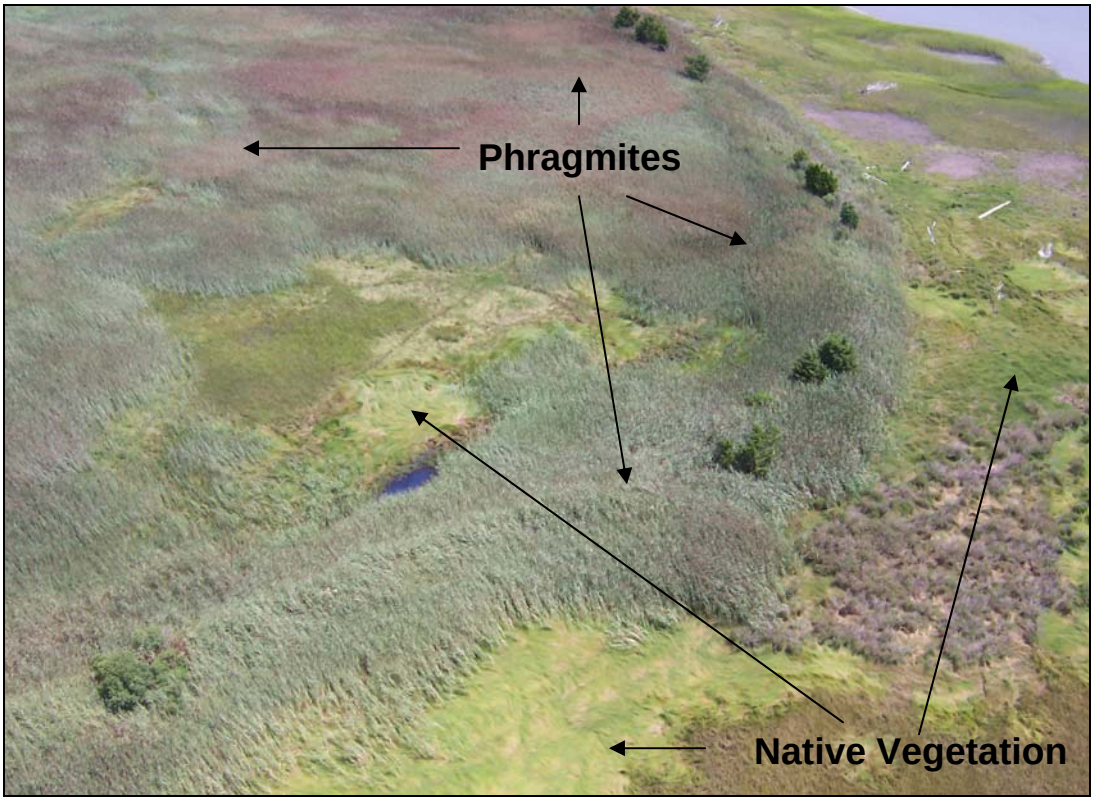

Figure F-2. *Phragmites* patch as viewed from helicopter. Color, stature, and dense growth habit identify this as the invasive non-native variety of *Phragmites*.

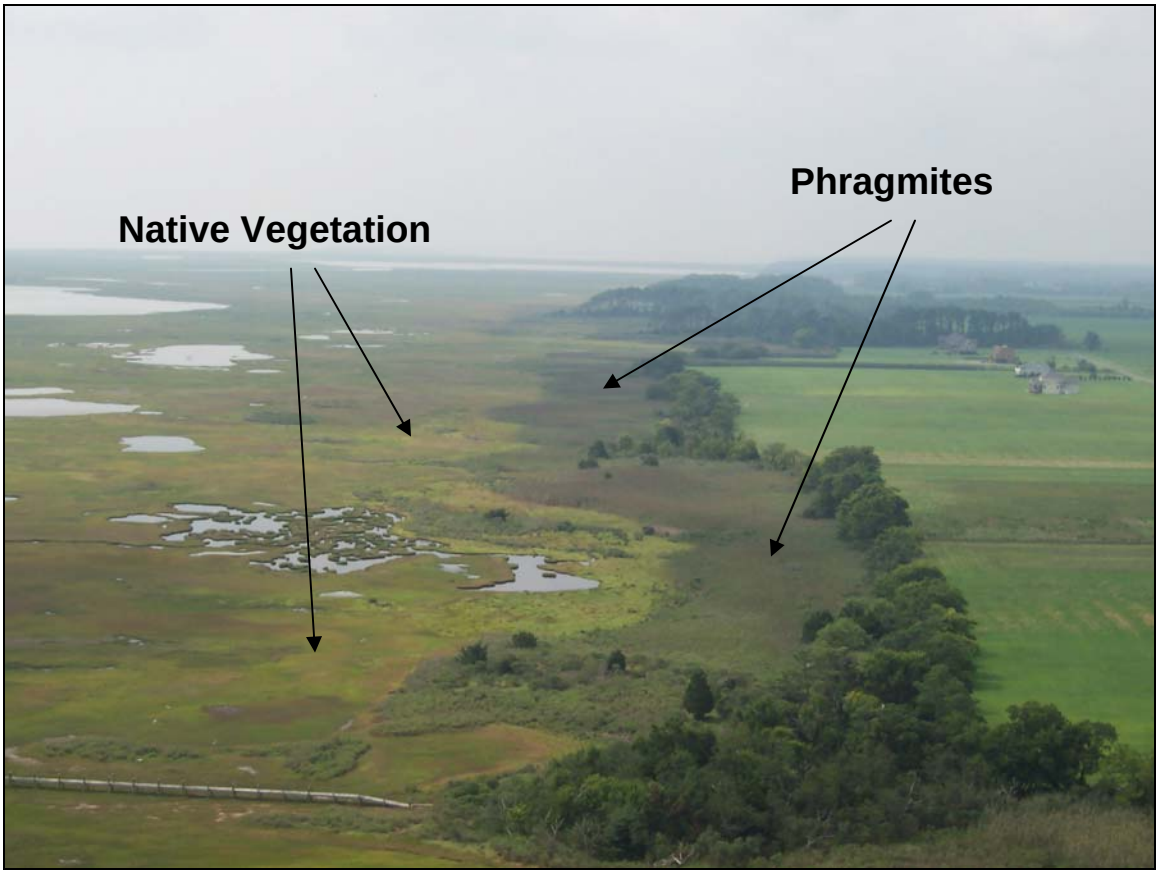

Figure F-3. Long linear patch of *Phragmites* bounded on the upland edge (to the right) by a treeline and by *Spartina patens* (to left) along the marsh edge. Photo was taken on the Eastern Shore of Virginia.

Large *Phragmites* patches were mapped as polygons. Point features were collected for patches of 0.125 acre or less and for patches greater than 0.125 to 0.25 acres in size, based on visual estimates.

All *Phragmites* patches were assigned a visual estimate of cover. Estimates were made by the observer from the helicopter while collecting GPS data on a given patch. Cover classes used were: < 25% cover, 26-50%, 51-75%, and 76-100%. Most patches occurring in open marsh had cover of 76-100% (Figure F-4).

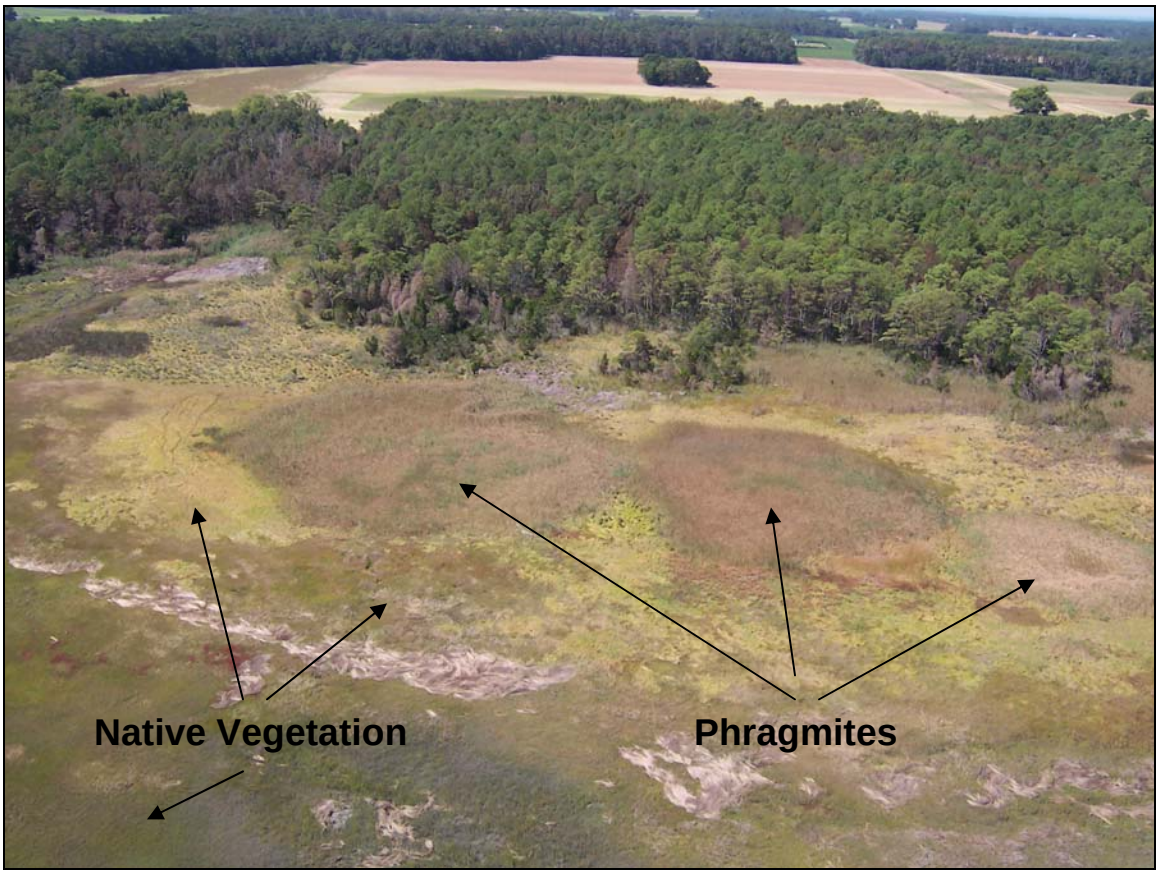

Figure F-4. Expanding *Phragmites* patches (cover class = 76-100%) still surrounded by native marsh vegetation. Photo was taken on the Eastern Shore of Virginia.

Summary of Procedures

Flight altitude during GPS collection varied from patch to patch and sometimes within a given patch, ranging from 15 feet to 80 feet above the surface. Altitude while searching for patches ranged from 50 feet to 200 feet above the surface. After the flight, GPS data files were downloaded and backed up as soon as possible. All GPS data was converted to ArcView shapefiles and projected over the Virginia Base Map data layer comprised of geo-referenced digital aerial photographs. For this report, USGS topographic layer was used to create the final map layout.

Summary of Findings

Fortunately, very little *Phragmites* occurs currently at Taskinas Creek Reserve or within York River State Park. Prior to 2005, numerous (6 – 7) small patches of *Phragmites* were located along Taskinas Creek within the Reserve. Herbicide treatments by DCR staff during summer/fall of 2005 resulted in apparent effective control of these areas, as aerial mapping during summer 2006 indicated the presence of just one small (0.125 ac) remaining patch.

Appendix G.
Federal and State Natural Resource Laws

LEGISLATION	CITATION	RESPONSIBLE AGENCY
Presidential Order on Introduction of Exotic Species	Executive Order # 11987	Office of the President
U.S. Noxious Weed Law	7 USC 2802-2814	U.S. Department of Agriculture (USDA)
U.S. Clean Water Act	33 USC 1344	U.S. Army Corps of Engineers (ACOE), U.S. Environmental Protection Agency (EPA)
U.S. Anadromous Fish Conservation Act	16 USC 757a-757g	National Marine Fisheries Service (NMFS)
U.S. Clean Air Act	42 USC 7401-7671q	EPA
National Environmental Policy Act	42 USC 4321-4307d	all Federal agencies
Lacey Act (exotics)	18 USC 42	U.S. Department of Interior (DOI)
U.S. Endangered Species Act	16 USC 1531-1544	U.S. Fish & Wildlife Service (FWS), NMFS
U.S. Fish & Wildlife Coordination Act	16 USC 661-668s	many
U.S. Migratory Bird Treaty Act	16 USC 701-712	FWS
U.S. Aquatic Nuisance Prevention & Control Act	16 USC 4701-4751	FWS, NMFS
VA Commercial Fishing Law / Recreational Fishing Law	VA Code 28.2-100 – 1001	VA Marine Resources Comm. (VMRC)
VA Wetlands Act	VA Code 28.2-1300 – 1320	VMRC
VA Historic Resources Law	VA Code 10.1-2200 – 2216	VA Department of Historic Resources (VDHR)
VA Antiquities Act	VA C ode 10.1-2300 – 2306	VDHR
VA Endangered Species Act	VA Code 29.1-563 – 570	VA Department of Game & Inland Fisheries (VDGIF)
VA Fish & Wildlife Law	VA Code 29.1-100 et seq.	VDGIF
VA Endangered Plant & Insect Species Act	VA Code 3.1-1020 – 1030	VA Department of Agriculture and Consumer Services (VDACS)
VA Noxious Weed Law	VA Code 3.1-296.11 - 296.21	VDACS

Federal and State Natural Resource Laws (continued)

LEGISLATION	CITATION	RESPONSIBLE AGENCY
VA Chesapeake Bay Preservation Act	VA Code 10.1-2100 - 2115	Chesapeake Bay Local Assistance Dept. (CBLAD)
VA Water Quality Improvement Act of 1997	VA Code 10.1-2118 – 2128.B.	VDCR
VA Water Control Law	VA Code 62.1-44.2 - 44.34	VA Department of Environmental Quality (VDEQ)
VA Ground-water Management Act	VA Code 62.1-44.84 - 44.104	VDEQ
VA Environmental Quality Act	VA Code 10.1-1200 - 1221	VDEQ
VA Waste Management Act	VA Code 10.1-1400 - 1457	VDEQ
VA Open Space Land Act	VA Code 10.1-1700 - 1705	VA Outdoors Foundation (VOF)
VA Erosion & Sediment Act	VA Code 10.1-560 - 571	VDCR
VA Natural Area Preserves Act	VA Code 10.1-202 - 217	VDCR
VA Conservation Easement Act	VA Code 10.1-1009 - 1016	VDCR

Appendix H.
Glossary Of Technical Terms And Abbreviations

ac – acre(s).

acidic – having a pH value < 7.0, often indicating moderate or low fertility.

alluvial – of or pertaining to deposition of sediment by a stream.

alluvium – unconsolidated sand, silt, clay, or gravel deposited by running water.

asl – above sea level

aspect – the direction a slope faces (e.g., a north aspect).

basal area – the cross-sectional area of a tree at breast height; extrapolated to a larger area, basal area is an estimated measure of how much of a site is occupied by trees.

basic – as applied to soils, having high levels of base cation (e.g., calcium and magnesium) saturation, typically indicating high fertility; as applied to rocks, having high concentrations of iron, magnesium, and calcium.

biological resource management – those components of natural areas stewardship pertaining to or impinging on vegetation, natural communities, or habitat for rare species. Examples of biological resource management include invasive species control, habitat restoration, and monitoring of species population status.

biomass – the total weight of all living organisms in a biological community; in vegetation science, usually the total weight of all above-ground plant parts.

bryophyte – a non-vascular green plant; includes mosses, hornworts, and liverworts

colluvial – of or pertaining to colluvium.

colluvium – unconsolidated earth materials deposited on steep slopes by direct gravitational action and local unconcentrated run-off.

community – as applied to plants, any unit of vegetation regardless of rank or development; an aggregation of plants on the landscape; in broader terms, any assemblage of organisms that co-occur and interact.

cover – the percentage of the ground covered by the vertical projection of above-ground plant parts.

DCR – Virginia Department of Conservation and Recreation.

dbh – diameter at breast height (4.6 ft above the ground); the standard position at which woody stems are measured in forestry procedures.

dedication – dedication of a natural area is the strongest form of protection that can be afforded a natural area in Virginia and involves recording a legally binding Deed of Dedication with the property deed. The Deed of Dedication states the preservation purpose of the property, designates the property as Open-Space Land, restricts land uses which are incompatible, and formally places the site in Virginia's Natural Area Preserve System. Dedication is perpetual, and although ownership of the property can be transferred, the dedication will remain in effect.

density – the number of plants per unit area; used more specifically in this study as a measure of the number of woody stems ≥ 1in in diameter at breast height per hectare.

DGIF – Virginia Department of Game & Inland Fisheries.

dip slope – a side slope determined by and approximately aligned with the angle of the underlying bedrock plane.

DNH –Virginia Department of Conservation & Recreation, Division of Natural Heritage.

DOF – Virginia Department of Forestry.

dominant – of or pertaining to an organism or taxon that by its size, abundance, or coverage exerts considerable influence on a community's biotic and abiotic conditions.

dry-mesic – intermediate between dry and moist but well drained; submesic to subxeric.

duff – the matted, partly decomposed organic surface layer of forest soils.

EO – element occurrence. A site that supports a population of a rare plant or animal or an exemplary stand of an ecological community. EOs are sites tracked in the natural heritage database by the Division of Natural Heritage.

EO rank – the viability of a particular EO, graded from A to D.

ecological community - an assemblage of co-existing, interacting species, considered together with the physical environment and associated ecological processes, that usually recurs on the landscape.

ecological community group – a level in the hierarchical ecological community classification used by DNH (Fleming et al. 2001). An ecological community group consists of ecological communities with similar topographic, edaphic, physiognomic, and gross floristic traits. This level is comparable to the level at which many natural community classifications define their basic units, *e.g.*, Basic Oak-Hickory Forests. Ecological community groups are not defined at a single, standard scale. Because community groups differ in their extent on the landscape, some are very broadly defined and have large geographic coverage (*e.g.*, Chestnut Oak Forests), while

others are very narrow in concept and distribution (*e.g.*, Granitic Flatrocks). Ecological community types are nested within an ecological community group.

ecological community type – an abstract unit of vegetation representing concrete plant communities sharing a similar structure and floristic composition, and occurring under similar environmental conditions; more or less equivalent to the "association" used in traditional vegetation studies and the U.S. National Vegetation Classification. Ecological community types are the next finest level in the community classification hierarchy after ecological community groups.

ecotone – a transitional area where characteristics of adjacent communities or environments intermingle or intergrade.

ecosystem – a complete interacting system of organisms and their environment, applicable at any spatial scale.

edaphic – of or pertaining to the influence of soils on living organisms, particularly plants.

endemic – geographically restricted; a species or taxonomic group restricted to a particular geographic region.

environmental gradient - a spatially varying aspect of the environment (*e.g.*, elevation, slope position, soil pH) that is expected to be related to species composition.

ericaceous – of the Heath Family (*Ericaceae*).

ericad – a plant of the Heath Family (*Ericaceae*); for example, blueberries (*Vaccinium* spp.), rhododendrons (*Rhododendron* spp.), and mountain-laurel (*Kalmia latifolia*).

exotic – an introduced, non-native species.

fire management – all activities associated with the management of fire-prone land, including the use of fire to meet land management goals and objectives - a unique and distinct component of natural areas stewardship combining elements of both biological and operations management. Fire management activities include both prescribed fire implementation and wildfire management.

fire management plan – statement, for a specific area, of fire policy, objectives, and prescribed action.

flora – all the vascular plants that make up the vegetation of a specified area.

floristic – of or pertaining to the flora of an area and the geographic patterns of distribution represented by its taxa.

floristics – the study of a flora and the geographic distributions of its taxa.

floodplain – a nearly level alluvial plain that borders a stream and is subject to inundation (non-tidal) under flood-stage conditions.

foliose lichen - a lichen typically lying flush to its substrate, but removable such that the lower surface is visible; foliose lichens are often attached to rocks and other substrates by numerous fine structures called rhizines.

forb – a broad-leaved herbaceous plant.

forest – an ecosystem dominated by trees (≥ 20ft tall) producing a more or less closed canopy, typically with 60-100% cover; some forests may temporarily have < 60% canopy cover following disturbances such as windthrow, disease, etc.

fruticose lichen – a lichen that grows erect or pendent, with thalli that have no clearly distinguishable upper and lower surfaces; includes species that are branched and shrubby, as well as those that form unbranched stalks.

ft – foot (feet).

geomorphic – of or pertaining to processes that change the form of the earth (e.g., volcanic activity, running waters, glaciers).

graminoid – grasses and grass-like plants (e.g., sedges and rushes).

groundwater – water occurring below the earth's surface in bedrock and soil.

heath - a plant of the Heath Family (*Ericaceae*); an Ericad; for example, blueberries (*Vaccinium* spp.), rhododendrons (*Rhododendron* spp.), and mountain-laurel (*Kalmia latifolia*).

herb – a vascular plant lacking woody tissue at or above ground level.

herbivory – the consumption of plants by animals.

hibernacula – over-wintering den sites used by animals such as bats, snakes, and insects.

humus – decomposed organic matter that has lost all trace of the structure and composition of the vegetable or animal matter from which it was derived.

hydric –wet and poorly drained.

hydrology – the science that deals with the circulation, distribution, movement, and chemistry of the waters of the earth.

in – inch(es).

invasive species – any species of plant, animal, or other organism (e.g. microbes) that is both non-native (exotic) to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm or harm to human health.

integrated pest management – is the maintenance of destructive agents, including insects, at tolerable levels by the planned use of a variety of preventative, suppressive, or regulatory tactics and strategies that are ecologically and economically efficient and socially acceptable. The methods used in pest management must be ecologically based, involve a combination of tactics from insecticides to "doing nothing" appropriate to the situation and the biota and be a part of an overall management plan for the ecosystem being considered.

interstice – an intervening space or crevice.

interstitial – of or pertaining to interstices.

Jurassic – the second period of the Mesozoic era (following the Triassic), from approximately 190 to 135 million years ago.

liana – a woody vine.

lichen – a symbiotic association between a fungus and one or more species of algae and/or blue-green algae; although not based on genetic relationships, lichen species, for the aid of identification, are divided into foliose, fruticose, crustose, and umbilicate groups based on their growth strategies.

lithologic – of or pertaining to the physical characteristics of a rock.

lithology – the description of rocks on the basis of physical characteristics such as color, mineralogical composition, and grain size.

liverwort - a nonvascular, chlorophyll-containing plant closely related to mosses and hornworts, but differing in reproductive structures; liverworts have two dominant growth forms, one which resembles moss with overlapping leaves, the other forming prostrate leafless bodies.

m – meter(s).

macroinvertebrate – an animal lacking a backbone (invertebrate) and visible without the aid of magnification.

mafic – geologically, containing large amounts of dark-colored silicate minerals rich in magnesium and iron, e.g., pyroxene, amphibole, and biotite mica; examples include igneous and metamorphic rocks such as amphibolite, basalt, diabase, gabbro, and greenstone; also applied to soils with high levels of magnesium and iron that are derived from these formations.

mesic – of intermediate moisture conditions (i.e., moist and well-drained).

mesophyte – a plant characteristic of mesic environments.

mesophytic – of or pertaining to plants or vegetation adapted to environments of moist, well-drained sites.

Mesozoic – an Era of geologic time, from the end of the Paleozoic to the beginning of the Cenozoic, or about 225 to 65 million years ago; includes the Triassic, Jurassic, and Cretaceous periods.

metabasalt – metamorphosed basalt, a fine-grained igneous rock composed largely of plagioclase feldspar, pyroxene, and volcanic glass.

metamorphic – altered in mineral composition, chemical composition, and structure by heat, pressure, and hot fluids at some depth below the earth's surface; applied to rocks of igneous and sedimentary origin.

metasedimentary – consisting of sedimentary rock that shows evidence of having been subject to metamorphism; examples include quartzite (= metasandstone) and metasiltstone.

mi – mile(s).

microclimate – the local climate of a small site; this may vary from the climate of the larger, surrounding area due to aspect, tree cover, elevation, wind exposure, and other local factors.

microhabitat – within a habitat, a subdivision or precise location that has distinctive environmental characteristics; e.g., a tree-base hummock in a flooded swamp.

microtopography – the fine-scale variation in topography within a habitat; e.g., the pattern of vertical rock faces, shelves, and crevices on a cliff.

monospecific – consisting wholly or largely of a single species.

moss - a nonvascular chlorophyll-containing plant closely related to liverworts and hornworts, but differing in reproductive structures.

muscovite – a mineral of the mica group that is common in gneisses and schists; also known as "white mica."

natural community - those ecological communities which have experienced only minimal human alteration or have recovered from anthropogenic disturbance under mostly natural regimes of species interaction and disturbance. No portion of Virginia's landscape, however, has altogether escaped modern human impacts – direct or indirect – and only a few small, isolated habitats support communities essentially unchanged from their condition before European settlement.

natural heritage resources – as defined in the Virginia Natural Area Preserves Act these are "…the habitat of rare, threatened, or endangered plant and animal species, rare or state significant natural communities or geologic sites, and similar features of scientific interest." (Code of Virginia, section 10.1-209, et seq.).

non-vascular – lacking a structural system of tissue (xylem and phloem) that conducts water and soluble nutrients; non-vascular plants include mosses, lichens, and liverworts.

oligotrophic – infertile; nutrient-poor.

operations management – those components of natural areas stewardship pertaining to or impinging on non-biological features of natural area preserves. Examples of operations management activities include public access facilities development and maintenance, boundary line marking, sign installation, law and regulation enforcement, and ensuring visitor safety.

overstory – the uppermost layer of trees forming the canopy of a forest or woodland.

Paleozoic – the era of geologic time from 600 to 230 million years ago.

patch-dominant – a species that exerts dominance by forming dense but spatially discrete colonies; such a species typically varies from abundant to completely absent within a given habitat.

pathogen – an organism that causes disease in another organism.

pH – a value on the scale 0 to 14 that gives a measure of the acidity or alkalinity of a medium.

physiognomic – of or pertaining to vegetative form and structure.

physiognomy – the form and structure of vegetation.

phytogeography – the study of the geographic distribution of plants and vegetation , with an emphasis on environmental determinants of distribution.

Pleistocene – the first Epoch of the Quaternary Period of geologic time, from approximately two million to ten thousand years ago.

prescribed burn plan – a written statement defining the objectives to be attained as well as the conditions of temperature, humidity, wind direction and speed, fuel moisture, and soil moisture, under which a fire will be allowed to burn. A prescription is generally expressed as acceptable ranges of the prescription elements, and the limit of the geographic area to be covered.

prescribed fire – a management ignited wildland fire that burns under specified conditions where the fire is confined to a predetermined area and produces the fire behavior and fire characteristics required to attain planned fire treatment and resource management objectives.

pyrophytic – of or pertaining to plants or vegetation adapted to environments in which fire is an important ecological process.

quartzite –metamorphosed sandstone.

rare species – species believed to be sufficiently rare or threatened in Virginia to merit an inventory of their status and locations by DNH.

recruitment – generally, the trees involved in natural supplementation of a forest stand; more specifically, trees that have entered a particular category (age or size class) during a given period.

refugia – sites where plants or vegetation that formerly had much wider distributions have survived locally through periods of unfavorable conditions in a region.

regolith – all unconsolidated earth materials above solid bedrock.

rhizomatous – having a horizontal, creeping, perennial rootstock that produces smaller roots and vegetative shoots.

riparian – of the area beside a stream, especially a river.

rill – a small streamlet or rivulet.

ruderal vegetation – vegetation resulting from succession following anthropogenic disturbance of an area; generally characterized by unnatural combinations of species (primarily native though including small to substantial numbers of exotics) and relatively short persistence in the absence of additional disturbance.

sandstone – a medium-grained sedimentary rock composed of rounded sand grains cemented together by silica, iron oxide, or calcium carbonate.

saturated – wet for extended periods during the growing season, but never or rarely flooded by surface water; usually applied to wetlands maintained by seepage inputs or perched water tables.

schist – a metamorphic rock containing abundant, visible platy minerals (*e.g*., mica), giving it a pronounced foliation and cleavage.

sedimentary – formed from the deposition and compression of mineral and rock particles, and sometimes material of organic origin; examples of sedimentary rocks include sandstone, shale, and limestone.

seep – a small area of groundwater discharge, either non-forested or shaded by trees rooted in adjacent, upland habitats; seeps generally support characteristic herbaceous wetland species but are too small or narrow to support hydrophytic woody vegetation.

seepage swamp – a large area of groundwater discharge supporting wetland forest or shrubland vegetation.

seral – of or pertaining to an intermediate or transitional stage in plant succession.

serotinous cone – the cone of a pine that remains closed for a period of time, sometimes years, following maturation; the opening of such cones are often triggered by the heat of fires; a reproductive adaptation that ensures seed dispersal under optimal conditions.

site operations – in the context of natural areas management, those activities that deal with boundaries, facilities, access, signage, public safety, and other human use issues.

smoke management – application of fire intensities and meteorological processes to minimize degradation of air quality during prescribed fires.

snag – a standing dead tree.

sp. – a species.

spp. - species (plural).

spring ephemeral – a plant that completes its reproductive cycle early in the growing season, typically before or during the period in which trees leaf out; such species usually die back and become dormant during unfavorable summer months when habitats are characterized by high temperatures and deep shade.

ssp. – subspecies, a taxonomic rank below species.

stewardship – in the context of natural areas management, the combination of three primary components – biological resource management, site operations, and fire management – with the objective of perpetuating occurrences of natural heritage resources and preserving inherent biological diversity.

stratigraphy – the arrangement of bedrock strata, particularly their geographic position and chronological order of sequence.

stratum – a distinct vertical layer of vegetation defined by relative height (e.g., overstory, understory) and/or by a specific range of heights.

sub-canopy – the understory tree layer immediately below the overstory.

submesic – somewhat moist but well drained, or intermediate between dry and moist; dry-mesic.

subxeric – somewhat dry and drought-prone; intermediate between submesic and xeric.

succession – natural change in the composition and structure of a plant community over time in the absence of disturbance.

successional – of or pertaining to the process of succession.

surface substrate – a collective term for the abiotic materials (e.g., leaf litter, rocks, dead wood) that constitute the ground cover of a site.

terrestrial – of or pertaining to upland (non-wetland) environments.

Triassic – the earliest period of the Mesozoic Era, from approximately 225 million to 190 million years ago.

umbilicate lichen - a leaf-like lichen attached to rocks by a single cord; umbilicate lichens, especially those of the genus *Umbilicaria*, are often referred to as "rock tripes."

understory – collective term for the small trees and shrubs growing beneath the canopy in a forest or woodland.

var. – variety, a taxonomic rank below species.

vascular – having a structural system of tissue (xylem and phloem) that conducts water and soluble nutrients; vascular plants include ferns and flowering plants.

vegetation – the plant life of an area, including its floristic composition, structure, biomass, and phenology.

watch-list species – species of uncommon or uncertain status in Virginia. More information is needed on these species, which may or may not be of high conservation concern at this time; these species are monitored for general population trends.

woodland – vegetation dominated by trees (≥ 20 ft tall) producing an open canopy, typically with 5-60% cover; such vegetation with canopy cover from 5 to 25% is referred to as a sparse woodland; some woodlands may have > 60% canopy cover following elimination or reduction of natural disturbances (e.g., fire).