A NATURAL HERITAGE INVENTORY OF FOURTEEN HEADWATER SITES IN THE DRAGON RUN WATERSHED

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INTRODUCTION AND SUMMARY OF FINDINGS

INTRODUCTION

In February 2003, the Middle Peninsula Planning District Commission (MPPDC) contracted the Virginia Department of Conservation and Recreation's Division of Natural Heritage (DCR-DNH) to inventory 14 predetermined sites in the upper reaches of the Dragon Run watershed and describe the vegetation, natural features, and any rare species encountered.

DCR-DNH is the state agency responsible by statutory authority under the Virginia Natural Area Preserves Act (§10.1-209 through 217, *Code of Virginia*) for inventory, database maintenance, protection, and management of Virginia's natural heritage resources. Such resources are defined as the habitats of rare, threatened, or endangered plant and animal species, rare or state significant communities, and other natural features. The Division represents the first comprehensive attempt to identify the Commonwealth's most significant natural areas through ongoing scientific biological survey.

Rare species surveyed for at the 14 sites include:

1. Species federally listed by the US Fish and Wildlife Service in the categories of Endangered or Threatened, Proposed Threatened or Endangered, and Candidate;

2. Species state listed by Virginia in the categories of Endangered, Threatened, Special Concern, and Candidate; and

3. Natural Heritage Program species with global rankings of G1, G2, G3, T1, T2, or T3 and state rankings of S1, S2, SH, or SX (See Appendix B for an explanation of these ranks.).

All biological information gathered in this inventory has been incorporated into DCR-DNH's Biotics data management system (Biotics). Biotics is a sophisticated data system in which information on ecosystems and species, their biology, habitats, locations, conservation status, and management needs is maintained and updated. DCR-DNH, as part of an international network of Natural Heritage Programs coordinated by NatureServe, uses standardized inventory methodologies and database management technologies such as Biotics.

Fieldwork for this project was conducted by DCR-DNH field botanist Allen Belden Jr., field zoologist Anne C. Chazal, and natural areas zoologist Christopher S. Hobson on May 1, June 10-11, and September 9-10, 2003.

SUMMARY OF FINDINGS

The following section of this report provides a description of the vegetation and natural features for each of the 14 sites. The location of each site is specified, and any natural heritage resources located are listed. Wetland vegetation at each site is classified according to **The Natural Communities of Virginia: Classification of Ecological Community Groups** (Fleming et al. 2001). A copy of this publication is attached as Appendix C.

Zoological findings were not intended to represent a comprehensive list of fauna at each site. In fact, it should be noted that observations were made at each site for only a short period of time (2-3 hours) on one day. Time of year, time of day, weather, and other factors all play a role in which animals were observed. Further surveys would, undoubtedly, increase the species diversity for each taxonomic group. What is listed at each site reflects only the more interesting observations for that site.

Scientific names are used throughout the site reports. Each scientific name used is cross-referenced to a common name in Appendix A. Plant scientific and common names follow Kartesz 1999. Animal scientific names follow a variety of sources depending upon the taxa. Each source is listed in Appendix A.

Photographs of each of the 14 sides are being provided in digital format to accompany this report.

One rare plant species occurrence was located during this inventory. A small population of *Carex decomposita* (cypress-knee sedge) was located just northwest of where Route 614 crosses Holmes Swamp (a creek) at Site 5. This is the first time this globally-rare plant has been reported from the Middle Peninsula. Brief conservation recommendations for this occurrence are included in the Site 5 description. A digital map (Figure 1) showing the location of the population follows this site report.

Two rare animal species were located during this inventory. A single male *Somatochlora filosa* (Fine-lined Emerald) was captured along Route 607 at site 6. This state-rare dragonfly inhabits sheet flow swamp thickets and boggy, forested seeps and streams. A single male *Epitheca spinosa* (Robust Baskettail) was collected from site 12 near Route 612. An additional individual was observed in the same area. This dragonfly is considered state rare and inhabits slow-moving streams and bottomlands. Figures 2 and 3 show the locations of *Somatochlora filosa* and *Epitheca spinosa*, respectively, and brief conservation recommendations for these occurrences are included in the site reports.

SITE DESCRIPTIONS

SITE 1

Location: About 0.4 kilometers northwest of Daisy where Route 607 crosses Exol Swamp, King and Queen County.

Natural Heritage Resources Located: None.

Description: This site encompasses palustrine wetlands located along Exol Swamp north of Route 607 and classified as a **Coastal Plain Semipermanent Impoundment**. An open water pond is found here created by the road embankment and beaver activity. This grades into an emergent wetland to the north and east and a shrub-scrub wetland to the west. The emergent zone is dominated by *Scirpus cyperinus* and also supports *Polygonum punctatum, Juncus effusus, Sparganium americanum, Nymphaea odorata,* and *Nuphar lutea* ssp. *advena*. The carnivorous herb *Utricularia gibba* is also found here. The shrub-scrub wetland supports *Cephalanthus occidentalis, Itea virginica, Salix nigra,* and *Acer rubrum*. Fringing these open wetlands is a forested zone with *Acer rubrum, Quercus phellos, Liquidambar styraciflua, Nyssa biflora, Clethra alnifolia, Gaylussacia frondosa,* and *Vaccinium fuscatum*.

South of Route 607 is a forested wetland classified as a **Coastal Plain/Piedmont Bottomland Forest.** Canopy trees found here include *Nyssa biflora, Liquidambar styraciflua,* and *Acer rubrum*. Shrubs and smaller trees include *Clethra alnifolia, Magnolia virginiana, Vaccinium corymbosum, Carpinus caroliniana, Ilex opaca,* and *Chionanthus virginicus*. The sparse herb layer here includes *Woodwardia areolata* and *Osmunda cinnamomea*.

Uplands in this area are plantation *Pinus taeda*, agricultural fields, or young mixed forest.

The zoological surveys at this site revealed an odonate fauna typical of artificial Coastal Plain wetland habitats, including *Pachydiplax longipennis, Anax junius, Lestes disjunctus australis,* and *Sympetrum vicinum*. Birds heard in the vicinity were common species, including *Picoides pubescens, Poecile carolinensis,* and *Thryothorus ludovicianus*.

SITE 2

Location: Dragon Run just west of an unnamed logging road that crosses the Run about 2.4 kilometers southwest of Center Cross, King and Queen and Essex counties.

Natural Heritage Resources Located: None.

Description: This site supports extensive palustrine wetlands located along Dragon Run and classified as a **Coastal Plain Semipermanent Impoundment**. Wetlands here are primarily of the shrub-scrub type, with smaller areas of emergent wetlands along several open water channels. Small areas of forested wetlands are found in a narrow strip along the southern edge of the system and as small "islands" within the shrub-scrub type. Beaver dams, road embankments, and possibly other human activities appear responsible for the impounded nature of the wetlands found here.

The vast shrub-scrub wetlands found here support *Acer rubrum, Cephalanthus occidentalis, Rosa palustris, Salix nigra, Alnus serrulata, Cornus amomum, Viburnum recognitum,* and *Betula nigra*. Herbs include *Carex alata, Carex lurida, Carex comosa, Juncus effusus, Dulichium arundinaceum,* and *Asclepias incarnata*. Emergent wetlands along open channels support *Nuphar lutea* ssp. *advena, Sparganium americanum, Peltandra virginica, Pontederia cordata,* and *Leersia oryzoides*. In forested areas, *Acer rubrum, Quercus phellos, Liquidambar styraciflua, Fraxinus pennsylvanica, Quercus nigra, Ulmus rubra, Carex crinita, Carex lupulina, Sphenopholis pensylvanica,* and *Torreyochloa pallida* are found.

Uplands in the area are mostly agricultural fields or are forested in plantation *Pinus taeda*.

Two individuals of *Nerodia sipedon* were observed here, along with one of *Chrysemys picta*. In addition, *Hyla cinerea* and *Rana clamitans* were heard calling.

SITE 3

Location: 1.6 kilometers northwest of Ino along an unnamed tributary of Dragon Run, King and Queen and County.

Natural Heritage Resources Located: None.

Description: This site supports palustrine wetlands located along a small, unnamed tributary of Dragon Run and classified as a **Coastal Plain Semipermanent Impoundment**. Wetlands here are mostly a mosaic of a shrub-scrub and an herbaceous type. It appears that this area was once an open-water pool behind a beaver dam that has now been breached and abandoned, allowing for succession to herbaceous and, now, woody species. A narrow strip of forested wetland occurs along the southern bank of the stream.

Shrub-scrub areas here are dominated by *Alnus serrulata* and also support *Acer rubrum*, *Clethra alnifolia*, *Viburnum recognitum*, *Ilex verticillata*, *Cornus amomum*, *Itea virginica*, and *Sambucus nigra* ssp. *canadensis*. Grassy, herb-dominated openings between shrub thickets are dominated by *Leersia oryzoides*. *Polygonum arifolium*, *Polygonum sagittatum*, *Impatiens capensis*, *Boehmeria cylindrica*, *Scirpus cyperinus*, *Eupatorium perfoliatum*, *Sagittaria latifolia*, and *Cyperus strigosus* are prevalent as well. *Murdannia keisak*, a non-native invasive herb, is also quite common.

The narrow strip of forested wetlands supports *Platanus occidentalis*, *Acer rubrum*, *Clethra alnifolia*, *Morella cerifera*, *Cornus amomum*, *Carpinus caroliniana*, *Leucothoe racemosa*, *Saururus cernuus*, *Liquidambar styraciflua*, and *Thelypteris noveboracensis*.

Uplands in this area are mostly plantation *Pinus taeda*.

Evidence of feral hogs was seen in the wetlands at this site, along with a number of common native animal species including, *Ancyloxypha numitor*, *Papilio glaucus*, *Eurytides marcellus*, *Corvus brachyrhynchos*, *Poecile carolinensis*, and *Zonotrichia albicollis*.

SITE 4

Location: Holmes Swamp about 1.7 kilometers west southwest of where the creek crosses Route 614. An overgrown logging road comes down to (but does not cross) Holmes Swamp at the site location.

Natural Heritage Resources Located: None.

Description: This site supports extensive palustrine wetlands located along Holmes Swamp (a creek) and classified as a **Coastal Plain Semipermanent Impoundment**. An impressive beaver dam has been here for quite some time; the dam supports a dense growth of well-established shrubs. Behind this dam is a large open-water pool with a smattering of *Nuphar lutea* ssp. *advena.* The pool is fringed with emergent vegetation, mainly *Juncus effusus*.

Below (east) of the dam is a dense shrub-scrub wetland. Woody succession is advancing here as the downstream beaver dam that created this opening is apparently no longer active. Plants found here include *Alnus serrulata, Acer rubrum, Clethra alnifolia, Vaccinium corymbosum, Viburnum nudum, Viburnum recognitum, Itea virginica, Leucothoe racemosa, Cephalanthus occidentalis,* and *Itea virginica*. Small herbaceous openings within the shrub thickets here support *Leersia oryzoides, Sparganium americanum, Hydrocotyle ranunculoides, Carex alata,* and *Dulichium arundinaceum*.

An unnamed tributary steam enters Holmes Swamp from the south in the vicinity of the active beaver dam. A small open shrub-scrub wetland occurs at the mouth of this stream dominated by *Alnus serrulata*. Upstream of this is a small example of a forested wetland classified as a **Coastal Plain/Piedmont Acidic Seepage Swamp**. *Acer rubrum* dominates the canopy here, and *Nyssa biflora* is also found. Small woody species include *Clethra alnifolia, Magnolia virginiana, Vaccinium corymbosum, Itea virginica,* and *Viburnum nudum*. Herbs include *Carex crinita, Orontium aquaticum, Woodwardia areolata, Thelypteris noveboracensis,* and *Medeola virginiana*.

The fairly steep upland slopes that abut the south side of Holmes Swamp in this area are cloaked in good-quality forest dominated by *Fagus grandifolia*. Plantation *Pinus taeda* grows above the slope.

This site had a very nice diversity of odonata with eleven species identified: *Erythemis simplicicollis, Enallagma signatum, Epiaeschna heros, Ischnura posita, Lestes disjunctus, Libellula cyanea, Pachydiplax longipennis, Perithemis tenera, Plathemis lydia, Tramea carolina,* and *Tramea lacerata.* Also noted at this site were turtle eggs that had been predated on by a raccoon (*Procyon lotor*).

SITE 5

Location: Holmes Swamp west of Route 614 and about 3.6 kilometers north northeast of Dragonville, King and Queen County.

Natural Heritage Resources Located: *Carex decomposita* (G3/S2; see Appendix B for an explanation of Natural Heritage ranks).

Description: This site supports extensive palustrine wetlands located near the mouth of Holmes Swamp (a creek) and classified as a **Coastal Plain Semipermanent Impoundment**. Formed by the road embankment and beaver activity, wetlands here are of the shrub-scrub type. Species found here include *Alnus serrulata, Acer rubrum, Cornus amomum, Viburnum recognitum, Rosa palustris, Lyonia ligustrina, Ilex verticillata, Fraxinus pennsylvanica, Salix nigra, Cephalanthus occidentalis, Peltandra virginica, Sparganium americanum, Leersia oryzoides, Cicuta maculata, Saururus cernuus, Carex alata, Nuphar lutea* ssp. *advena, Pontederia cordata, Carex comosa, Chelone glabra,* and *Dulichium arundinaceum*.

The steep slope leading down to Holmes Swamp on the south side supports a nice stand of *Fagus grandifolia* and *Quercus* species. The flatter uplands above this are cloaked in plantation *Pinus taeda*.

A small population of a globally-rare sedge, *Carex decomposita,* was found a short distance to the northwest of the Route 614 bridge within the shrub-scrub wetlands at this site (Figure 1). Eight to 10 clumps of the plant were seen here within a 0.05 acre area. The clumps were quite difficult to see due to high water levels and the fact that culms had already fruited and were beginning to shed their seed and senesce. It is possible that a larger population of the sedge occurs in the area.

In Virginia, 11 populations of *Carex decomposita* are known from seven counties (Fairfax, Isle of Wight, James City, Loudoun, Southampton, Surry, and Sussex) and two cities (Chesapeake and Virginia Beach). Most of these populations are historical; previous to this find, the species had only been seen at three stations in Virginia in the past 30 years. This new station represents the first time the species has been found on the Middle Peninsula. (Virginia Department of Conservation and Recreation 2003).

Carex decomposita is a species of inundated wetlands, where it grows at or near surface water level from the bases of trees (often *Taxodium distichum*) and shrubs (often *Cephalanthus occidentalis*) or on hummocks, fallen logs, or stumps. It prefers wetlands with a stable hydrologic regime and is, apparently, unable to tolerate significant flooding or draw-down during its growing season (Ostlie 1990, Ludwig 1991). The major potential threat to this population appears to be hydrologic change resulting from human activity such as road construction or alteration or from beaver activity.

Monitoring of this *Carex decomposita* population on an annual basis would be beneficial to determine demographic and health trends over time and to assess for any impending

threats. It is also quite possible that this species occurs elsewhere in the Dragon Run watershed. Thus, additional survey work for the species may be warranted.

Animal observations included four species of Odonata (*Calopteryx maculata, Argia apicalis, Libellula vibrans,* and *Ischnura posita*) and four species of Lepidoptera (*Vanessa virginiensis, Papilio glaucus, Papilio troilus,* and *Celastrina ladon*). Undoubtedly, further surveys would dramatically increase these numbers.

SITE 6

Location: North of where Route 607 crosses Dragon Run and about 0.8 kilometers northeast of Prince, King and Queen County.

Natural Heritage Resources Located: *Somatochlora filosa* (G5/S2, see Appendix B for explanation of Natural Heritage ranks)

Description: This site supports an extensive floodplain forest along Dragon Run and a small tributary stream that enters Dragon Run from the north. The community found here is classified as a **Coastal Plain/Piedmont Bottomland Forest.**

Dragon Run in this area is an entrenched stream only a few meters wide. The tributary stream is shallow and poorly defined, often dividing into two or more meandering braids. The tributary probably once supported a series of beaver ponds that have now filled in and succeeded to forest. These former ponds are now occupied by stands dominated by fairly young *Acer rubrum*. Older, larger trees are found in areas that were not strongly inundated by past beaver activity. Uplands to the east contain numerous seeps and springs that feed into the tributary.

Tree species in addition to *Acer rubrum* include *Liquidambar styraciflua, Quercus michauxii, Fraxinus pennsylvanica, Platanus occidentalis, Ulmus americana,* and *Quercus lyrata*. The shrub layer is generally sparse and includes *Alnus serrulata, Clethra alnifolia, Lindera benzoin, Carpinus caroliniana, Itea virginica,* and *Ilex opaca*. The herb layer is fairly dense and diverse. Species found here include *Saururus cernuus, Chelone glabra, Boehmeria cylindrica, Peltandra virginica, Impatiens capensis, Scutellaria lateriflora, Cinna arundinacea, Polygonum punctatum, Athyrium filix-femina, Thelypteris noveboracensis, Woodwardia areolata, Lobelia cardinalis, Eupatorium perfoliatum, Osmunda cinnamomea, Cicuta maculata,* and *Symphyotrichum lateriflorum. Murdannia keisak* is a problem exotic.

The wetlands at this site are nicely buffered with middling aged mixed forest with *Fagus grandifolia, Quercus rubra, Liriodendron tulipifera, Pinus taeda,* and *Oxydendrum arboreum.*

A single adult male *Somatochlora filosa* (Fine-lined Emerald) was captured along Route 607 about 0.8 km north northeast of Prince (Figure 2). The area of observation was a roadside clearing, where the specimen appeared to be foraging. Dunkle (2000) states that this species feeds in forest clearings, or sometimes in dense shade, from near the ground to treetops, perching on tree twigs.

In Virginia, *Somatochlora filosa* is known from fewer than 10 sites. There is little information available for the species from anywhere in its known range, which includes much of the southeastern U.S. and extends north to New Jersey. Dunkle (2000) states that breeding habitat is unknown, but probably consists of either boggy forest trickles or sheet flow swamp thickets. Although no direct evidence of breeding at Site 6 was

documented, habitats similar to Dunkle's description were found in the springs and seeps of upland and floodplain forests at this site. Similar habitats are also common elsewhere in the Dragon Run watershed.

Potential threats to this species include water pollution and erosion, habitat destruction, and alteration of natural hydrological regimes, including changes brought about by road construction or beaver activity. Further studies on the life history of this species are needed to better understand the threats and conservation issues it faces.

Other fauna observed at this site included common species such as *Melanerpes carolinus, Dryocopus pileatus, Phoebis sennae, Phyciodes tharos, Rana palustris, Kinosternon subrubrum, Sympetrum vicinum, Colias philodice,* and *Papilio glaucus.* A piebald white tailed deer (*Odocoileus virginianus*) was also observed here.

SITE 7

Location: Exol Swamp just west of Route 615 and about 2.6 kilometers south of Ino, King and Queen County.

Natural Heritage Resources Located: None.

Description: This site supports nice quality, older floodplain forest stands located along Exol Swamp, a creek with a clearly defined channel in this area. This community is classified as a **Coastal Plain/Piedmont Bottomland Forest.** *Quercus michauxii, Acer rubrum, Liquidambar styraciflua, Platanus occidentalis, Betula lenta,* and *Liriodendron tulipifera* are found in this rather well-drained example of the type. Smaller woody species include *Lindera benzoin, Carpinus caroliniana, Viburnum recognitum, Ilex opaca,* and *Cornus florida*. Herbs include *Galium aparine, Galium triflorum, Carex blanda, Polygonatum biflorum,* and *Athyrium filix-femina*. Woody vines are prevalent; they include *Smilax rotundifolia, Parthenocissus quinquefolia,* and also the non-native invasive, *Lonicera japonica,* which is well entrenched. This community is extensive on the south side of Exol Swamp in the vicinity of Route 615 and is found to a lesser extent on the north side of the creek.

Upland forest dominates the north bank of the creek. Small stands of older forest dominated by *Fagus grandifolia* and *Quercus alba* were found in a narrow band immediately adjacent to the creek and on a small island in the creek. A much younger mixed forest was found further upslope with *Fagus grandifolia, Liriodendron tulipifera, Quercus alba, Quercus rubra, Pinus taeda, Liquidambar styraciflua,* and *Carya alba*.

A very small example of a forested wetland community classified as a **Coastal Plain/Piedmont Acidic Seepage Swamp** was also found on the north side of Exol Swamp. Plants found here include *Magnolia virginiana, Viburnum nudum, Saururus cernuus, Carex tribuloides, Carex seorsa,* and *Glyceria striata*.

This bottomland forest had a nice diversity of songbirds. Observations included: *Baeolophus bicolor, Empidonax virescens, Oporornis formosus, Parula americana, Piranga olivacea, Seiurus noveboracensis, Setophaga ruticilla, Thryothorus ludovicianus, Turdus migratorius, Vireo griseus, Vireo olivaceus,* and *Wilsonia citrina.*

SITE 8

Location: About 3.4 kilometers east of Jamaica where Route 666 crosses an unnamed tributary of Dragon Run.

Natural Heritage Resources Located: None.

Description: This site supports a young forested wetland located to the south of Route 666 and classified as a **Coastal Plain/Piedmont Bottomland Forest.** *Acer rubrum* and *Fraxinus pennsylvanica* dominate the canopy here; *Nyssa biflora* and *Quercus michauxii* are also present. Smaller woody species include *Clethra alnifolia, Ilex verticillata, Itea virginica, Alnus serrulata,* and *Carpinus caroliniana*. The diverse herb layer includes *Cinna arundinacea*, *Boehmeria cylindrica*, *Onoclea sensibilis, Amphicarpaea bracteata, Chelone glabra, Athyrium filix-femina, Woodwardia areolata, Cicuta maculata, Saururus cernuus, Eupatorium fistulosum, Triadenum walteri, and Leersia virginica*. The invasive *Lonicera japonica* is also found here.

To the north of Route 666, beaver activity and the road embankment have created a wetland type classified as a **Coastal Plain Semipermanent Impoundment.** This wetland consists of open water adjacent to the road and, proceeding upstream, a small emergent wetland dominated by *Scirpus cyperinus,* a recently flooded stand of *Acer rubrum*, and an open scrub-shrub wetland with *Cephalanthus occidentalis, Salix nigra, Acer rubrum*, *Fraxinus pennsylvanica*, and *Leersia oryzoides*. Still further upstream is another beaver dam with an open-water pond behind it.

Uplands in this area are mostly plantation *Pinus taeda*.

Animal species observed at this site included *Aix sponsa*, *Poecile carolinensis, Castor canadensis, Rana clamitans,* and *Papilio glaucus*

SITE 9

Location: About 1.8 kilometers northwest of Contra where an unnamed logging road crosses Contrary Swamp, King and Queen County.

Natural Heritage Resources Located: None.

Description: This site supports a **Coastal Plain Semipermanent Impoundment** on the southeast side of a logging road that crosses Contrary Swamp. The impoundment appears to have been created by the road embankment and beaver activity.

The impoundment can be divided into several concentric zones: a large area of open water near the road; an emergent wetland strongly dominated by *Scirpus cyperinus*; a shrub-scrub wetland with *Acer rubrum, Cephalanthus occidentalis, Salix nigra, Rosa palustris* and *Ilex verticillata*; and a forested wetland with *Acer rubrum, Quercus phellos, Pinus taeda*, and *Nyssa biflora*. The presence of dead snags and shrubs indicates that water levels have increased in the recent past.

On the northwest side of the logging road is a small, well-drained forested wetland. This community is classified as a **Coastal Plain/Piedmont Bottomland Forest**. *Acer rubrum* dominates the canopy here, and *Liriodendron tulipifera* is also present. *Fraxinus pennsylvanica* is the subcanopy dominant. Shrubs include *Ilex verticillata, Lindera benzoin, Ilex opaca, Vaccinium corymbosum, Magnolia virginiana, Corylus americana*, and *Carpinus caroliniana*. Herbs include *Onoclea sensibilis, Arisaema triphyllum, Thelypteris palustris, Saururus cernuus, Osmunda regalis*, and *Collinsonia canadensis*. *Lonicera japonica* is an invasive species problem.

Nice hardwood stands are found on the gentle slope above Contrary Swamp to the southwest. *Quercus rubra* and *Liriodendron tulipifera* predominate on this slope to the northwest of the road. Some large specimens of *Quercus phellos, Platanus occidentalis*, and *Liriodendron tulipifera* are found on this slope to the southeast of the road. Uplands to the northeast of Contrary Swamp are forested in plantation *Pinus taeda*.

A pair of *Melanerpes erythrocephalus* was observed in the area, utilizing the dead trees and snags created by the flooding conditions. Other birds identified in the area are *Buteo jamaicensis, Dendroica pinus*, and *Hylocichla mustelina*.

SITE 10

Location: About 2.2 kilometers southeast of Upright where Dragon Run crosses an unnamed road extending south from Route 605, Essex and King and Queen counties.

Natural Heritage Resources Located: None.

Description: This site encompasses an extensive palustrine shrub-scrub wetland located along Dragon Run and classified as a **Coastal Plain Semipermanent Impoundment**. The impoundment is located on the west side of an unnamed road and appears to be maintained by the road embankment and beaver activity. *Acer rubrum, Cephalanthus occidentalis*, and *Peltandra virginica* dominate here. Other plants observed are *Rosa palustris, Salix nigra, Alnus serrulata, Toxicodendron radicans, Smilax rotundifolia, Nuphar lutea* ssp. *advena, Pontederia cordata, Gratiola virginiana, Polygonum hydropiperoides, Juncus effusus, Scirpus cyperinus, Glyceria obtusa*, and *Limnobium spongia*. This shrub-scrub wetland is fringed by a narrow band of swamp forest with *Acer rubrum, Pinus taeda, Quercus phellos, Quercus nigra, Liquidambar styraciflua, Saururus cernuus*, and *Smilax rotundifolia.*

Goundwater seepage at the toe of the slope to the north of the impoundment supports a modest amount of a community type classified as **Coastal Plain/Piedmont Acidic Seepage Swamp**. Plants found here include *Magnolia virginiana, Clethra alnifolia, Osmunda cinnamomea, Itea virginica,* and *Vaccinium formosum*. This area has been disturbed to some extend by an old road. Most of this slope is cloaked in a young mixed upland forest with *Liriodendron tulipifera, Quercus falcata, Quercus alba, Quercus rubra, Quercus nigra, Pinus taeda, Ilex opaca,* and *Prunus serotina.*

Animal diversity was generally low at this site for unknown reasons. Frog calls identified included *Acris crepitans, Hyla chrysoscelis, Rana catesbeiana,* and *Rana clamitans.*

SITE 11

Location: West side of Route 614 where it crosses an unnamed tributary of Dragon Run about 1.9 kilometers northeast of Dragonville, King and Queen County.

Natural Heritage Resources Located: None.

Description: This site encompasses a young swamp forest located at the head of a small, unnamed tributary of Dragon Run and classified as a **Coastal Plain/Piedmont Bottomland Forest.** The stream in this area consists of two small meandering channels each about a meter wide. Flooding in this area is seasonal or infrequent.

Acer rubrum is the dominant canopy species in this swamp, with *Nyssa biflora* also prevalent. *Clethra alnifolia* is the dominant shrub. Other woody species include *Fraxinus pennsylvanica, Liquidambar styraciflua, Sambucus nigra* ssp. *canadensis, Viburnum recognitum, Ilex verticillata, Ilex opaca, Vaccinium corymbosum,* and *Itea virginica*. Herbs include *Saururus cernuus, Juncus effusus, Woodwardia areolata, Onoclea sensibilis, Athyrium filix-femina, Boehmeria cylindrica, Carex intumescens, Arisaema triphyllum,* and *Glyceria striata*. *Lonicera japonica* is a problem invasive species here.

Two or three small seeps, where groundwater is discharged at surface level, feed into the main stream here. These areas support a somewhat different vegetation classified as **Coastal Plain/Piedmont Acidic Seepage Swamp.** *Magnolia virginiana, Viburnum nudum, Osmunda cinnamomea,* and *Carex seorsa,* are characteristic species in these areas. Uplands in the area are forested in plantation *Pinus taeda.*

The closed canopy and thick understory of this area provides good habitat for songbirds, including *Mniotilta varia, Parula americana, Seiurus aurocapillus, Vireo griseus, Vireo olivaceus,* and *Wilsonia citrina.* In addition, *Colinus virginianus* and *Picoides pubescens* were heard.

SITE 12

Location: About 2.4 kilometers north northeast of Cumnor where Route 612 crosses Exol Swamp, King and Queen County.

Natural Heritage Resources Located: *Epitheca spinosa* (G4/S2; see Appendix B for an explanation of Natural Heritage ranks).

Description: This site encompasses a ponded wetland located along Exol Swamp and classified as a **Coastal Plain Semipermanent Impoundment**. The impoundment is located along the west side of Route 612 and appears to be maintained by the road embankment and beaver activity. A very small emergent wetland dominated by *Nuphar lutea* ssp. *advena* is found at the eastern edge of the pond adjacent to the road. A large scrub-shrub wetland dominated by *Acer rubrum* and *Salix nigra* occupies the rest of the impoundment. Other plants found in this zone include *Alnus serrulata, Cephalanthus occidentalis, Rosa palustris, Quercus lyrata, Itea virginica, Cornus amomum, Polygonum hydropiperoides, Spirodela punctata, Sparganium americanum, Dulichium arundinaceum,* and *Callitriche heterophylla*.

A disturbed saturated swamp forest is located along Exol Swamp to the east of Route 612. *Acer rubrum* dominates here, and *Platanus occidentalis, Alnus serrulata, Cornus amomum, Carpinus caroliniana, Smilax rotundifolia, Toxicodendron radicans, Peltandra virginica,* and *Woodwardia areolata* are also found. The invasive *Lonicera japonica* is prevalent.

Uplands in this area are mostly stands of variously aged plantation *Pinus taeda* or recently harvested areas. A narrow hardwood fringe surrounds the wetlands with *Quercus falcata, Liriodendron tulipifera, Quercus coccinea, Cornus florida,* and *Ilex opaca*.

A single male individual of the state-rare *Epitheca spinosa* was collected and one other individual was observed near the northwest side of Rt. 612 crossing of Exol Swamp (Figure 3). The area of observation was in slow-moving water, which was shaded by *Acer rubrum* but with little vegetation in the understory. It is likely that a larger population occurs in the area.

In Virginia, five populations of *Epitheca spinosa* have been documented including one from the Dragon Run between the Rt. 602 and Rt. 603 bridges. The other sightings are from southeastern Virginia in the Chowan River drainage.

Epitheca spinosa prefers slow moving water of river or lake edges and is often associated with swamp habitats. It forages along forest edges, and males will patrol small sunny channels among wetland trees (Dunkle 2000). This habitat type is extensive in the Dragon Run watershed, and it is likely that more populations exist in the area. Potential threats to this species include water pollution and erosion, habitat destruction, and alteration of natural hydrological regimes, including changes brought about by road

construction or beaver activity. It is possible, however, that impoundments may create suitable habitat for this species by slowing down the water flow and flooding adjacent forests. Further studies on the life history of this species are needed to better understand the threats and conservation issues it faces.

SITE 13

Location: Dragon Run just east of Route 612 and about 1.0 kilometer south of Howertons, Essex County.

Natural Heritage Resources Located: None.

Description: This site encompasses a vast, open shrub-scrub wetland located along Dragon Run and classified as a **Coastal Plain Semipermanent Impoundment**. The wetland appears to be the result of beaver activity and the embankment of Route 612. The presence of many dead snags here indicates that water levels have recently risen.

Woody species found here include *Acer rubrum, Rosa palustris, Cephalanthus occidentalis, Diospyros virginiana, Alnus serrulata, Salix nigra,* and *Leucothoe racemosa.* The herb layer is diverse and includes *Peltandra virginica, Leersia oryzoides, Saururus cernuus, Carex comosa, Polygonum pensylvanicum, Nuphar lutea* ssp. *advena, Ludwigia palustris, Triadenum walteri, Dulichium arundinaceum, Bidens frondosa, Sparganium americanum, Decodon verticillatus, Polygonum punctatum, Proserpinaca palustris, Boehmeria cylindrica, Scirpus cyperinus, Spirodela polyrrhiza, Polygonum sagittatum, Juncus effusus,* and *Thelypteris palustris*. A large population of the small, floating aquatic fern, *Azolla caroliniana*, is found here. The carnivorous herb *Utricularia gibba* and the parasitic herb *Cuscuta gronovii* are also present. The invasive non-native herb *Murdannia keisak* was noticeably absent from the wetlands but occurs along Route 612.

To the east of Route 612, a small feeder stream enters Dragon Run from the northwest. This stream supports a denser, better-drained, shrub-scrub wetland dominated by *Alnus serrulata*.

The south-facing slope on the north side of Dragon Run just east of Route 612 supports a decent stand of mixed forest. *Liriodendron tulipifera, Quercus phellos, Liquidambar styraciflua, Pinus virginiana, Quercus falcata,* and *Pinus taeda* are found here. *Lonicera japonica* is also prevalent. In other areas, the wetlands here are bordered by disturbed forests or clearings.

Extensive aquatic and marsh habitats at this site, combined with surrounding uplands provided for a fairly diverse fauna at this site. Bird species observed at this site included, *Thryothorus ludovicianus, Pipilo erythrophthalmus, Sitta carolinensis, Carduelis tristis, Cathartes aura, Corvus brachyrhynchos, Cyanocitta cristata, Contopus virens, Vireo griseus, Poecile carolinensis,* and *Baeolophus bicolor*. Frog species observed included *Rana sphenocephala, Acris crepitans,* and *Rana clamitans*. Also noted were dragonflies and damselflies such as *Pachydiplax longipennis, Sympetrum vicinum, Libellula incesta, Ischnura posita, Lestes disjunctus australis, Lestes vigilax,* and *Erythemis simplicicollis*. Butterflies observed included *Papilio glaucus, Ancyloxypha numitor, Phyciodes tharos, Papilio troilus,* and *Euphyes dion*. Additional surveys would add to these lists at this diverse site.

SITE 14

Location: West side of Route 617 about 1.1 kilometers north of Carlton Corner, King and Queen County.

Natural Heritage Resources Located: None.

Description: This site encompasses a ponded wetland located along a small, unnamed tributary of Exol Swamp and classified as a **Coastal Plain Semipermanent Impoundment**. The impoundment appears to be maintained by the road embankment and beaver activity. An emergent wetland dominated by *Nuphar lutea* ssp. *advena* is found in the center of the pond, and a scrub-shrub wetland occurs along the pond's edges. This later zone is diverse and dominated by *Acer rubrum* and *Scirpus cyperinus*. Other shrubs in this zone include *Alnus serrulata, Cephalanthus occidentalis, Rosa palustris, Leucothoe racemosa, Salix nigra, Morella cerifera,* and *Vaccinium formosum.*

Uplands surrounding the impoundment are mostly cloaked in maturing plantation *Pinus taeda*. A narrow buffer around the wetland also supports *Quercus alba, Fagus grandifolia, Liquidambar styraciflua, Liriodendron tulipifera, Quercus falcata, Nyssa sylvatica, Ilex opaca,* and *Cornus florida*. Small drainages leading into the impoundment from the east side support a modest amount of a community type classified as **Coastal Plain/Piedmont Acidic Seepage Swamp**. Plants found here include *Magnolia virginiana, Viburnum nudum, Clethra alnifolia, Osmunda cinnamomea, Woodwardia areolata,* and *Carex seorsa*.

Site 14 offered a variety of habitats for songbirds and wading birds. Bird species identified in the area include *Ardea herodias, Baeolophus bicolor, Carduelis tristis, Cathartes aura, Dendroica pinus, Geothlypis trichas, Hylocichla mustelina, Melanerpes carolinus, Mniotilta varia, Parula americana, Poecile carolinensis, Polioptila caerulea, Seiurus aurocapillus, Thryothorus ludovicianus, Vireo griseus, Vireo olivaceus, Wilsonia citrina,* and *Zonotrichia albicollis.* In addition, five frog species were identified: *Acris crepitans, Hyla chrysoscelis, Pseudacris feriarum, Rana clamitans,* and *Rana sphenocephala*. More extensive surveys would greatly expand both of these lists.

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APPENDIX A:
COMMON NAMES FOR THE SCIENTIFIC NAMES USED IN THIS REPORT

PLANT COMMON NAMES

Acer rubrum	red maple
Alnus serrulata	brookside alder
Amphicarpaea bracteata	American hog-peanut
Arisaema triphyllum	Jack-in-the-pulpit
Asclepias incarnata	swamp milkweed
Athyrium filix-femina	subarctic lady fern
Azolla caroliniana	Carolina mosquito fern
Betula nigra	river birch
Bidens frondosa	devil's pitchfork
Boehmeria cylindrica	small-spike false nettle
Callitriche heterophylla	greater water-starwort
Carex alata	broad-wing sedge
Carex blanda	eastern woodland sedge
Carex comosa	bearded sedge
Carex crinita	fringed sedge
Carex decomposita	cypress-knee sedge
Carex intumescens	greater bladder sedge
Carex lupulina	hop sedge
Carex lurida	sallow sedge
Carex seorsa	weak stellate sedge
Carex tribuloides	blunt broom sedge
Carpinus caroliniana	American hornbeam
Carya alba	mockernut hickory
Cephalanthus occidentalis	common buttonbush
Chionanthus virginicus	white fringetree
Cicuta maculata	spotted water-hemlock
Cinna arundinacea	sweet wood-reed
Chelone glabra	white turtlehead
Clethra alnifolia	coastal sweet-pepperbush
Collinsonia canadensis	richweed
Cornus amomum	silky dogwood
Cornus florida	flowering dogwood
Corylus americana	American hazelnut
Cuscuta gronovii	scaldweed
Cyperus strigosus	straw-color flat sedge
Decodon verticillatus	swamp-loosestrife
Diospyros virginiana	common persimmon
Dulichium arundinaceum	three-way sedge
Eupatorium perfoliatum	common boneset
Eupatorium fistulosm	trumpetweed
Fagus grandifolia	American beech
Fraxinus pennsylvanica	green ash
Galium aparine	*sticky-willy*

Galium triflorum	fragrant bedstraw
Gaylussacia frondosa	blue huckleberry
Glyceria obtusa	Atlantic manna grass
Glyceria striata	fowl manna grass
Gratiola virginiana	round-fruit hedge-hyssop
Hydrocotyle ranunculoides	floating marsh-pennywort
Ilex opaca	American holly
Ilex verticillata	common winterberry
Impatiens capensis	spotted touch-me-not
Itea virginica	Virginia sweetspire
Juncus effusus	lamp rush
Leersia oryzoides	rice cut grass
Leersia virginica	white grass
Leucothoe racemosa	swamp doghobble
Limnobium spongia	American spongeplant
Lindera benzoin	northern spicebush
Liquidambar styraciflua	sweet-gum
Liriodendron tulipifera	tuliptree
Lobelia cardinalis	cardinal-flower
Lonicera japonica	Japanese honeysuckle
Ludwigia palustris	marsh primrose-willow
Lyonia ligustrina	maleberry
Magnolia virginiana	sweet-bay
Medeola virginiana	Indian cucumber-root
Morella cerifera	southern bayberry
Murdannia keisak	wart-removing-herb
Nuphar lutea ssp. *advena*	yellow pond-lily
Nymphaea odorata	American white water-lily
Nyssa biflora	swamp tupelo
Nyssa sylvatica	black tupelo
Onoclea sensibilis	sensitive fern
Orontium aquaticum	goldenclub
Osmunda cinnamomea	cinnamon fern
Osmunda regalis	royal fern
Oxydendrum arboreum	sourwood
Parthenocissus quinquefolia	Virginia-creeper
Peltandra virginica	green arrow-arum
Pinus taeda	loblolly pine
Platanus occidentalis	American sycamore
Polygonatum biflorum	King Solomon’s-seal
Polygonum arifolium	halberd-leaf tearthumb
Polygonum hydropiperoides	swamp smartweed
Polygonum pensylvanicum	pinkweed
Polygonum punctatum	dotted smartweed
Polygonum sagittatum	arrow-leaf tearthumb
Pontederia cordata	pickerelweed

Proserpinaca palustris	marsh mermaidweed
Prunus serotina	black cherry
Quercus species	oaks
Quercus alba	northern white oak
Quercus coccinea	scarlet oak
Quercus falcata	southern red oak
Quercus lyrata	overcup oak
Quercus michauxii	swamp chestnut oak
Quercus nigra	water oak
Quercus phellos	willow oak
Quercus rubra	northern red oak
Rosa palustris	swamp rose
Sagittaria latifolia	duck-potato
Salix nigra	black willow
Sambucus nigra ssp. *canadensis*	black elderberry
Saururus cernuus	lizard's-tail
Scirpus cyperinus	cottongrass bullrush
Scutellaria lateriflora	mad dog skullcap
Smilax rotundifolia	horsebrier
Sparganium americanum	American burr-reed
Sphenopholis pensylvanica	swamp wedgescale
Spirodela polyrrhiza	common duckmeat
Spirodela punctata	spotted duckmeat
Symphyotrichum lateriflorum	farewell-summer
Taxodium distichum	southern bald-cypress
Thelypteris noveboracensis	New York fern
Thelypteris palustris	eastern marsh fern
Torreyochloa pallida	pale false manna grass
Toxicodendron radicans	eastern poison-ivy
Triadenum walteri	greater marsh-St. John's-wort
Ulmus americana	American elm
Ulmus rubra	slippery elm
Utricularia gibba	humped bladderwort
Vaccinium corymbosum	highbush blueberry
Vaccinium formosum	southern blueberry
Vaccinium fuscatum	black blueberry
Viburnum nudum	possumhaw
Viburnum recognitum	smooth arrow-wood
Woodwardia areolata	netted chain fern

ANIMAL COMMON NAMES

Amphibians and Reptiles

(Nomenclature source: Crother, B.I. (compiler). 2000. Scientific and standard English names of amphibians and reptiles of North America north of Mexico, with comments regarding confidence in our understanding. Society for the Study of Amphibians and Reptiles. Herpetological Circular Number 29. 82 pp.)

Acris crepitans	Eastern Cricket Frog
Chrysemys picta	Painted Turtle
Hyla cinerea	Green Treefrog
Hyla chrysoscelis	Cope's Gray Treefrog
Kinosternon subrubrum	Eastern Mud Turtle
Nerodia sipedon	Northern Water Snake
Pseudacris feriarum	Southeastern Chorus Frog
Rana catesbeiana	Bullfrog
Rana clamitans	Green Frog
Rana palustris	Pickerel Frog
Rana sphenocephala	Southern Leopard Frog

Birds

(Nomenclature source: American Ornithologists' Union. 1998. Check-list of North American birds. Seventh edition. American Ornithologists' Union. Washington, D.C. 829 pp.)

Aix sponsa	Wood Duck
Ardea herodias	Great Blue Heron
Baeolophus bicolor	Tufted Titmouse
Buteo jamaicensis	Red-tailed Hawk
Carduelis tristis	American Goldfinch
Cathartes aura	Turkey Vulture
Colinus virginianus	Northern Bobwhite
Contopus virens	Eastern Wood Pewee
Corvus brachyrhynchos	American Crow
Cyanocitta cristata	Blue Jay
Dendroica pinus	Pine Warbler
Dryocopus pileatus	Pileated Woodpecker
Empidonax virescens	Acadian Flycatcher
Geothlypis trichas	Common Yellowthroat
Hylocichla mustelina	Wood Thrush
Melanerpes carolinus	Red-bellied Woodpecker
Melanerpes erythrocephalus	Red-headed Woodpecker
Mniotilta varia	Black and White Warbler
Oporornis formosus	Kentucky Warbler

Papilo erythrophthalmus	Eastern Towhee
Parula americana	Northern Parula
Picoides pubescens	Downy Woodpecker
Pipilo erythropthalmus	Eastern towee
Piranga olivacea	Scarlet Tanager
Poecile carolinensis	Carolina Chickadee
Polioptila caerulea	Blue-gray Gnatcatcher
Seiurus aurocapillus	Ovenbird
Seiurus noveboracensis	Northern Waterthrush
Setophaga ruticilla	American Redstart
Sitta carolinensis	White-breasted Nuthatch
Thryothorus ludovicianus	Carolina Wren
Turdus migratorius	American Robin
Vireo griseus	White-eyed Vireo
Vireo olivaceus	Red-eyed Vireo
Wilsonia citrina	Hooded Warbler
Zonotrichia albicollis	White-throated Sparrow

Dragonflies and Damselflies

(Nomenclature source: Dragonfly Society of the Americas. 1996. Common names of North American dragonflies and damselflies. Supplement to Argis. 8(2): 4 pp.)

Anax junius	Common Green Darner
Argia apicalis	Blue-fronted Dancer
Calopteryx maculata	Ebony Jewelwing
Enallagma signatum	Orange Bluet
Epiaeschna heros	Swamp Darner
Epitheca spinosa	Robust Baskettail
Erythemis simplicicollis	Eastern Pondhawk
Ischnura posita	Fragile Forktail
Lestes disjunctus	Common Spreadwing
Lestes vigilax	Swamp spreadwing
Libellula cyanea	Spangled Skimmer
Libellula incesta	Slaty Skimmer
Libellula vibrans	Great Blue Skimmer
Pachydiplax longipennis	Blue Dasher
Perithemis tenera	Eastern Amberwing
Plathemis lydia	Common Whitetail
Somatochlora filosa	Fine-lined Emerald
Sympetrum vicinum	Yellow-legged Meadowfly
Tramea carolina	Carolina Saddlebags
Tramea lacerata.	Black Saddlebags

Lepidoptera

(Nomenclature source: Glassberg, J. 1999. Butterflies through binoculars: the East. Oxford University Press, New York, NY. 242 pp.)

Ancyloxypha numitor	Least Skipper
Celastrina ladon	Spring Azure
Colias philodice	Common Sulphur
Euphyes dion	Dion Skipper
Eurytides marcellus	Zebra Swallowtail
Papilio glaucus	Eastern Tiger Swallowtail
Papilio troilus	Spicebush Swallowtail
Phoebis sennae	Cloudless Giant Sulphur
Phyciodes tharos	Pearl Crescent
Vanessa virginiensis	American Lady

APPENDIX B:
EXPLANATION OF NATURAL HERITAGE RANKS

Definition of Abbreviations Used on Natural Heritage Resource Lists of the Virginia Department of Conservation and Recreation

Natural Heritage Ranks

The following ranks are used by the Virginia Department of Conservation and Recreation to set protection priorities for natural heritage resources. Natural Heritage Resources, or "NHR's," are rare plant and animal species, rare and exemplary natural communities, and significant geologic features. The primary criterion for ranking NHR's is the number of populations or occurrences, i.e. the number of known distinct localities. Also of great importance is the number of individuals in existence at each locality or, if a highly mobile organism (e.g., sea turtles, many birds, and butterflies), the total number of individuals. Other considerations may include the quality of the occurrences, the number of protected occurrences, and threats. However, the emphasis remains on the number of populations or occurrences such that ranks will be an index of known biological rarity.

S1 Extremely rare; usually 5 or fewer populations or occurrences in the state; or may be a few remaining individuals; often especially vulnerable to extirpation.

S2 Very rare; usually between 5 and 20 populations or occurrences; or with many individuals in fewer occurrences; often susceptible to becoming extirpated.

S3 Rare to uncommon; usually between 20 and 100 populations or 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 >100 populations or 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.

S#B Breeding status of an organism within the state.

SH Historically known from the state, but not verified for an extended period, usually > 15 years; this rank is used primarily when inventory has been attempted recently.

S#N Non-breeding status within the state. Usually applied to winter resident species.

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

SX Apparently extirpated from the state.

SZ Long distance migrant whose occurrences during migration are too irregular, transitory and/or dispersed to be reliably identified, mapped and protected.

Global ranks are similar, but refer to a species' rarity throughout its total range. Global ranks are denoted with a "G" followed by a character. Note that GA and GN are not used and GX means apparently extinct. A "Q" in a rank indicates that a taxonomic question concerning that species exists. Ranks for subspecies are denoted with a "T". The global and state ranks combined (e.g. G2/S1) give an instant grasp of a species' known rarity.

These ranks should not be interpreted as legal designations.

Federal Legal Status

The Division of Natural Heritage uses the standard abbreviations for Federal endangerment developed by the U.S. Fish and Wildlife Service, Division of Endangered Species and Habitat Conservation.

LE Listed Endangered - threatened with extinction throughout all or a significant portion of its range
LT Listed Threatened - likely to become endangered in the foreseeable future
PE Proposed Endangered
PT Proposed Threatened
E(S/A) Treat as endangered because of similarity of appearance
T(S/A) Treat as threatened because of similarity of appearance

C Candidate - enough information is available to propose for listing, but listing is precluded by other pending proposals of higher priority
SOC Species of Concern -- species that merit special concern (not a regulatory category)
NF No federal legal status

State Legal Status

The Division of Natural Heritage uses similar abbreviations for State endangerment.

LE	Listed Endangered	**PE**	Proposed Endangered
LT	Listed Threatened	**PT**	Proposed Threatened
C	Candidate		
SC	Special Concern -- animals that merit special concern according to VDGIF (not a regulatory category)		
NS	No state legal status		

Definition of Abbreviations Used on Natural Heritage Resource Lists of the Virginia Department of Conservation and Recreation

Conservation Site Ranks

Brank is a rating of the significance of the conservation site based on presence and number of natural heritage resources; on a scale of 1-5, 1 being most significant:

B1 - Outstanding significance
B2 - Very high significance
B3 - High significance
B4 - Moderate significance
B5 - of General Biodiversity significance

Site names ending in Habitat Zone are B5 sites on private lands.

For information on the laws pertaining to threatened or endangered species, contact:
U.S. Fish and Wildlife Service for all FEDERALLY listed species
Department of Agriculture and Consumer Services Plant Protection Bureau for STATE listed plants and insects
Department of Game and Inland Fisheries for all other STATE listed animals

APPENDIX C:
THE NATURAL COMMUNITIES OF VIRGINIA:
CLASSIFICATION OF ECOLOGICAL COMMUNITY GROUPS

COMMONWEALTH of VIRGINIA

THE NATURAL COMMUNITIES OF VIRGINIA
Classification of Ecological Community Groups

FIRST APPROXIMATION

Virginia Department of Conservation and Recreation
Division of Natural Heritage
Natural Heritage Technical Report 01-1
January 2001

DCR
Department of Conservation & Recreation
CONSERVING VIRGINIA'S NATURAL AND RECREATIONAL RESOURCES

THE NATURAL COMMUNITIES OF VIRGINIA:

Classification of Ecological Community Groups

FIRST APPROXIMATION

January 2001

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INTRODUCTION

This document is the first in a planned series of reports that will provide a comprehensive classification of natural communities in Virginia. Its purpose is to construct a broad framework for understanding and defining such communities at several hierarchical levels. This goal is integral to the mission of the Virginia Department of Conservation and Recreation's Division of Natural Heritage (DCR-DNH), which is responsible by statutory authority for documenting, protecting, and managing "the habitats of rare, threatened, or endangered plant and animal species, rare or state-significant communities, and other natural features" (section 10.1: 209-217, *Code of Virginia*). As part of its work, the Division maintains database information on the status, distribution, and ecology of rare native species and all natural communities; protects and manages these resources through a system of natural area preserves; and provides information and technical advice to other agencies, organizations, and individuals. Within this context, community inventory and classification represent an important "coarse-filter" approach to biological conservation that ensures the protection of diverse organisms. By identifying and protecting excellent examples of all natural community types, the majority of native plant and animal species, including a host of cryptic and poorly known ones, can be protected without redundant individual attention.

An ecological community is an assemblage of co-existing, interacting species, considered together with the physical environment and associated ecological processes, that usually recurs on the landscape. This present treatment is restricted to **natural communities**, those 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. Most of the communities treated here, while somewhat modified in composition or structure, are in mid- to late-successional stages of recovery from some form of human disturbance, such as agricultural conversion or logging. This document does not include early-successional communities that have experienced recent disturbance or highly modified habitats such as fields and plantation forests that are artificially maintained in an arrested stage of succession. Such communities, which cover extensive areas of Virginia, may nevertheless develop into natural systems given sufficient time and freedom from further anthropogenic disturbance. A few communities that are very rare in the state and now represented only by highly degraded examples are included because of their importance to the state's biodiversity.

Classifications of natural communities can be based on various components (*e.g.*, vegetation, fauna, landforms, hydrologic regime), used singly or in combination. Natural community classifications prepared by Natural Heritage ecologists for several other eastern states (*e.g.*, North Carolina [Schafale and Weakley 1990], Pennsylvania [Fike 1999], New York [Reschke 1990], and Vermont [Thompson and Sorensen 2000]) rely on a "multi-factor" approach that incorporates both biotic and abiotic elements in a community concept. Except in deepwater systems, however, plants have proven to be the most useful components for characterizing finer-scale communities on the landscape and providing a basis for comparing classifications covering different geographic areas. Although animals, especially invertebrates, can be very important in natural communities, they are often highly mobile, difficult to document, and found in many different ecological settings. Likewise, environmental conditions and processes encompass a spatially diverse array of factors from regional climate to site-specific moisture conditions that are impossible or excessively time- and labor-intensive to measure directly. On the other hand, the plants that together form the vegetation of a site are immobile, are easy to measure in a variety of ways, and typically reflect (both individually and as an assemblage) specific site conditions. Despite the drawback that it can be dynamic over short time periods,

> Vegetation is often chosen as the basis for a single-factor system for classifying terrestrial ecological systems because it generally integrates the ecological processes operating on a site or landscape more measurably than any other factor or set of factors .... Because patterns of vegetation and co-occurring plant species are easily measured, they have received far more attention than those of other components, such as fauna. Vegetation is a critical component of energy flow in ecosystems and provides habitat for many organisms in an ecological community. In addition, vegetation is often used to infer soil and climatic patterns. For these reasons, a classification ... based on vegetation can serve to describe many (though not all) facets of biological and ecological patterns across the landscape (Grossman *et al.* 1998).

The United States National Vegetation Classification (NVC; Grossman *et al*. 1998, Anderson *et al*. 1998), currently under development by the Association for Biodiversity Information (ABI), The Nature Conservancy (TNC), and state Natural Heritage programs, in conjunction with the Vegetation Panel of the Ecological Society of America and the Federal Geographic Data Committee, promises to deliver a comprehensive "single-factor" approach to ecological communities based on a hierarchical classification of vegetation. Divisions within the upper levels of the NVC hierarchy rely on physiognomic criteria such as vegetation structure and predominant leaf phenology. The two lowest divisions, the *alliance* and the *association*, are based on floristic criteria. The association, constituting the basic unit of inventory and biodiversity assessment, serves as a surrogate for natural communities.

Methods and Data Sources

The NVC proposes to determine the compositional variation, geographic range and conservation status of each unique vegetation type in the country. In its current state of development, however, this massive project is far from complete; it contains vegetation types that are inconsistent in level of resolution and geographic scale and poorly supported by data . Hence, it does not readily meet the parochial needs of many individual Heritage programs and their clientele. To satisfy the requirement for a system by which natural communities in Virginia can be identified, named, and ranked, DCR-DNH ecologists have embarked on a multi-year program to develop a comprehensive, hierarchical classification of the state's vegetation and natural communities which can be applied in the field by a range of users. Two central tenets of this endeavor are that (1) the basic systematic units of the classification are based on quantitative, plot-referenced data comprising full floristic composition of vegetation, and (2) these units are identified through rigorous analysis of data using multivariate techniques. This effort will in turn help to inform and refine the NVC.

The qualitative documentation of "significant" natural community occurrences in Virginia was initiated by The Nature Conservancy in 1983, and continued after the establishment of DCR-DNH as a state agency in 1986. Such occurrences were defined as outstanding examples of common community types and all examples of rare community types. The required assessments of rarity and quality were based on subjective evaluations and experiences of staff ecologists, often in consultation with other knowledgeable individuals in Virginia and other states. Throughout the early years of the program, emphasis was placed on inventory and identification of the rarer, more threatened communities in urgent need of protection (*e.g.*, bogs, fens, and barrens). This, in turn, supported the identification and acquisition of a number of natural area preserves. To date, the Division has compiled database information on more than 900 significant community occurrences.

Staff ecologists began collecting quantitative vegetation data in 1990, and this effort has intensified over the past several years. Our program is strongly committed to a "specimen-based" approach to community classification that depends on structural, floristic, and environmental plot data collected from uniform areas supporting homogeneous stands of vegetation. Although the analogy is imperfect, data from each plot represents a "specimen" that may be compared with other plot data in order to delimit vegetation "taxa," in much the same way as a botanist analyzes preserved plant specimens to determine the

taxonomic limits of species. As a result, procedures for observing, measuring, describing, and comparing vegetation are standardized to a specific scale, which facilitates more precise and objective characterization of vegetation types than is possible through purely qualititative field observation. Standard DCR-DNH protocols for data collection and analysis are summarized in the Appendix (p. 75).

To date, nearly 2500 vegetation plots have been sampled by DCR-DNH ecologists and contractors. A substantial proportion (26%) of these data has been collected as part of landscape-level classification projects for several discrete areas of the George Washington and Jefferson National Forests (Fleming and Moorhead 2000, Coulling and Rawinski 1999, Fleming and Moorhead 1996, Rawinski *et al*. 1996); the Fort Belvoir military reservation (McCoy and Fleming 2000); three adjacent watersheds in southeastern Virginia (Fleming and Moorhead 1998); and the Grafton Ponds complex in York County (Rawinski 1997). More recently, a classification of forests and woodlands on calcareous substrates was prepared for the Forest Service, using data collected across a broader geographic range in western Virginia (Fleming 1999). Currently underway are projects to classify communities of the Pamunkey River watershed in the northern Coastal Plain and Shenandoah National Park in the Blue Ridge, as well as preliminary analyses of three regional data sets:

- 415 plots of tidal wetland vegetation collected throughout eastern Virginia;
- 450 plots of Piedmont and inner Coastal Plain upland and alluvial floodplain vegetation; and
- 880 plots collected throughout the mountain region of Virginia.

Beginning in 1997, a provisional classification of natural communities was developed internally through a subjective analysis of plot and other field data. This approach synthesized a top-down natural-group ("multi-factor") approach with a bottom-up classification of vegetation types consistent with the NVC and based on rigorous analytical methods. The provisional classification has served as a "place-holder" for the program's significant community records, and has been refined through quantitative data analyses, field testing and, to a lesser extent, a review of Virginia vegetation literature. With sufficient plot data now in hand to support a growing need for within-state regional analyses and, ultimately, a state-wide community classification, there is a concurrent need to formalize the overall hierarchical framework within which both classified community types and community occurrence records are placed. This document attempts to fill that need by presenting an updated version of the classification which conceptually defines and describes 120 ecological community groups in Virginia.

Structure of the Virginia Natural Community Classification

The divisions of the Virginia classification hierarchy, from the top down, are:

- System
- Ecological Class
- Ecological Community Group
- Community Type

At present, our work is limited to all vegetated upland communities and all wetland communities that are vegetated with emergent, floating, or submerged aquatic vascular plants. The System level is based on gross hydrologic regime and presently includes five divisions: the **Terrestrial System** includes all upland (non-wetland) habitats, while the **Palustrine System** encompasses all non-tidal wetlands dominated by woody plants and herbaceous emergents. The **Estuarine System** includes emergent and floating / submergent tidal wetlands, extending to the upstream limits of tidal influence. The **Riverine System** and the **Marine System** are each represented by a single ecological group that supports vascular plants. This system-level treatment generally follows Cowardin *et al*. (1979), except that freshwater tidal wetlands are included in the Estuarine System, and communities that would be placed in the Lacustrine System of Cowardin *et al*. (1979) are included in the Palustrine System. Classification of deepwater Lacustrine,

Riverine, Estuarine, and Marine System communities that lack vascular plants, as well as of Subterranean System (cave) communities, may be undertaken at a later time if resources permit.

Except for a few nomenclatural and conceptual modifications, the **Ecological Class** level follows the comparable level of Schafale and Weakley's (1990) classification of North Carolina natural communities. Divisions at this level are based primarily on gross climatic, geographic, and edaphic similarities, *e.g.*, High-Elevation Mountain Communities or Non-Alluvial Wetlands of the Coastal Plain and Piedmont. Ecological Classes are primarily useful for grouping physiographically and topographically related community groups, which often co-occur on the landscape.

At the **Ecological Community Group** level, which this document describes in detail, units are based on combinations of topographic, edaphic, physiognomic, and gross floristic similarities. This level is comparable to the level at which many natural community classifications define their basic units, *e.g.*, Northern Red Oak Forests or Low-Elevation Basic Outcrop Barrens. 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.*, Mixed Oak / Heath Forests), while others are very narrow in concept and distribution (*e.g.*, Granitic Flatrocks). A few groups (*e.g.*, Inland Salt Marshes) may have only a single occurrence in Virginia but are known to have representatives in other states.

Although they are not treated in this document, **Community Types** are the fundamental units of the classification system and will be nested within the Ecological Community Groups. The Community Type level is equivalent to the "association" level of the NVC and traditional phytosociological studies. Types within a given ecological community group share definite environmental, structural, and floristic similarities. Occasionally **Community Subtypes** are employed to describe well-marked variation within community types. The methods and criteria used to define community types, as well as the types themselves, will be described in future iterations of this classification. A partial example of a fully nested classification within the framework outlined here is provided in Table 1. The protocol for naming community types is described in the Appendix (p. 75).

Table 1. Partial example of the Virginia hierarchical classification system

System: ESTUARINE
Ecological Class: TIDAL WETLANDS
Ecological Community Group: TIDAL FRESHWATER MARSHES

Community Types:	*Nuphar advena* Tidal Herbaceous Vegetation Tidal Freshwater Marsh (Spatterdock Tidal Mud Flat Type) — *Typha latifolia – Schoenoplectus fluviatilis – Carex co*mosa Tidal Herbaceous Vegetation Tidal Freshwater Marsh (Broad-leaved Cattail – River Bulrush – Bristly Sedge Type) — *Zizania aquatica* var. *aquatica – Polygonum punctatum* Tidal Herbaceous Vegetation Tidal Freshwater Marsh (Wild Rice – Dotted Smartweed Type)
Community Subtypes:	*Zizania aquatica* var. *aquatica – Bidens laevis* Subtype (wild rice – smooth bur-marigold subtype) *Zizania aquatica* var. *aquatica – Polygonum punctatum* Subtype (wild rice – dotted smartweed subtype)

Because this classification is based on composition in all layers, not just the tallest, community types differ considerably from "cover types" used in forestry and large-scale vegetation mapping. Each approach is valid for certain purposes. Since our purpose is to classify ecological units, it is very important to consider all plants at a site. In forests, for instance, shrubs and herbs often respond to more subtle environmental gradients and may reveal more about local site conditions and associated animal species than do trees, which tend to be more broadly distributed and exhibit less environmental specificity. Likewise, herbaceous species occurring with low cover may be more restricted to certain site conditions and thus far more diagnostic of a community type than more widespread, dominant shrubs and trees.

The aggregation of community types defined exclusively with biotic criteria into coarser, broadly defined ecological community groups and classes is controversial and may not satisfy those who adhere strictly to either physiognomic-floristic or natural-group classification systems. Physiognomic-floristic systems such as the NVC clearly identify the physiognomic and vegetational criteria used to distinguish types at different levels and provide consistent upper-level criteria that can be applied to virtually all vegetation in the world. Nevertheless, the higher physiognomic levels of the NVC hierarchy pose many uncomfortable constraints on the lower, floristic levels, and units above the association level have limited utility at the regional level, especially for conservation. In response to these problems, developers of the NVC have recently initiated an effort to define an alternative, complementary system of standardized ecological groups (most comparable to the Virginia Ecological Class level) that can be applied across the United States.

The ecological community groups treated in this report offer a number of advantages over comparable hierarchical units based strictly on physiognomy or floristics. These include:

- concepts and terminology that are more communicable, familiar, accessible, and useful to many potential users
- a system that encourages the ecological interpretation of vegetation patterns on the landscape
- units that have greater utility for conservation purposes and for naming community records where more detailed classifications of vegetation are lacking.

One of the disadvantages of the approach taken here is the imperfect correspondence of community names with those used in similar classifications. For example, although we have adopted a number of names used in the North Carolina natural community classification (Schafale and Weakley 1990), major biogeographic differences between the two states made it impossible to do so consistently. Additionally, the colloquial application of many terms used in community nomenclature, including "bog," "fen," and "swamp," varies widely. We have addressed the latter problem by including a Glossary (p. 57) that clearly articulates our interpretation of terms that may be unfamiliar or ambiguous. Future classification of Virginia community types crosswalked to the NVC, as well as the NVC's development of standardized ecological groups, should assist in resolving problems of inconsistent regional nomenclature.

Identifying community types or ecological community groups in the field is sometimes problematic since vegetation and associated site conditions are gradational across the landscape. While the boundaries between vegetation types may be sharp in some areas, more often they are represented by broad zones of compositional and environmental transition. It is important to recognize that the DCR-DNH classification system, like other similar systems, is an attempt to partition an extremely complex set of factors into practical units for conservation, mapping, and management. Such an artificial group structure can never be perfect and there will always be environments and vegetation that are intermediate, anomalous, and/or difficult to classify.

Future Directions

Much of the information provided in this report, as well as photographs of representative stands of ecological community groups, will be made available soon on the Virginia Natural Heritage website (http://www.dcr.state.va.us/dnh/) and will be periodically updated. Additional, detailed information about our plot-sampling and data analysis methodologies will be posted in the future. Plot data and PDF versions of technical reports may also be made available online.

Classification of community types on more geographically extensive scales within Virginia will be the focus of work in the immediate future. Plot data that supported landscape-level community classifications during the past six years will be re-examined in larger regional datasets. Since a significant percentage of our plot data have been collected in a small number of discrete landscapes, there are many geographic and compositional gaps in the database. Large dataset analysis that is either currently underway or planned for the near future will facilitate the identification of these gaps and assist in prioritizing future inventory and sampling sites. Another critical task will be to populate the environmental database with digitally derived, topographically-based environmental indices, which will improve our ability to relate vegetation patterns to variation in site conditions, particularly those that are difficult to measure accurately in the field.

We expect the full development of the state classification to be an iterative process of successive approximations. Progressive classification at the community type level will likely result in modifications to and greater consistency in the circumscription of ecological community groups. Collaborative efforts with ABI and TNC regional ecologists will ensure that vegetation types classified through these efforts are crosswalked or incorporated into the NVC. Over the next ten years, we anticipate a series of technical reports and peer-reviewed publications that will detail state-wide classifications of various broad ecological/taxonomic groups (*e.g.*, Coastal Plain tidal wetlands). A relatively non-technical version of the classification will be available to the public on the DCR-DNH website, and possibly as a well-illustrated publication in the future.

As always, we appreciate and welcome comments or feedback on our work, as well as information or questions concerning Virginia's natural communities. Please direct inquiries to any member of the ecology staff:

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Hierarchical Classification and Description of ECOLOGICAL COMMUNITY GROUPS

Format: Units at the System and Class levels are identified, and summary information is provided for all 120 units at the Ecological Community Group level. As a rule, this information includes a concise statement of the group's concept; distribution within Virginia; environmental and site conditions; vegetation structure and general floristic attributes; threats; associated rare species; and an assessment of the rarity of included community types, if known and applicable. The term "globally rare" indicates that a community or species is rare throughout its range. Characterization of habitats, soil chemistry, vegetation, and floristics is based almost exclusively on plot and other data collected by DCR-DNH ecologists. Literature pertinent to a group is cited at the end of the description. Note that the Literature Cited and Additional References section of this report (p. 64) is divided into three parts: 1) published literature on Virginia vegetation; 2) unpublished technical reports and academic works on Virginia vegetation; and 3) general references. Definitions of many scientific and technical terms are provided in a Glossary of Selected Terms (p. 57).

The major physiographic regions referred to in the descriptions are depicted in Figure 1. Note that the term "mountains" includes three physiographic provinces: the Blue Ridge, the Ridge and Valley, and the Appalachian Plateaus, which is represented in Virginia by the Cumberland and Allegheny Mountains. The southern Blue Ridge and northern Blue Ridge are separated by Roanoke Gap. The Piedmont is divided into northern and southern sections by the James River, and into "inner" and "outer" zones by topographic features. The inner Piedmont contains the steeply rolling to hilly belt lying east of the Blue Ridge and containing a number of more or less isolated foothill ranges. The outer Piedmont comprises the eastern two-thirds of the province, including several low, nearly level Triassic-age basins. The outer Coastal Plain is defined by the flat terraces that lie east of the Suffolk Scarp on the south and encompass the Eastern Shore and maritime zone along the western shore of the Chesapeake Bay. The inner Coastal Plain is more rolling to dissected, particularly near the "fall line" boundary with the Piedmont. For a detailed treatment of Virginia physiography and biogeography, see Woodward and Hoffman (1991).

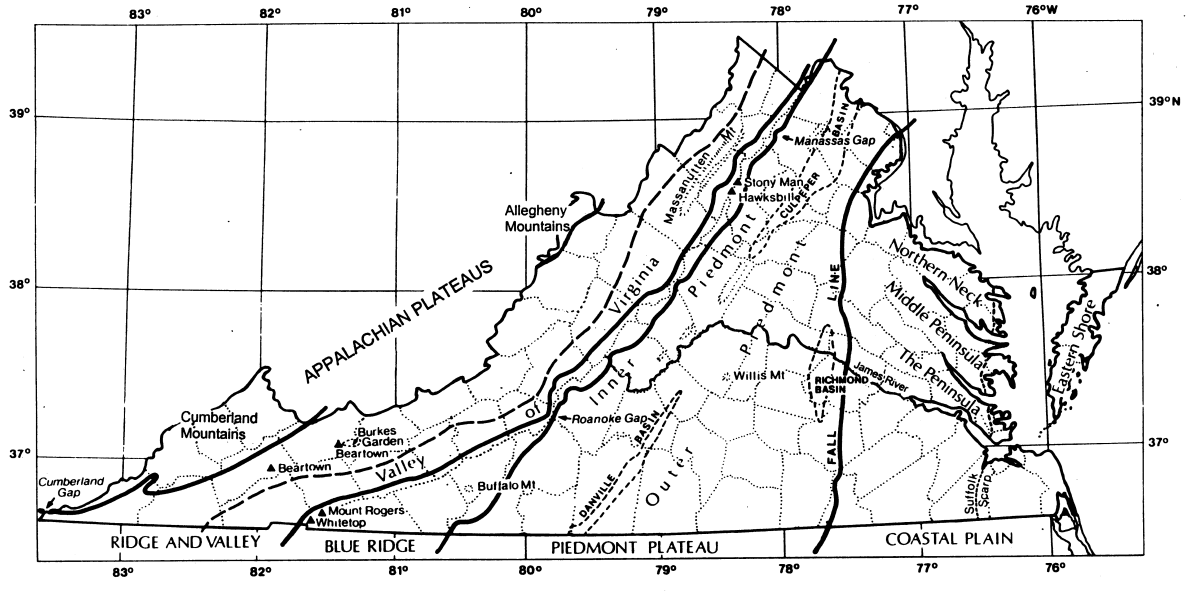

Figure 1. The physiographic provinces and subregions of Virginia. Modified from Woodward and Hoffman (1991), with copyright permission.

TERRESTRIAL SYSTEM

HIGH-ELEVATION MOUNTAIN COMMUNITIES

Ecological community groups with distributions centered above 900 m (3000 ft) elevation and representing structurally and compositionally diverse vegetation rich in northern species.

Fraser Fir – Red Spruce Forests

Coniferous forests of the southern Blue Ridge dominated by Fraser fir (*Abies fraseri*) or combinations of Fraser fir and red spruce (*Picea rubens*). These forests reach their northern range limit in southwestern Virginia, where they are confined to elevations above 1700 m (5400 ft) on Mount Rogers in Grayson and Smyth Counties. Habitats are characterized by extremely acidic, organic-rich soils; cold microclimates; high rainfall; frequent fogs; and lush bryophyte cover. Understory layers are sparse, while mountain wood-fern (*Dryopteris campyloptera*) and mountain wood-sorrel (*Oxalis montana*) dominate a relatively dense herb layer. Fraser fir – red spruce vegetation is seriously threatened by air pollution and destruction of fir stands by the balsam woolly adelgid (*Adelges piceae*), an introduced insect pest. Communities in this group are considered globally rare. References: Adams (1991), Rheinhardt and Ware (1984), Smith and Nicholas (1999), Stephenson and Adams (1984).

Southern Appalachian Red Spruce Forests

Coniferous and mixed forests dominated or co-dominated by red spruce (*Picea rubens*). Reaching their northern range limit in southwestern Virginia, these forests are restricted to high-elevation slopes and summits (> 1300 m [4300 ft]) of the Blue Ridge (Grayson, Smyth, and Washington Counties) and Clinch Mountain (Russell and Tazwell Counties). Environmental conditions are similar to those of the Fraser Fir-Red Spruce Forests. Mountain-cranberry (*Vaccinium erythrocarpum*) is often a prevalent shrub in these communities. Yellow blue-bead lily (*Clintonia borealis*), mountain wood-fern (*Dryopteris campyloptera*), mountain wood-sorrel (*Oxalis montana),* shining clubmoss (*Huperzia lucidula*), and Canada mayflower (*Maianthemum canadense*) are abundant herbs rooting in the thick moss cover. As lower elevation limits are approached, co-dominance by hardwoods, particularly yellow birch (*Betula alleghaniensis*), increases. Due to their restricted geographic and elevation ranges, community types in this group are considered globally uncommon to rare. Red spruce forests provide Virginia's only viable habitats for the northern flying squirrel (*Glaucomys sabrinus fuscus*), a federally and state-listed endangered species. References: Adams (1991), McLaughlin *et al*. (1987), Rheinhardt and Ware (1984).

Central Appalachian Red Spruce Forests

Coniferous and mixed forests characterized by red spruce (*Picea rubens*) and spruce-hardwood mixtures, reaching their southern range limit at high elevations of Allegheny Mountain (above 1100 m [3600 ft]) and Jack Mountain (above 1280 m [4200 ft]) in Highland County. At least two community types, a unit of submesic ridge crests and a unit of mesic stream-head valleys, are present on Allegheny Mountain. Distinctly southern species are nearly lacking from these forests, while northern species such as late lowbush blueberry (*Vaccinium angustifolium*), stiff ground-pine (*Lycopodium annotinum*), tree clubmoss (*L. dendroideum*), and staghorn clubmoss (*L. clavatum*), are abundant. Communities in this group are state-rare. Noteworthy faunal members include the federally listed northern flying squirrel (*Glaucomys sabrinus fuscus*) and the state-endangered snowshoe hare (*Lepus americanus virginianus*). Several northern songbirds, including the northern saw-whet owl (*Aegolius acadicus*), hermit thrush (*Catharus guttatus*), and golden-crowned kinglet (*Regulus satrapa*), rely on high-elevation coniferous forests for breeding in Virginia. References: Adams (1991), Bailey and Ware (1990), Fleming and Moorhead (1996), Pielke (1981), Rawinski *et al*. (1994), Stevens (1969).

Southern Appalachian Grassy Balds
A group of globally rare communities restricted to high-elevation (> 1500 m [5000 ft]) summits and upper slopes in the southern Blue Ridge. There is a single occurrence in Virginia covering approximately 80 ha (200 ac) near the summit of Whitetop Mountain at the convergence of Grayson, Smyth, and Washington Counties. Vegetation of this site is dominated by mountain oat-grass (*Danthonia compressa*), sedges (*Carex brunnescens* var. *sphaerostachya*, *C. debilis* var. *rudgei*, *C. pensylvanica*), and forbs such as three-toothed cinquefoil (*Sibbaldiopsis tridentata*) and Blue Ridge St. Johns-wort (*Hypericum mitchellianum*); several state-rare and globally rare species are present. The ecological dynamics that created and maintain this habitat are debatable, but probably include shallow rocky soils, fires, grazing, and microclimatic impacts such as frequent high-velocity winds and ice storms. Moreover, it is possible that the Whitetop bald represents a relict of true alpine vegetation that was more widely distributed at high elevations during the Pleistocene. Reference: Weigl and Knowles (1999).

Southern Appalachian Shrub Balds
Dense shrub-dominated vegetation of high-elevation rocky summits in the southern Blue Ridge. In Virginia, these communities are confined to elevations over 1500 m (5000 ft) in the Mount Rogers – Whitetop Mountain area of Grayson, Smyth, and Washington Counties. At least two community types are present: an evergreen shrubland dominated by Catawba rhododendron (*Rhododendron catawbiense*) and a deciduous shrubland dominated by American mountain-ash (*Sorbus americana*), minniebush (*Menziesia pilosa*), and southern mountain-cranberry (*Vaccinium erythrocarpum*). Very rocky, cold, windswept habitats probably contribute heavily to the creation and maintenance of shrub balds. At least some may have originated after catastrophic logging and fire disturbances almost a century ago, but even in these there is little or no evidence of tree reproduction. Due to their restricted ranges and habitat requirements, communities in this group are generally considered globally uncommon to rare.

Southern Appalachian Northern Hardwood Forests
Mixed hardwood forests occurring at elevations above 1200 m (3900 ft) in southwestern Virginia. Dominant trees are sugar maple (*Acer saccharum* var. *saccharum*), American beech (*Fagus grandifolia*), yellow birch (*Betula alleghaniensis*), and yellow buckeye (*Aesculus flava*). Overall composition varies with specific site conditions, and several community types are represented. Hobblebush (*Viburnum lantanoides*), mountain maple (*Acer spicatum*), and striped maple (*Acer pensylvanicum*) are abundant understory species. Typical herbs include Appalachian white snakeroot (*Ageratina altissima* var. *roanensis*), mountain wood aster (*Aster chlorolepis*), Blue Ridge sedge (*Carex lucorum* var. *austrolucorum*), mountain wood-fern (*Dryopteris campyloptera*), and mountain rattlesnake-root (*Prenanthes roanensis*). In southwestern Virginia these communities are prevalent throughout the high-elevation Mount Rogers–Whitetop Mountain area of the Blue Ridge (Grayson, Smyth, and Washington Counties), with outliers at the highest elevations of the Iron Mountains (Grayson and Smyth Counties), Clinch Mountain (Russell, Smyth, Tazewell, and Washington Counties), and Stone Mountain (Wise County). All community types in this group are locally restricted in Virginia and at least some are state-rare. Reference: Rheinhardt and Ware (1984).

Central Appalachian Northern Hardwood Forests
Mixed hardwood forests prevalent at high elevations (> 1000 m [3300 ft]) of Allegheny Mountain in Highland County, with rare, small-patch outliers occurring on north-facing slopes over 1200 m (4000 ft) on both the Blue Ridge and Ridge and Valley ridges south to Botetourt and Giles Counties. Dominant trees are sugar maple (*Acer saccharum* var. *saccharum*), American beech (*Fagus grandifolia*), black cherry (*Prunus serotina* var. *serotina*), yellow birch (*Betula alleghaniensis*), sweet birch (*Betula lenta*), and northern red oak (*Quercus rubra*). Composition varies with site conditions and has been heavily influenced by past logging and destructive fires. Characteristic herbs include whorled aster (*Aster acuminatus*), hayscented fern (*Dennstaedtia punctilobula*), evergreen wood-fern (*Dryopteris intermedia*), tree clubmoss (*Lycopodium dendroideum*), tall millet-grass (*Milium effusum*), grove bluegrass (*Poa*

alsodes), purple oat-grass (*Schizachne purpurascens*) and sweet white violet (*Viola blanda* var. *blanda*). Forests of this group are more common northward in the high Allegheny Mountains to the unglaciated Allegheny Plateau of northern Pennsylvania and southern New York. In Virginia, several northern songbirds, including the brown creeper (*Certhia americana*), mourning warbler (*Oporornis philadelphia*), and yellow-bellied sapsucker (*Sphyrapicus varius*), breed only in northern hardwood forests. References: Coulling and Rawinski (1999), Fleming and Moorhead (1996), Rawinski *et al*. (1996).

High-Elevation Boulderfield Forests and Woodlands
Open forests and woodlands occupying relatively unweathered boulderfields at elevations above 900 m (3000 ft) in both the Blue Ridge and Ridge and Valley provinces. Yellow birch (*Betula alleghaniensis*), American mountain-ash (*Sorbus americana*), and mountain maple (*Acer spicatum*) are the dominants of north-facing boulderfields weathered from granite, metabasalt, quartzite, and sandstone at the highest elevations. Trees here are typically gnarled and widely spaced because of difficult establishment and repeated damage from wind and ice. Typical shrubs include gooseberries (*Ribes* spp.) and red-berried elder (*Sambucus racemosus* ssp. *pubens*). On metabasaltic, granitic, and calcareous sandstone boulderfields that are somewhat more protected or warmer, forests dominated by basswoods (*Tilia americana* vars. *americana* and *heterophylla*), white ash (*Fraxinus americana*), and northern red oak (*Quercus rubra*) are typical. The high cover of exposed rock in these habitats tends to limit overall species richness and herbaceous density. Cool microclimates favor the occurrence of many northern and high mountain species. The globally rare and federally listed Shenandoah salamander (*Plethodon shenandoah*) is endemic to three thinly wooded, high-elevation boulderfields on the northern Blue Ridge (Page and Madison Counties). References: Johnson and Ware (1982), Rheinhardt and Ware (1984).

High-Elevation Outcrop Barrens
Scrub and herbaceous vegetation of exposed, metamorphic and igneous outcrops in the Blue Ridge. The lower-elevation limit of these barrens is about 975 m (3200 ft) in northern Virginia, increasing to about 1200 m (4000 ft) in the southern Blue Ridge. The full range of environmental and compositional variation in this group, especially in the southern Blue Ridge occurrences, has not been documented. In the northern Blue Ridge, high-elevation outcrop barrens occupy granitic and metabasaltic outcrops of mostly west- to north-facing upper slopes and summits. Known examples in the southern Blue Ridge occur on amphibolite (Buffalo Mountain, Floyd Co.) and rhyolite (Mount Rogers area). While bedrock chemistry no doubt exerts some influence on floristics, geologically heterogeneous habitats share similar microclimatic and edaphic stresses. The habitats are wind-blasted and subject to severe winter temperatures and ice, while oligotrophic soils consist of very thin, local veneers of organic matter, gravel, or silt. Vegetation is usually a patchwork of shrub thickets, herbaceous mats, and lithophytic lichens. Characteristic shrubs are American mountain-ash (*Sorbus americana*), red chokeberry (*Aronia melanocarpa*), pin cherry (*Prunus pensylvanica*), northern bush-honeysuckle (*Diervilla lonicera*), ninebark (*Physocarpus opulifolius* var. *opulifolius*, on mafic outcrops), mountain-laurel (*Kalmia latifolia*), and severely stunted yellow birch (*Betula alleghaniensis*). Typical herbs are Michaux's saxifrage (*Saxifraga michauxii*), Rand's goldenrod (*Solidago randii*), mountain sandwort (*Minuartia groenlandica*), Alleghany stonecrop (*Sedum telephioides*), three-toothed cinquefoil (*Sibbaldiopsis tridentata*), wavy hairgrass (*Deschampsia flexuosa* var. *flexuosa*), and Appalachian rock polypody (*Polypodium appalachianum*). A number of remarkable, long-range boreal disjuncts, *e.g.*, highland rush (*Juncus trifidus*), Appalachian fir clubmoss (*Huperzia appalachiana*), and narrow false-oats (*Trisetum spicatum*), are associated with these outcrops. Community types in this group are considered very rare in Virginia and globally. Threats include trampling and destruction of fragile vegetation mats and invasive exotic weeds such as flat-stemmed bluegrass (*Poa compressa*) and sheep-sorrel (*Rumex acetosella*). References: Coulling and Rawinski (1999), Rawinski and Wieboldt (1993).

Northern Red Oak Forests
Dominance by northern red oak (*Quercus rubra*) characterizes these forests, which reach maximal importance at elevations above 900 m (3000 ft) throughout western Virginia. Composition of these communities varies considerably with geologic substrate and soil chemistry, with ericaceous shrubs and hayscented fern (*Dennstaedtia punctilobula*) occurring abundantly on the poorer sites and diverse nutrient-demanding forbs such as purple giant-hyssop (*Agastache scrophulariaefolia*), pale-leaf sunflower (*Helianthus strumosus*), and cut-leaved coneflower (*Rudbeckia laciniata*) occupying more fertile sites. A widespread compositional variant of moist sites features extensive, nearly monospecific colonies of interrupted fern (*Osmunda claytoniana*). Some stands in this group have replaced mixed northern red oak-American chestnut (*Castanea dentata*) forests following the decimation of chestnut canopy trees by an introduced fungal blight (*Cryphonectria parasitica*) early in the twentieth century. Perhaps because of widespread fire suppression, oak reproduction is poor and invasion by mesophytic trees such as sugar maple (*Acer saccharum* var. *saccharum*) is increasing in many present-day montane red oak forests. Gypsy moth infestation, which has lead to repeated defoliation and widespread tree mortality on the northern Blue Ridge, is another serious threat to this and other oak-dominated communities. References: Abrams *et al*. (1997), Agraawal and Stephenson (1983), Coulling and Rawinski (1999), Johnson and Ware (1982), Rawinski *et al*. (1994), Rawinski *et al*. (1996), Rheinhardt and Ware (1984), Stephenson (1982a), Stephenson (1982b), Stephenson and Adams (1989), Stephenson and Adams (1991).

Montane Pine Barrens
A group of rare, northern and central Appalachian communities occurring on exposed, gently sloping to sub-level, xeric summits of high-elevation sedimentary ridges. Sandy soils, weathered from the underlying quartzite or sandstone, are oligotrophic, shallow, and rocky. The habitats are fire-prone, but the vegetation retains a dwarfed, shrubland (< 6 m [20 ft] tall) physiognomy even during long absences of fire due to the droughty, nutrient-poor soils and constant exposure to severe winds and ice. Only one occurrence of montane pine barrens is documented in Virginia, covering about 60 ha (150 ac) on Warm Springs Mountain (Bath County), at elevations between 1100 and 1200 m (3600 and 4000 ft). Larger barrens occur in nearby West Virginia at elevations from 1200 to 1375 m (4000 to 4500 ft) on the summit of North Fork Mountain (Pendleton County). The singular Virginia occurrence is characterized by dense, nearly impenetrable thickets of Catawba rhododendron (*Rhododendron catawbiense*), bear oak (*Quercus ilicifolia*), mountain-laurel (*Kalmia latifolia*), black huckleberry (*Gaylussacia baccata*), and late lowbush blueberry (*Vaccinium angustifolium*), with scattered emergent (but still shrub-sized) pitch pines (*Pinus rigida*). The average height of the barrens vegetation varies from knee-high in years following intense burns to about 5 m (16 ft). This community type is considered globally rare and is floristically intermediate between the West Virginia pine barrens and certain Southern Appalachian Shrub Balds. It is very closely related to communities of the Pine-Oak/Heath Woodlands group but differs in its restriction to high-elevation sites, its permanently dwarfed physiognomy, the greater influence of edaphic and climatic stresses, and the absence of tree oaks. The globally rare herodias underwing moth (*Catocala herodias gerhardii*), a bear oak feeder, has been documented at the Warm Springs Mountain barrens.

LOW-ELEVATION MESIC FORESTS
Ecological community groups with distributions centered below 900 m (3000 ft) elevation and representing mesophytic to submesophytic forest vegetation. A few community types of the Rich Cove and Slope Forests, Acidic Cove Forests, and Eastern Hemlock Forests extend into the high-elevation zone (> 900 m).

Rich Cove and Slope Forests
Mixed hardwood forests of fertile, mesic, mountain-slope habitats at elevations ranging from about 450 m (1500 ft) commonly to 1100 m (3600 ft) and more locally to 1400 m (4600 ft). Distinctive rich forests occurring at higher elevations of the Allegheny Mountains (Highland County) and the Blue Ridge are transitional to the two northern hardwood forest groups. Distributed locally throughout western Virginia, these forests are strongly associated with moist, sheltered, landforms (*i.e*., coves, ravines, and concave lower slopes). Soils may be weathered from various substrates but are generally moderately acidic to moderately alkaline, with high base saturation. Characteristic trees include sugar maple (*Acer saccharum* var. *saccharum*), basswoods (*Tilia americana* var. *americana* and var. *heterophylla*), white ash (*Fraxinus americana*), tulip-poplar (*Liriodendron tulipifera*), and yellow buckeye (*Aesculus flava*). Herbaceous growth is lush with spring ephemerals and leafy, shade-tolerant forbs such as blue cohosh (*Caulophyllum thalictroides*), yellow jewelweed (*Impatiens pallida*), large-flowered trillium (*Trillium grandiflorum*), wood-nettle (*Laportea canadensis*), and many others. Compositional variation related to substrate and elevation is complex and will require intensive future study. The principal threats to rich cove forests are logging and invasion by garlic-mustard (*Alliaria petiolata*) and other shade-tolerant, exotic weeds. References: Coulling and Rawinski (1999), Fleming (1999), Fleming and Moorhead (1996), Fleming and Moorhead (2000), Johnson and Ware (1982), Olson and Hupp (1986), Rawinski *et al*. (1994), Rawinski *et al*. (1996), Rheinhardt and Ware (1984).

Basic Mesic Forests
Mixed hardwood forests of fertile, mesic, low-elevation habitats in the Coastal Plain, Piedmont and major mountain valleys. Typical sites are deep ravines, sheltered north- or east-facing slopes subtending large streams and rivers, and occasionally well-drained floodplain terraces. Soils are usually weathered from carbonate or mafic bedrock, or from calcareous, shell-rich deposits in the Coastal Plain. Dominant trees include the species of Rich Cove and Slope Forests, as well as chinkapin oak (*Quercus muhlenbergii*), black maple (*Acer nigrum*), southern sugar maple (*Acer barbatum*), American beech (*Fagus grandifolia*), bitternut hickory (*Carya cordiformis*), and black walnut (*Juglans nigra*). Shrub and herb layers contain a number of species that are atypical of mountain slopes, such as paw-paw (*Asimina triloba*), twinleaf (*Jeffersonia diphylla*), harbinger-of-spring (*Erigenia bulbosa*), and toadshade (*Trillium sessile*). Several distinctive community types appear to be represented in this group, including a river-slope unit of the Piedmont and northern mountains, a river-slope unit of southwestern Virginia carbonate rock districts, a foothill/low mountain unit, and a Coastal Plain calcareous ravine unit. The extent and viability of basic mesic forests has been much reduced by repeated logging and invasive exotic weeds. References: Fleming (1999), Rawinski *et al*. (1996), Vanderhorst (2000), Ware and Ware (1992).

Acidic Cove Forests
Mixed hardwood and hardwood-hemlock forests of infertile, mesic, mountain-slope habitats. In Virginia,, these forests occur most extensively in the west-central and southwestern mountains, occupying moist lower slopes, ravines, and coves in districts underlain by sandstone, quartzite, or other acidic bedrock. Typical canopy trees include tulip-poplar (*Liriodendron tulipifera*), eastern hemlock (*Tsuga canadensis*), red maple (*Acer rubrum*), sweet and yellow birches (*Betula lenta* and *B. alleghaniensis*), cucumber magnolia (*Magnolia acuminata*), and Fraser magnolia (*M. fraseri*) in variable mixtures. At the highest elevations, red spruce (*Picea rubens*) is a canopy associate, while in the Cumberland Mountains, American beech (*Fagus grandifolia*) is important. Dense, evergreen shrub layers of great-laurel (*Rhododendron maximum*) are characteristic, although largely absent in northwestern Virginia. Herbaceous species, limited by dense shade and poor soils, are much sparser and less diverse than in fertile cove habitats. Composition of these forests appears to vary with elevation and physiographic region. The hemlock component has been reduced by past logging and, more recently, by outbreaks of the hemlock woolly adelgid (*Adelges tsugae*), an exotic insect pest. References: Stephenson and Adams (1991), Coulling and Rawinski (1999), Fleming and Moorhead (1996), Fleming and Moorhead (2000), Rawinski *et al*. (1996).

Mesic Mixed Hardwood Forests
Mixed hardwood forests of mesic to submesic, infertile habitats throughout the Coastal Plain and Piedmont, and more locally at low elevations in the mountains. Forests in this group occupy mesic uplands, ravines, lower slopes, and well-drained "flatwoods" on acidic, relatively nutrient-poor soils. The most typical tree canopies contain mixtures of American beech (*Fagus grandifolia*), oaks (*Quercus* spp., varying by region), tulip-poplar (*Liriodendron tulipifera*), and hickories (*Carya* spp.), but a wide variety of hardwood associates occur. American hornbeam (*Carpinus caroliniana* ssp. *caroliniana* and ssp. *virginiana*), flowering dogwood (*Cornus florida*) and, in eastern Virginia, American holly (*Ilex opaca* var. *opaca*) are prominent understory plants. In mesic "flatwoods" of the southeastern Virginia Coastal Plain, silky camelia (*Stewartia malacodendron*) and big-leaf snowbell (*Styrax grandifolia*) are characteristic small trees. These communities lack the lush herbaceous layers of rich mixed hardwood forests, although herbaceous species such as Christmas fern (*Polystichum acrostichoides*) may form moderately dense clumps. The name "Southern Mixed Hardwood Forest" has often been applied to Coastal Plain representatives of this group. Although mesic mixed hardwood forests still cover sizeable areas east of the mountains in Virginia, their quality and extent has been reduced by repeated logging. Several distinct community types are represented in this widespread group. References: Coulling (1999), Crouch (1990), DeWitt and Ware (1979), Frost and Musselman (1987), McCoy and Fleming (2000), Monette and Ware (1983), Plunkett and Hall (1995), Ware (1970), Ware (1978), Ware (1991), Wolff and Ware (1994).

Eastern Hemlock Forests
Forests dominated by eastern hemlock (*Tsuga canadensis*), occupying mesic, sheltered habitats throughout the mountains and isolated, north-facing river bluffs and ravines of the Piedmont. A number of tree associates, especially sweet and yellow birches (*Betula lenta* and *B. alleghaniensis*) and eastern white pine (*Pinus strobus*), may contribute to mixed canopies, but the total cover of overstory and understory hemlock in these forests greatly exceeds that of any other species. In the Piedmont, where hemlock forests may intergrade with Mesic Mixed Hardwood forests, American beech (*Fagus grandifolia*) and white oak (*Quercus alba*) are frequent associates,. Understories vary from sparse to moderately dense; some stands have ericaceous shrub layers dominated by mountain-laurel (*Kalmia latifolia*), great-laurel (*Rhododendron maximum*), or Catawba rhododendron (*R. catawbiense*). Herbs are typically very sparse, but rare stands on basic or calcareous substrates have more diverse lower strata. Several notable old-growth hemlock forests occur in Virginia, including a stand in the Skidmore Fork drainage on Shenandoah Mountain (Rockingham County) and The Limberlost in Shenandoah National Park (Madison County). All eastern hemlock forests in Virginia are now highly threatened by the hemlock woolly adelgid (*Adelges tsugae*), an introduced insect that has caused extensive mortality in many stands. References: Coulling (1999), Harrison *et al*. (1989), Nemeth (1973), Rawinski *et al*. (1994), Rawinski *et al*. (1996).

Eastern Arborvitae Slope Forests
Mixed, largely coniferous forests in which eastern arborvitae (*Thuja occidentalis*) is a dominant or co-dominant tree. This is a rare natural community occurring in small, isolated patches from the Ridge and Valley province of western Virginia south to the Eastern Highland Rim, Ridge and Valley, and low Blue Ridge regions of Tennessee. Habitats are on steep, rocky, mesic to submesic slopes that are undercut by streams and have west to north aspects. Underlying bedrock is usually limestone or dolomite, but one Virginia site is underlain by calcareous Silurian sandstone. Eastern white pine (*Pinus strobus*) and/or eastern hemlock (*Tsuga canadensis*) are the most frequent (often co-dominant) tree associates, with scattered hardwoods also present. Understory and herbaceous layers are variable but generally contain a number of typical calciphiles such as American barberry (*Berberis canadensis*), leatherwood (*Dirca palustris*), northern bedstraw (*Galium boreale*), and sharp-lobed hepatica (*Hepatica acutiloba*). Reference: Fleming (1999).

LOW-ELEVATION DRY AND DRY-MESIC FORESTS AND WOODLANDS

Ecological community groups with distributions centered below 900 m (3000 ft) elevation and representing xerophytic to submesophytic forest and woodland vegetation. A few community types of the Montane Oak-Hickory Forests, Mixed Oak / Heath Forests, Chestnut Oak Forests, and Pine – Oak / Heath Woodlands extend into the high-elevation zone (> 900 m).

Dry-Mesic Calcareous Forests

A group of montane, mixed hardwood forests occupying submesic slopes and crests with warm (southeast to southwest) aspects and fertile soils weathered from underlying limestone, dolomite, calcareous sandstone, or metabasalt. Habitats in Virginia include mountain valley sideslopes, lower mountain slopes, and ravines up to about 900 m (3000 ft) elevation. Forests of this group are widely distributed in the Ridge and Valley province, but rather local in the Blue Ridge and Cumberland Mountains. Mixtures of sugar maple (*Acer saccharum* var. *saccharum*), black maple (*Acer nigrum*), white oak (*Quercus alba*), northern red oak (*Quercus rubra*), black oak (*Quercus velutina*), and hickories (*Carya* spp.) are typical. Tulip-poplar (*Liriodendron tulipifera*) is most abundant as an invader of logged stands. Understory and herbaceous vegetation varies from sparse to lush (especially on limestone sites), but is generally dominated by species characteristic of intermediate to somewhat dry moisture conditions, such as white snakeroot (*Ageratina altissima* var. *altissima*), hog-peanut (*Amphicarpaea bracteata*), common eastern bromegrass (*Bromus pubescens*), and black bugbane (*Cimicifuga racemosa*). Many dry-mesic calcareous forests have been heavily cut over or destroyed for agriculture. References: Fleming (1999), Fleming and Moorhead (1996), Fleming and Moorhead (2000).

Basic Oak – Hickory Forests

Mixed hardwood forests of submesic to subxeric upland habitats over basic rocks such as diabase, gabbro, amphibolite, and metabasalt. Soils range from moderately acidic to circumneutral and have high levels of base saturation. Communities in this group are scattered throughout the Virginia Piedmont and on low-elevation slopes of the northern Blue Ridge; their distribution elsewhere in the state is uncertain. The largest patches of this vegetation occur in the Piedmont Triassic basins, on the more extensive intrusions of mafic and ultramafic formations elsewhere in the Piedmont, and on soils derived from greenstone in the Blue Ridge and foothills. Overstory composition varies regionally, but is generally characterized by mixtures of white oak (*Quercus alba*), northern red oak (*Q. rubra*), black oak (*Q. velutina*), chestnut oak (*Q. montana*), post oak (*Q. stellata*), pignut hickory (*Carya glabra*), red hickory (*C. ovalis*), shagbark hickory (*C. ovata*), mockernut hickory (*C. alba*), and white ash (*Fraxinus americana*). Hickories are especially abundant in these forests and may dominate some stands. Eastern redbud (*Cercis canadensis* var. *canadensis*), eastern hophornbeam (*Ostrya virginiana*), and flowering dogwood (*Cornus florida*) are common understory species. Herb layers are frequently species-rich and support diverse mixtures of both mesophytic and dry-site species. With a distribution in the Piedmont already restricted by limited available habitat, basic oak-hickory forests have also been reduced considerably by a long history of agriculture, conversion of hardwood forests to silvicultural pine stands, and urban development. Most, if not all, community types in this group can be considered uncommon or rare in the state. References: Farrell and Ware (1991), Ware (1991), Ware (1992).

Acidic Oak – Hickory Forests

Mixed hardwood forests of submesic to subxeric upland habitats over subacidic rocks such as siltstone, metasiltstone, shale, and certain granites. These forests are widely but locally distributed throughout the Piedmont and mountain valleys and lower mountain slopes of both the Blue Ridge and Ridge and Valley, up to about 600 m (2000 ft) elevation. Hickories are less abundant than in the Basic Oak-Hickory Forests group but are nevertheless prominent, sometimes primarily as understory trees. Dominant oaks include white oak (*Quercus alba*), black oak (*Q. velutina*), scarlet oak (*Q. coccinea*), southern red oak (*Q. falcata*), and chestnut oak (*Q. montana*). Deciduous ericads such as lowbush blueberry (*Vaccinium*

pallidum) and deerberry (*V. stamineum*) are usually present, but patchy. Herbaceous diversity is somewhat less than in Basic Oak-Hickory Forests but considerably greater than in Mixed Oak/Heath Forests. References: Fleming and Moorhead (2000), Gemborys (1974), Olson and Hupp (1986).

Montane Oak – Hickory Forests

Mixed hardwood forests of submesic to subxeric mountain slopes and crests up to about 1200 m (4000 ft) elevation. Communities in this group reach maximal importance on base-rich igneous, metamorphic, and subcalcareous metasedimentary rocks. Northern red oak (*Quercus rubra*), white oak (*Q. alba*), chestnut oak (*Q. montana*), red hickory (*Carya ovalis*), shagbark hickory (*C. ovata*), and bitternut hickory *(C. cordiformis*) are typical co-dominant trees. Understory and herbaceous composition varies with geography and site conditions, but is often relatively species-rich, even on dry sites. Included are a number of species, *e.g.*, choke cherry (*Prunus virginiana* var. *virginiana*) and Appalachian meadow-rue (*Thalictrum coriaceum*), characteristic of middle and higher elevations. The herbaceous layers of some stands on moister sites attain a luxuriance that rivals that of the Rich Cove and Slope Forests. Montane Oak-Hickory Forests are transitional to Northern Red Oak Forests at higher elevations, and to several other oak and oak-hickory forests at lower elevations. References: Adams and Stephenson (1983), Coulling and Rawinski (1999), Fleming and Moorhead (2000), Johnson and Ware (1982), McCormick and Platt (1980), Rawinski *et al*. (1994), Rawinski *et al*. (1996), Stephenson (1982a), Stephenson (1982b), Stephenson and Adams (1991).

Mixed Oak / Heath Forests

Oak-dominated forests of submesic to xeric, infertile upland sites. This is a robust group of communities that are distributed across Virginia in every physiographic province. In some cases, particularly in the mountains and foothills, these communities have replaced former mixed oak – American chestnut (*Castanea dentata*) forests following the decimation of chestnut canopy trees by an introduced fungal blight (*Cryphonectria parasitica*) early in the twentieth century. Habitats are variable, ranging from sterile, low-elevation "flatwoods" to steep, rocky mountainsides. All have soils with a distinctly oligotrophic nutrient regime, *i.e.*, strongly acidic, with low base cation levels and relatively high levels of iron. Accumulations of thick duff and high biomass of inflammable shrubs in these forests make them susceptible to periodic fires, which in turn favors recruitment of oaks. Regionally varying mixtures of white oak (*Quercus alba*), chestnut oak (*Q. montana*), scarlet oak (*Q. coccinea*), black oak (*Q. velutina*), northern red oak (*Q. rubra*), southern red oak (*Q. falcata*), and post oak (*Q. stellata*) compose the canopies of these forests. Pines – including pitch pine (*Pinus rigida*) in the mountains, shortleaf and Virginia pines (*P. echinata* and *P. virginiana*) in the Piedmont, and loblolly pine (*P. taeda*) in the Coastal Plain – are common associates that usually indicate past disturbance. Hickories (*Carya* spp.) are generally unimportant and mostly restricted to the understory. Red maple (*Acer rubrum*), blackgum (*Nyssa sylvatica*) and sourwood (*Oxydendrum arboreum*) are frequent canopy associates and abundant understory trees. Ericaceous (heath-family) plants, including mountain-laurel (*Kalmia latifolia*), black huckleberry (*Gaylussacia baccata*), and blueberries (*Vaccinium* spp.), form dense colonies in the shrub and herb layers, and true herbaceous species are sparse. Evergreen rhododendrons (*Rhododendron maximum* and *R. catawbiense*) and dangleberry (*Gaylussacia frondosa*) are locally prevalent members of the ericaceous shrub complex in the mountains and Coastal Plain, respectively. Community types in this group constitute a widespread element of large-patch vegetation in Virginia's landscape. Although still relatively extensive, they are subject to multiple disturbances, including clear-cutting, conversion to pine silvicutures, gypsy moth infestation, fire suppression, and destruction by development. References: Adams and Stephenson (1983), Clark and Ware (1980), Cole and Ware (1997), Coulling and Rawinski (1999), Crouch (1990), Farrell and Ware (1988), Fleming and Moorhead (1996), Fleming and Moorhead (2000), Gemborys (1974), Harrison *et al*. (1989), Martin *et al*. (1982), McCoy and Fleming (2000), McEvoy *et al*. (1980), Rawinski *et al*. (1994), Rawinski *et al*. (1996), Rhoades (1992), Rhoades (1995), Stephenson (1974), Stephenson (1982a), Stephenson and Adams (1991), Stephenson and Fortney (1998), Vanderhorst (2000), Ware (1991).

Chestnut Oak Forests
Forests overwhelmingly dominated by chestnut oak (*Quercus montana*) on subxeric to xeric, usually rocky, upland slopes. These communities are most widespread and extensive on sandstone or quartzite ridges in the mountains, but are found on monadnocks, foothills, and rocky or gravelly bluffs throughout the Piedmont and inner Coastal Plain. Minor tree components vary considerably by region. Associates in the mountains include bear oak (*Quercus ilicifolia*), pitch pine (*Pinus rigida*) and table-mountain pine (*P. pungens*), while American beech (*Fagus grandifolia*) and American holly (*Ilex opaca* var. *opaca*) are associates in the eastern part of the state. Red maple (*Acer rubrum*) and blackgum (*Nyssa sylvatica*) are common understory trees throughout the range. Prior to the introduction of chestnut blight in 1904, American chestnut (*Castanea dentata*) was a co-dominant tree in some of these forests. Ericaceous shrubs, including mountain-laurel (*Kalmia latifolia*) and a variety of deciduous heaths, are prevalent in shrub layers of chestnut oak forests. On many mountain ridges, chestnut oak forests form large patches, a number of which have escaped cutting because of the stunted growth and poor form of the canopy trees. References: Abrams *et al*. (1997), Adams and Stephenson (1983), Allard and Leonard (1943), Fleming and Moorhead (2000), McCoy and Fleming (2000), Harrison *et al*. (1989), Johnson and Ware (1982), Olson and Hupp (1986), Rawinski *et al*. (1994), Rawinski *et al*. (1996), Stephenson (1982a).

Eastern White Pine – Hardwood Forests
Mixed forests characterized by co-dominance of eastern white pine (*Pinus strobus*) and hardwoods. In pure stands white pine is a fast-growing, early successional invader of disturbed habitats, but it is long-lived and apparently persistent in more successionally stable mixed forests. Communities in this group occur throughout the mountains, but are especially prevalent on low shale knobs of the Ridge and Valley province in west-central Virginia. These forests become much more local eastward in the Piedmont. A single occurrence is known from the northern Coastal Plain (Caroline County). On submesic sites, co-dominant hardwoods include white oak (*Quercus alba*), northern red oak (*Q. rubra*), hickories (*Carya* spp.), tulip-poplar (*Liriodendron tulipifera*), and eastern hemlock (*Tsuga canadensis*). On more exposed, subxeric sites, chestnut oak (*Quercus montana*) and scarlet oak (*Q. coccinea*) are common co-dominants, and ericaceous shrubs such as mountain-laurel (*Kalmia latifolia*) prevail in the lower layers. Occasional fire may be a influential natural disturbance that ensures periodic regeneration of white pine, but the ecological dynamics of this group are poorly understood. References: Coulling and Rawinski (1999), Fleming and Moorhead (2000).

Piedmont / Coastal Plain Oak – Beech / Heath Forests
Mixed hardwood forests of submesic, usually north-facing bluffs, and steep ravine slopes with acidic, nutrient-poor soils. In Virginia, these forests are widely, but locally, distributed in small patches across much of the Piedmont and dissected, inner Coastal Plain. White oak (*Quercus alba*), northern red oak (*Q. rubra*), chestnut oak (*Q. montana*), and American beech (*Fagus grandifolia*) are the major canopy trees. Eastern hemlock (*Tsuga canadensis*) and sweet birch (*Betula lenta*) are occasional associates. Sourwood (*Oxydendrum arboreum*), blackgum (*Nyssa sylvatica*), and red maple (*Acer rubrum*) are common understory trees. Dense colonies of mountain-laurel (*Kalmia latifolia*) or, very locally, evergreen rhododendrons (*Rhododendron catawbiense* or *R. maximum*) form a continuous shrub layer. Few herbaceous species occur in the stands. On very steep and rocky bluffs, tree canopies may be quite open as the result of poor establishment and frequent downfalls. Communities in this group are similar to Mesic Mixed Hardwood Forests but usually occupy drier, steeper sites that support fewer mesophytic plants and a greater abundance of heaths.

Carolina Hemlock Forests
Forests dominated or co-dominated by Carolina hemlock (*Tsuga caroliniana*). In Virginia, these forests occupy a few local, scattered areas on xeric mountain slopes of the Blue Ridge and Ridge and Valley provinces in the southwestern part of state, south of the James River. A single stand is known from a

river bluff in the southern Piedmont (Pittsylvania County). Sites are typically very steep and rocky, with shallow, nutrient-poor soils. Common associates are chestnut oak (*Quercus montana*), white oak (*Quercus alba*), scarlet oak (*Quercus coccinea*), pines (*Pinus* spp.), blackgum (*Nyssa sylvatica*), and various ericaceous shrubs. Physiognomy of stands varies from closed-canopy to very open, approaching a woodland structure. These communities often occur in patch-mosaics with fire-influenced oak/heath and pine-oak/heath vegetation. Fire may be an important factor that has limited Carolina hemlock, evidently a fire-intolerant species, to rocky areas and bluffs that are somewhat protected from burning. Currently, the exotic insect pest, hemlock woolly adelgid (*Adelges tsugae*), poses a major threat to the viability of Carolina hemlock stands. Community types in this group are generally considered globally rare. References: Rentch *et al*. (2000), Stevens (1971).

Pine – Oak / Heath Woodlands

Species-poor, fire-influenced, mixed woodlands of xeric, exposed mountain slopes. Habitats are typically located on convex, south to west facets of steep spur ridges, narrow rocky crests, and cliff tops. Pine–oak/heath woodlands are widespread throughout both the Ridge and Valley and Blue Ridge provinces in western Virginia. They occur at elevations from 450 to 1200 m (1500 to 4000 ft) on various substrates, but most commonly on acidic, sedimentary and metasedimentary substrates, *e.g*., sandstone, quartzite, and shale. A few stands occur on Piedmont monadnocks and foothills. Soils are very infertile, shallow, and droughty. Thick, poorly decomposed duff layers, along with dead wood and inflammable shrubs, contribute to a strongly fire-prone habitat. Short-statured table-mountain pine (*Pinus pungens*) and pitch pine (*Pinus rigida*) are usually the dominants of an open canopy. Low-cover tree associates include chestnut oak (*Quercus montana*), scarlet oak (*Q. coccinea*), Virginia pine (*P. virginiana*), and sassafras (*Sassafras albidum*). Except in the Piedmont stands, bear oak (*Quercus ilicifolia*) is characteristically abundant in the shrub layer, along with various ericaceous shrubs. Colonial shrubs usually pre-empt available microhabitats for most herbaceous species, but bracken fern (*Pteridium aquilinum* var. *latiusculum*) and the spectacular turkey-beard (*Xerophyllum asphodeloides*) are often competitive enough to achieve significant cover. Periodic fire is an important ecological process that provides opportunities for regeneration of both pines and less competitive herbaceous species, while setting back successional encroachment of potential canopy oaks (especially chestnut oak). On cliffs and other very rocky sites, the vegetation is self-perpetuating due to extreme edaphic conditions. Fire reduction and the insect pest, southern pine beetle (*Dendroctonus frontalis*) are the most serious threats to communities of this group. The state-rare northern pine snake (*Pituophis melanoleucus melanoleucus*) and several rare moths, all bear oak feeders, are locally associated with these woodlands. References: Fleming and Moorhead (2000), Groeschl *et al*. (1992), Martin *et al*. (1982), Olson and Hupp (1986), Rawinski *et al.* (1994), Rawinski *et al.* (1996).

Montane Acidic Woodlands

Coniferous and mixed woodlands of xeric, edaphically stressful habitats. Communities in this group are scattered throughout the Virginia mountains and occupy somewhat heterogeneous habitats that are characterized by shallow, drought-prone, highly oligotrophic soils. Four distinct environmental / compositional variants have been identified: 1) barren Virginia pine (*Pinus virginiana*) woodlands of acidic shale slopes and crests in the Ridge and Valley province; 2) Virginia pine – oak (*Quercus* spp.) and pitch pine (*P. rigida*) – oak woodlands of sandstone outcrop slopes in the Ridge and Valley and Cumberland Mountains; 3) Virginia Pine – post oak (*Quercus stellata*) woodlands of xeric cobble terraces on massive alluvial fans along the west foot of the Blue Ridge; and 4) shortleaf pine (*P. echinata*) – oak – hickory (*Carya* spp.) woodlands of sloping sandstone outcrops in the Cumberland Mountains. In many cases, Montane Acidic Woodlands are floristically similar to Pine-Oak/Heath Woodlands but are maintained primarily by drought stresses associated with outcrop environments rather than by fire. They also tend to have a sparser representation of heath shrubs and a more diverse herb layer, with a larger component of graminoids such as little bluestem (*Schizachyrium scoparium* ssp. *scoparium*) or Pennsylvania sedge (*Carex pensylvanica*). At least some of the community types in this group appear to

be state- or globally rare, but their relationship to vegetation on a regional scale needs further investigation. Reference: Fleming and Moorhead (2000).

Piedmont / Mountain Basic Woodlands
Deciduous and mixed woodlands of xeric, rocky habitats over mafic substrates such as diabase, gabbro, metabasalt, and amphibolite. A few examples of this group occur in habitats underlain by base-rich granite, calcareous shale, and calcareous sandstone. Occurrences in Virginia are widely and locally scattered throughout the Piedmont and mountains, often occurring in patch-mosaics with exposed outcrops. They are most frequent (but still very local) in metabasaltic (greenstone) districts of the northern Blue Ridge. Habitats are situated on south- to west-facing slopes with numerous outcrops and shallow, rocky soils that are dry but relatively fertile, with moderately high pH and levels of calcium and magnesium. Although oaks (*Quercus* spp.) are frequent (sometimes dominant) components, these woodlands are more often dominated by variable mixtures of white ash (*Fraxinus americana*) and hickories (*Carya* spp.), often with eastern red cedar (*Juniperus virginiana* var. *virginiana*) or Virginia pine (*Pinus virginiana*) as a major associate. Trees are usually somewhat stunted and form an open or sparse canopy. Typical small trees and shrubs include eastern redbud (*Cercis canadensis* var. *canadensis*), eastern hophornbeam (*Ostrya virginiana*), ninebark (*Physocarpus opulifolius* var. *opulifolius*), aromatic sumac (*Rhus aromatica* var. *aromatica*), hackberries (*Celtis occidentalis* and *C. tenuifolia*), slippery elm (*Ulmus rubra*), and hoptree (*Ptelea trifoliata* ssp. *trifoliata*). These woodlands contain a surprisingly diverse array of herbaceous graminoids and forbs; a few of the more widespread, representative species are cliff muhly (*Muhlenbergia sobolifera*), elm-leaved goldenrod (*Solidago ulmifolia* var. *ulmifolia*), bottlebrush grass (*Elymus hystrix* var. *hystrix*), Pennsylvania sedge (*Carex pensylvanica*), and hoary mountain-mint (*Pycnanthemum incanum* var. *incanum*). There is considerable compositional variation over the state, and several community types will be recognized. All of these communities are considered state-rare, and some may also be globally rare. There are few threats, although the shrub coralberry (*Symphoricarpos orbiculatus*), introduced from farther west, is a troublesome invasive in some stands. References: Coulling and Rawinski (1999), Rawinski *et al*. (1996).

Ultramafic Woodlands
Mixed woodlands of xeric uplands underlain by serpentinite, soapstone, talc-tremolite schist, and other ultramafic rocks. Only five occurrences of this vegetation are documented in Virginia: three in the Piedmont (Amherst, Franklin, and Nelson Counties) and two in The Glades region of the southern Blue Ridge plateau (Grayson County). Habitats are relatively gentle, rocky uplands with very dry, shallow, magnesium- and iron-rich soil. The original vegetation of the Piedmont examples was probably open, stunted savanna of post oak (*Quercus stellata*), blackjack oak (*Q. marilandica*), and Virginia pine (*Pinus virginiana*) over little bluestem (*Schizachyrium scoparium* ssp. *scoparium*). The present-day stands are semi-closed and more heavily dominated by Virginia pine as the result of disturbances such as cutting and possibly fire suppression. The Blue Ridge occurrences are open woodlands dominated by post oak, pitch pine (*P. rigida*), and eastern white pine (*P. strobus*), with a relatively dense herb layer containing little bluestem, big bluestem (*Andropogon gerardii*), balsam ragwort (*Senecio pauperculus*), skunk meadowrue (*Thalictrum revolutum*) and other xerophytes. Also present are anomalous populations of several species more typical of wetland habitats, *e.g*., Canada burnet (*Sanguisorba canadensis*) and pine-barren death-camas (*Zigadenus leimanthoides*). These ultramafic woodlands are extremely rare in Virginia and globally. Quarrying has partly or wholly destroyed occurrences at two of the sites and poses a serious threat at another site. Additional threats to these communities include grazing, agriculture, and development.

Montane Dry Calcareous Forest and Woodlands
Deciduous or occasionally mixed forests and woodlands of mostly subxeric, fertile habitats over carbonate formations of limestone or dolomite. Habitats are steep, usually rocky, south- to west-facing slopes at elevations from 450 to 900 m (1500 to 2900 ft). Soils vary from circumneutral to moderately

alkaline, and have high calcium levels. Confined in Virginia to the mountains, these communities are most frequent and extensive in the Ridge and Valley, but occur locally in both the Blue Ridge and Cumberland Mountains. Tree canopies vary from nearly closed to sparse and woodland-like. Overstory mixtures of chinkapin oak (*Quercus muhlenbergii*), sugar maple (*Acer saccharum* var. *saccharum*), black maple (*Acer nigrum*), northern red oak (*Q. rubra*), white oak (*Q. alba*), Shumard oak (*Q. shumardii* var. *shumardii*), and white ash (*Fraxinus americana*) are typical. These forests and woodlands share many understory and herbaceous plants with the Piedmont / Mountain Basic Woodlands group and are similarly species-rich. A few of the taxa that are confined to or most important in the limestone and dolomite communities include Carolina buckthorn (*Frangula caroliniana*), round-leaved ragwort (*Senecio obovatus*), robin's-plantain (*Erigeron pulchellus* var. *pulchellus*), American beakgrain (*Diarrhena americana*), slender muhly (*Muhlenbergia tenuiflora*), black-fruited mountain ricegrass (*Oryzopsis racemosa*), purple sedge (*Carex purpurifera*, in extreme southwestern Virginia only), stiff-haired sunflower (*Helianthus hirsutus*), small-headed sunflower (*Helianthus microcephalus*), and mountain death-camas (*Zigadenus elegans* ssp. *glaucus*). Much compositional variation is evident in these communities across western Virginia. A rare and distinctive community type in this group, confined to the largely dolomitic Elbrook formation in the southwestern Ridge and Valley, features an abundance of the magnesiophiles prairie ragwort (*Senecio plattensis*), glade wild quinine (*Parthenium auriculatum*), and tall larkspur (*Delphinium exaltatum*), as well as populations of the federally listed smooth coneflower (*Echinacea laevigata*) and the globally rare, Virginia endemic Addison's leatherflower (*Clematis addisonii*). References: Fleming (1999), Rawinski *et al*. (1996).

Coastal Plain Dry Calcareous Forests and Woodlands
A group of rare and localized, deciduous or occasionally mixed forests and woodlands of subxeric to xeric, fertile habitats over unconsolidated, calcareous deposits. Occurrences are small and highly localized in dissected portions of the inner coastal plain from southeastern Virginia north to Stafford County. The majority of documented stands are on The Peninsula near Williamsburg. Habitats are developed on the steep, convex, south-facing slopes of deep ravines and stream-fronting bluffs that have downcut into Tertiary shell deposits or limesands. Soils are circumneutral to slightly alkaline, with high calcium levels. Canopies range from semi-closed to very open. Chinkapin oak (*Quercus muhlenbergii*) is the most characteristic tree; southern sugar maple (*Acer barbatum*), white oak (*Q. alba*), northern red oak (*Q. rubra*), bitternut hickory (*Carya cordiformis*), American beech (*Fagus grandifolia*), and white ash (*Fraxinus americana*) are common associates. The understory includes eastern red cedar (*Juniperus virginiana* var. *virginiana*) and eastern redbud (*Cercis canadensis* var. *canadensis*). Although not lush, the herb layer contains a diversity of species, including several long-range mountain disjuncts. Particularly abundant or noteworthy herbaceous species include robin's-plantain (*Erigeron pulchellus* var. *pulchellus*), Bosc's panic-grass (*Dichanthelium boscii*), white crownbeard (*Verbesina virginica* var. *virginica*), American bellflower (*Campanulastrum americanum*), bear's-foot (*Smallanthus uvedalius*), whorled rosinweed (*Silphium trifoliatum* var. *trifoliatum*), few-flowered tick-trefoil (*Desmodium pauciflorum*), crested coralroot (*Hexalectris spicata*), and eastern needlegrass (*Piptochaetium avenaceum*). Compared to Basic Mesic Forests of the Coastal Plain, these dry calcareous forests have a larger component of oaks (particularly chinkapin oak) in the overstory and have a much less lush herb layer. Communities in this group are considered globally rare and are threatened by logging and development.

Acidic Oak – Hickory Woodlands and Savannas
Deciduous woodlands occurring in Piedmont military base training areas ("impact areas") that have been subject to frequent incendiary fires for at least 50 years. Communities in this group are now found only at Quantico Marine Base in northern Virginia (Fauquier, Prince William, and Stafford Counties) and Fort Pickett in south-central Virginia (Dinwiddie and Nottoway Counties), where they cover hundreds of hectares. Habitats at both sites are rolling uplands underlain by granitic rocks. Soils are sandy and range from extremely to strongly acidic, with relatively low base cation levels. Stand physiognomy

encompasses semi-closed woodland with little understory, graminoid-rich savannas with widely spaced trees, and dense thickets of small, sprout-origin trees. Variable mixtures of white oak (*Quercus alba*), black oak (Q. *velutina*), southern red oak (*Q. falcata*), scarlet oak (*Q. coccinea*), post oak (*Q. stellata*), and mockernut hickory (*Carya alba*) form the woodland canopies. Understories are highly variable in both density and composition. Dense herb layers are rich in both grasses and legumes. Abundant species include little bluestem (*Schizachyrium scoparium* ssp. *scoparium*), indian grasses (*Sorghastrum nutans* and *S. elliottii*), broomsedges (*Andropogon virginicus* and *A. gyrans*), poverty oat-grass (*Danthonia spicata*), silver plumegrass (*Saccharum alopecuroidum*), tick-trefoils (*Desmodium* spp.), and lespedezas (*Lespedeza* spp.). Goldenrods (*Solidago* spp.), thoroughworts (*Eupatorium* spp.), and other composites are characteristic of the diverse late-flowering flora of the woodlands. Although communities of this group are strongly influenced by an artificial disturbance regime, they are Virginia's only remaining examples of vegetation that is shaped by random burns of a size, frequency, and intensity comparable to those of putative pre-settlement fire regimes. Thus, they may provide important clues about the probable composition and environmental dynamics of woodlands that were more widespread prior to European colonization of Virginia. The largest known population in the world of the globally rare, federally listed shrub Michaux's sumac (*Rhus michauxii*) is associated with the fire-influenced woodlands at Fort Pickett. Reference: Maxwell (1910).

Basic Oak – Hickory Woodlands and Savannas

Deciduous woodlands occurring in Piedmont military base training areas ("impact areas") that have been subject to frequent incendiary fires for at least 50 years. Communities in this group are found only in a small (20-25 ha) area of Fort Pickett in south-central Virginia (Dinwiddie County). The habitat is a rolling upland underlain by a sill of intrusive Triassic diabase. Soils are dark, circumneutral loams with relatively high calcium and magnesium levels. The structure and overstory composition of these woodlands are similar to those of the acidic woodlands at Fort Pickett (see Acidic Oak-Hickory Woodlands and Savannas), but their herbaceous flora is more species-rich and characterized by forbs. Dominants of the herb layer include the low-statured, federally listed shrub Michaux's sumac (*Rhus michauxii*), nettle-leaf sage (*Salvia urticifolia*), glade wild quinine (*Parthenium auriculatum*), naked-flowered tick-trefoil (*Desmodium nudiflorum*), perfoliate bellwort (*Uvularia perfoliata*), sunflowers (*Helianthus strumosus* and *H. divaricatus*), lesser snakeroot (*Ageratina aromatica*), skunk meadowrue (*Thalictrum revolutum*), and hog-peanut (*Amphicarpaea bracteata*). Although their current fire regime can be regarded as artificial, communities of this group are likely similar to woodlands alleged to have been widespread in a pre-Colonial landscape much influenced by natural fires. Reference: Maxwell (1910).

Piedmont Hardpan Forests

Deciduous and mixed forests occupying gentle to flat Piedmont uplands and ancient, never-flooded stream terraces with impermeable clay subsoil. Sites are usually underlain either by mafic rocks such as diabase or by acidic slates. Surficial soils are typically silt or clay loams, with an abrupt transition to heavy, plastic clay hardpans at depths of 23 to 38 cm (9 to 15 in). These shrink-swell clay soils pond water for brief or, at some sites, prolonged periods during rainy weather, but tend to be very hard and dry during significant portions of the growing season. Post oak (*Quercus stellata*) is the typical dominant canopy tree, growing in nearly pure stands or in variable mixtures with blackjack oak (*Q. marilandica*), white oak (*Q. alba*), Virginia pine (*Pinus virginiana*), pignut hickory (*Carya glabra*), and white ash (*Fraxinus americana*). Virginia pine increases following cutting and may dominate on heavily disturbed, clear-cut sites. Winged elm (*Ulmus alata*), sweetgum (*Liquidambar styraciflua*), and eastern red cedar (*Juniperus virginiana* var. *virginiana*) are characteristic understory trees. Shrubs include eastern redbud (*Cercis canadensis* var. *canadensis*), black haw (*Viburnum prunifolium*), fringetree (*Chionanthus virginicus*), and blueberries (*Vaccinium* spp.). In closed stands, there is often little herbaceous growth, while xerophytic grasses such as poverty oat-grass (*Danthonia spicata*) and eastern needlegrass (*Piptochaetium avenaceum*) form large patches in more open stands. Stands in which water ponds for

longer periods contain peculiar mixtures of upland and wetland species, but their hydrological status is problematic and they are treated here as communities of the Terrestrial System. In these periodically wet variants, species such as willow oak (*Q. phellos*), sweetgum (*Liquidambar styraciflua*), deciduous holly (*Ilex decidua*), hairy highbush blueberry (*Vaccinium fuscatum*), St. Peter's-wort (*Hypericum crux-andriae*), and beakrushes (*Rhynchosora* spp.) are intermingled with the xerophytic species listed above. Piedmont hardpan forests are scattered throughout the Piedmont in specialized soil environments and are considered uncommon to rare in Virginia.

Low-Elevation Boulderfield Forests and Woodlands
Open forests and woodlands occupying relatively unweathered boulderfields at elevations below 900 m (3000 ft). These habitats are widely scattered throughout the mountains on steep sideslopes of ridges, often in zones below large outcrops. Stand composition varies greatly with substrate, aspect, and slope position. Sweet birch (*Betula lenta*) is often the sole invader of large-block sandstone and quartzite boulderfields, forming pure stands of gnarled, spreading trees. Here, Virginia creeper (*Parthenocissus quinquefolia*) is sometimes the only low-growing plant able to become established in the deep interstices between boulders. On somewhat more weathered or less blocky boulderfields, chestnut oak (*Quercus montana*) or mixtures of chestnut oak, northern red oak (*Q. rubra*), blackgum (*Nyssa sylvatica*), and sweet birch, along with a greater diversity of shrubs and herbs, may prevail. Cool, north-facing, sandstone/quartzite boulderfields frequently support eastern hemlock (*Tsuga canadensis*) and, locally, disjunct populations of paper birch (*Betula papyrifera* var. *cordifolia*). On base-rich metabasalt boulderfields of the northern Blue Ridge, basswood (*Tilia americana* var. *americana* and var. *heterophylla*), white ash (*Fraxinus americana*), and butternut (*Juglans cinerea*) are characteristic trees. Dolomitic or limestone boulderfields support open stands of basswood and yellow buckeye (*Aesculus flava*), with a variety of mosses, bulblet fern (*Cystopteris bulbifera*), and other calciphilic herbs forming dense mats on rock surfaces. Communities in this group are uncommon in Virginia; their classification and distributional status need further assessment. References: Fleming (1999), Fleming and Moorhead (2000), Harrison *et al*. (1989), Hupp (1983a), Rawinski *et al*. (1994), Rawinski *et al*. (1996).

LOW-ELEVATION ROCK OUTCROPS AND BARRENS
Ecological community groups with distributions centered below 900 m (3000 ft) elevation and representing edaphically (or in one case, fire-) controlled woodland, scrub, herbaceous, and moss/lichen vegetation.

Low-Elevation Acidic Outcrop Barrens
Scrub and herbaceous vegetation of exposed sandstone, quartzite, and granitic outcrops up to about 975 m (3200 ft) elevation. These communities are scattered over the western Piedmont, Blue Ridge, Cumberland Mountains, and Ridge and Valley strike ridges. Habitats typically have very high cover of exposed bedrock, with vascular plants occupying crevices and locally developed organic mats. Soil environments are minimal and highly oligotrophic. Vegetation is usually a mosaic of shrub thickets, herbaceous patches, and lithophytic lichens. Composition varies to some extent with aspect and elevation. Woody scrub usually consists of scattered, highly stunted trees, bear oak (*Quercus ilicifolia*), and ericaceous shrub thickets. Herbaceous species, which are characteristically scattered, include silverling (*Paronychia argyrocoma*), little bluestem (*Schizachyrium scoparium* ssp. *scoparium*), broomsedge (*Andropogon virginicus*), Pennsylvania sedge (*Carex pensylvanica*), poverty oat-grass (*Danthonia spicata*), and silky oat-grass (*D. sericea*). A few sites support relatively dense cover of graminoids. Community types in this group are uncommon to rare and poorly inventoried in Virginia. Although many occurrences are in remote locations, degradation from trampling and invasive weeds are serious threats to outcrops located near popular trails and overlooks. Reference: Rawinski *et al*. (1996).

Low-Elevation Basic Outcrop Barrens
Scrub and herbaceous vegetation of exposed, base-rich outcrops in the Piedmont and mountain regions. The majority of documented occurrences are on mafic (diabase, amphibolite, gabbro) outcrops of the Piedmont and southern Blue Ridge, and metabasalt (greenstone) outcrops of the northern Piedmont and Blue Ridge. A few examples on granitic rocks and calcareous sandstone have also been documented. Habitats generally have high cover of exposed bedrock, but often have more extensive organic or soil mats, and thus more vascular plant cover, than do acidic outcrops. Soils usually consist of thin veneers and vary from moderately acidic to circumneutral, with moderately high base status. Vegetation is usually a patchwork of shrub thickets, herbaceous mats, and lithophytic lichens. Typical woody species include stunted white ash (*Fraxinus americana*), eastern red cedar (*Juniperus virginiana* var. *virginiana*), fringetree (*Chionanthus virginicus*), ninebark (*Physocarpus opulifolius* var. *opulifolius*), aromatic sumac (*Rhus aromatica*), and hoptree (*Ptelea trifoliata* ssp. *trifoliata*). Typical herbs include nodding onion (*Allium cernuum*), roundleaf fameflower (*Talinum teretifolium*), slender knotweed (*Polygonum tenue*), woodland sunflower (*Helianthus divaricatus*), hairy lipfern (*Cheilanthes lanosa*), rusty woodsia (*Woodsia ilvensis*), little bluestem (*Schizachyrium scoparium* ssp. *scoparium*), long-awn hairgrass (*Muhlenbergia capillaris* var. *capillaris*), whorled milkweed (*Asclepias verticillata*), Appalachian phacelia (*Phacelia dubia* var. *dubia*), and American alumroot (*Heuchera americana*). These small-patch communities are uncommon to rare in Virginia, and some of the community types are probably globally rare. Perhaps because of their more fertile substrates, basic outcrop barrens are more prone to invasion by exotic weeds than are acidic barrens. Reference: Rawinski and Wieboldt (1993).

Limestone and Dolomite Barrens
Scrub and herbaceous vegetation of exposed, carbonate rock outcrops and associated xeric rocky slopes. These calcareous barrens are scattered throughout the western Virginia Ridge and Valley region, usually occurring on steep, south- to west-facing slopes. In The Cedars region of Lee County, "flatrock" limestone barrens are present on gently rolling topography. The degree of exposed bedrock cover is variable, and many occurrences have considerable development of thin soils and gravel. Soils typically have high pH (> 7.0) and calcium levels; in addition, dolomitic soils have relatively high magnesium levels. Warm-season prairie grasses, including big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium* ssp. *scoparium*), indian grass (*Sorghastrum nutans*), side-oats grama (*Bouteloua curtipendula* var. *curtipendula*), and rough dropseed (*Sporobolus clandestinus*) characterize the largely herbaceous vegetation. Associated perennial forbs include western silky aster (*Aster pratensis*), false boneset (*Brickellia eupatorioides* var. *eupatorioides*), eastern indian-paintbrush (*Castilleja coccinea*), Canada bluets (*Houstonia canadensis*), tall gay-feather (*Liatris aspera* var. *intermedia*), false aloe (*Manfreda virginica*), southern obedient-plant (*Physostegia virginiana* ssp. *praemorsa*), white blue-eyed-grass (*Sisyrinchium albidum*), and stiff goldenrod (*Solidago rigida* ssp. *rigida*). Pitcher's stitchwort (*Minuartia patula* var. *patula*), wiry panic grass (*Panicum flexile*), sheathed dropseed (*Sporobolus vaginiflorus*), and other calciphilic annuals are characteristic of exposed, gravelly areas and rock crevices. Stunted trees and shrubs such as chinkapin oak (*Quercus muhlenbergii*), eastern red cedar (*Juniperus virginiana* var. *virginiana*), and Carolina buckthorn (*Frangula caroliniana*) are scattered in the barrens. Communities in this group are highly localized, small-patch units that are considered state-rare and, in some cases, globally rare. Threats include quarrying, grazing, and invasive exotic weeds. Reference: Ludwig (1999).

Xeric Calcareous Cliffs
Sparse shrub and herbaceous vegetation of very steep to precipitous, south- to west-facing limestone and dolomitic outcrops, cliffs, and rocky escarpments. In Virginia, communities of this group are confined to carbonate rock districts of the Ridge and Valley province and Cumberland Mountains. Habitats are usually undercut by large streams or rivers and are situated on upper slopes or crests with predominantly convex slope shapes. Microtopography is rugged and complex, with very high cover of exposed bedrock. The surficial rock and associated edaphic stresses limit overall vegetation cover, woody growth, and

species richness. Scattered scrub growth of eastern red cedar (*Juniperus virginiana* var. *virginiana*), chinkapin oak (*Quercus muhlenbergii*), hairy mock-orange (*Philadelphus hirsutus*), poison ivy (*Toxicodendron radicans*), and other shrubs is typical. Prevalent among herbaceous species are lithophytes such as black-stemmed spleenwort (*Asplenium resiliens*), wall-rue (*A. ruta-muraria*), aromatic aster (*Aster oblongifolius*), ebony sedge (*Carex eburnea*), rocktwist (*Draba ramosissima*), three-flowered melic (*Melica nitens*), rock sandwort (*Minuartia michauxii* var. *michauxii*), plains muhly (*Muhlenbergia cuspidata*), cliff-brakes (*Pellaea atropurpurea* and *P. glabella* ssp. *glabella*), and moss phlox (*Phlox subulata*). These small-patch communities are generally considered state-rare, but their conservation status needs further investigation. Because of inaccessible locations, stands seem immune from many types of anthropogenic disturbance. Scattered individuals of exotic weeds sometimes find footholds but are largely excluded from cliffs by the hot, xeric, rocky substrates. Reference: Fleming (1999).

Mesic Calcareous Cliffs
Sparse woodland, shrub and herbaceous vegetation of very steep to precipitous, somewhat sheltered north- to east-facing limestone and dolomitic outcrops. Like the Xeric Calcareous Cliffs, mesic cliffs are usually formed by incision of high-order streams into carbonate bedrock of the Ridge and Valley Province. Habitats are open, but have limited solar exposure because of their northerly aspects. Microtopography is complex and rugged, with high cover of bedrock. Local zones of ephemeral seepage are frequent. Woody vegetation of mesic calcareous cliffs is more diverse and often achieves larger size than on xeric calcareous cliffs. Typical woody plants include eastern arborvitae (*Thuja occidentalis*), basswoods (*Tilia americana* var. *americana* and var. *heterophylla*), slippery elm (*Ulmus rubra*), and wild hydrangea (*Hydrangea arborescens*). Characteristic herbs include ebony sedge (*Carex eburnea*), bulblet fern (*Cystopteris bulbifera*), cliff stonecrop (*Sedum glaucophyllum*), northern bedstraw (*Galium boreale*), white-flowered leafcup (*Polymnia canadensis*), walking fern (*Asplenium rhizophyllum*), smooth rock-cress (*Arabis laevigata* var. *laevigata*), lyre-leaf rock-cress (*Arabis lyrata*), fernleaf phacelia (*Phacelia bipinnatifida*), and Carolina saxifrage (*Saxifraga caroliniana*). Communities of this group are naturally rare and inherently protected because of their locations on inaccessible, dangerous bluffs. Reference: Fleming (1999).

Piedmont / Mountain Basic Cliffs
A group of poorly documented, sparsely vegetated communities known from relatively few siltstone, metasiltstone, and metabasaltic (greenstone) cliffs in the western Piedmont and Blue Ridge. Ordovician red mudstone/shale cliffs of the Ridge and Valley Province may also support communities of this group but require additional investigation. Habitats probably vary with aspect and other microhabitat conditions. Vegetation is generally dominated by umbilicate, foliose, and/or crustose lichens, with relatively sparse representation of vascular plants. Stunted trees and shrubs, *e.g.*, white ash (*Fraxinus americana*), eastern red cedar (*Juniperus virginiana* var. *virginiana*), and chestnut oak (*Quercus montana*), occur in crevices or on cliff shelves. Herbaceous lithophytes such as wild columbine (*Aquilegia canadensis*), rock-cresses (*Arabis* spp.), Alleghany stonecrop (*Sedum telephioides*), field chickweed (*Cerastium arvense* ssp. *velutina*), and various rock ferns also find scattered footholds. Japanese honeysuckle (*Lonicera japonica*) and other exotic plants find favorable growing conditions on some basic cliffs and pose a serious threat to the sparse indigenous flora of these habitats.

Piedmont / Mountain Acidic Cliffs
Sparse woodland, shrub, and herbaceous vegetation of very steep to precipitous sandstone, acidic shale, and quartzite outcrops, cliffs, and rocky escarpments. These communities are scattered throughout the mountain and western Piedmont foothill regions of Virginia, but are poorly inventoried and documented at present. Acidic cliffs occur under several geomorphic conditions, especially on slopes undercut by large streams or rivers and on resistant caprock exposed by differential weathering of weaker underlying strata. Habitats vary with aspect and other environmental conditions. Local zones of ephemeral seepage may be present. The vegetation is generally dominated by lichens, with umbilicate "rock tripe" species

such as *Umbilicaria* spp. and *Lasalia papulosa* especially prominent. Vascular plants are confined to crevices and humus-covered shelves. On drier, south- to west-facing cliffs, vascular species may be very sparse and consist of stunted pines (*Pinus virginiana, P. pungens*), ericaceous shrubs, and occasional herbaceous lithophytes such as mountain spleenwort (*Asplenium montanum*), silverling (*Paronychia argyrocoma*), and wild bleeding heart (*Dicentra eximia*). Sheltered, north- to east-facing cliffs often support more diverse shrub and herbaceous flora. Characteristic species include stunted eastern hemlock (*Tsuga canadensis*), evergreen rhododendrons (*Rhododendron maximum* and *R. catawbiense*), rock polypodies (*Polypodium appalachianum* and *P. virginianum*), Michaux's saxifrage (*Saxifraga michauxii*), rock alumroot (*Heuchera villosa* var. *villosa*), and wavy hairgrass (*Deschampsia flexuosa* var. *flexuosa*). Shaded grottoes and "rock houses" on cliffs of the Cumberland Mountains in southwestern Virginia support colonies of little-leaved alumroot (*Heuchera parviflora* var. *parviflora*) and round-leaved catchfly (*Silene rotundifolia*). There are few threats to acidic cliffs, except for local damage by rock climbers.

Central Appalachian Shale Barrens

A variable group of sparse woodlands, shrublands, and open herbaceous rock outcrops occurring on Ridge and Valley shales and Blue Ridge metashales of the central Appalachian Mountains. These small-patch communities range from western Virginia and eastern West Virginia to southern Pennsylvania. In Virginia, they occur at elevations from 300 to 850 m (1000 to 2600 ft). Although stunted trees of several species — *e.g*., chestnut oak (*Quercus montana*), Virginia pine (*Pinus virginiana*) and pignut hickory (*Carya glabra*) — are common, shale barrens are strongly characterized by their open physiognomy and by a suite of rare plants found almost exclusively in these habitats. Endemic or near-endemic shale barren species include shale-barren rock-cress (*Arabis serotina*), white-haired leatherflower (*Clematis albicoma*), Millboro leatherflower (*Clematis viticaulis;* also endemic to Virginia), shale-barren wild buckwheat (*Eriogonum allenii*), shale-barren evening-primrose (*Oenothera argillicola*), shale-barren ragwort (*Senecio antennariifolius*), and Kate's Mountain clover (*Trifolium virginicum*). Habitats generally occur on steep (~ 30 degree) slopes with south to west aspects. The steep, xeric slopes and friable nature of the shale create poorly vegetated hillsides of bare bedrock and loose channery visible from afar. Continual undercutting of thick but relatively weak shale strata by streams maintain shale barrens. Less common, densely graminoid-dominated variants occurring on steep spur ridge crests and mountain summits are sometimes referred to as "shale ridge balds." Shale barrens are considered globally uncommon and host many locally rare species including the butterflies Appalachian grizzled skipper (*Pyrgus wyandot*) and Olympia marble (*Euchloe olympia*) and the federally listed plant shale-barren rock-cress. The primary threat to these communities is probably invasion by exotic species, but examples of these communities near roads are also threatened by quarrying. References: Allard (1946), Fleming and Moorhead (2000), Platt (1951), Rawinski *et al*. (1996).

Granitic Flatrocks

Open, sparsely vegetated and gently sloping, granitic outcrops of the Piedmont physiographic region. This community group ranges from eastern Alabama to Virginia and is probably best represented in Georgia and south-central North Carolina. Granitic Flatrocks in Virginia range in elevation from about 70 to 100 m (230 to 320 ft) and occur on true granites and a range of related rocks such as granitic gneiss, and granodorite. Most examples are located on gentle slopes along streams, where the erosive power of water over time has worn rock surfaces smooth and created small, gravel-filled depressions. The dominant plants are non-vascular species of lichens (*e.g*., *Xanthoparmelia conspera, Cladonia caroliniana,* and other *Cladonia* ssp.) and the bryophyte *Grimmia laevigata,* which cover much of the exposed bedrock. However, vascular plants dominate locally in crevices, flats, and depressions where moisture and thin layers of detritus accumulate. Among the vascular plants, Small's stonecrop (*Diamorpha smallii*), Small's purslane (*Portulacca smallii*), and granite loving flat sedge (*Cyperus granitophilus*) are globally rare and endemic to these habitats. Other typical vascular plants include roundleaf fameflower (*Talinum teretifolium*), Appalachian sandwort (*Minuartia glabra*), rock spike-moss (*Seleginella rupestris*), buttonweed (*Diodia teres*), elliptical rushfoil (*Croton willdenowii*), broomsedge

(*Andropogon virginicus*), little bluestem (*Schizachyrium scoparium*), fork-tip three-awn grass (*Aristida dichotomum*), purple three-awn grass (*A. purpurascens*), common hair sedge (*Bulbostylis capillaris*), open-flower panic grass (*Dichanthelium laxiflorum*), and orange-grass (*Hypericum gentianoides*). These small-patch communities often cover less than 0.4 ha (1 ac) and are considered globally rare. Reference: Belden (1998), Berg (1974).

Piedmont Prairies
The only extant, prairie-like communities in the Virginia Piedmont are semi-natural and influenced by artificial disturbance regimes. Examples occurring in military base training areas ("impact areas") at Fort Pickett and Quantico Marine Base have been subject to frequent incendiary fires for at least 50 years; these comprise our only examples of grassland vegetation that has been shaped by random burns of a size, frequency, and intensity comparable to those of putative pre-settlement fire regimes. Similar grasslands have developed in Manassas National Battlefield Park and scattered powerline rights-of-way as the result of long-term periodic mowing. The vegetation of most sites is dominated by little bluestem (*Schizachyrium scoparium* ssp. *scoparium*) and indian grass (*Sorghastrum nutans*). Frequent associates include purple three-awn grass (*Aristida purpurascens*), bushy aster (*Aster dumosus*), tick-trefoils (*Desmodium* spp.), bushclovers (*Lespedeza* spp.), scaly blazing-star (*Liatris squarrosa* var. *squarrosa*), narrow-leaved mountain-mint (*Pycnanthemum tenuifolium*), orange coneflower (*Rudbeckia fulgida*), few-flowered nutrush (*Scleria pauciflora*), and goldenrods (*Solidago nemoralis* and *S. juncea*). A number of state-rare, light-demanding species, *e.g*., stiff goldenrod (*Solidago rigida* ssp. *rigida*), Torrey's mountain-mint (*Pycnanthemum torrei*), earleaf foxglove (*Agalinis auriculata*), and blue-hearts (*Buchnera americana*) are associated with these communities, particularly on mafic soils.

Ultramafic Barrens
Grasslands on soils developed from serpentinite, soapstone, talc-tremolite schist, and other ultramafic rocks. Only two occurrences of this very rare vegetation are known in Virginia: one in the southern Piedmont (Franklin County) and one in The Glades region of the southern Blue Ridge plateau (Grayson County). Habitats are relatively gentle uplands with harsh soils containing high levels of magnesium and iron. Vegetation of the two sites differs considerably. The dry, rocky Piedmont habitat is dominated by little bluestem (*Schizachyrium scoparium* ssp. *scoparium*), prairie ragwort (*Senecio plattensis*), and glade wild quinine (*Parthenium auriculatum*). Noteworthy associates include northern dropseed (*Sporobolus heterolepis*), Menge's fame-flower (*Talinum mengesii*), rock sandwort (*Minuartia michauxii* var. *michauxii*), and Kate's Mountain clover (*Trifolium virginicum*). The southern Blue Ridge habitat features considerable seasonal wetness and a peculiar mixture of upland and wetland species, but is treated here as a community of the Terrestrial System. Little bluestem and indian grass (*Sorghastrum nutans*) are the dominant grasses, while white colicroot (*Aletris farinosa*), narrowleaf whitetop aster (*Sericocarpus linifolius*), narrow-leaved mountain-mint (*Pycnanthemum tenuifolium*), and balsam ragwort (*Senecio pauperculus*) are characteristic forbs. Coastal plain disjuncts such as crossleaf milkwort (*Polygala cruciata*), twisted yellow-eyed-grass (*Xyris torta*), pitted nutrush (*Scleria muhlenbergii*), yellow screwstem (*Bartonia virginica*), and Virginia meadow-beauty (*Rhexia virginica*) are numerous in seasonally wet, gravelly microhabitats. Along with unusual edaphic conditions, fire probably played a key role in maintaining natural ultramafic barrens in the pre-settlement landscape. Both community types in Virginia are globally rare and occur in patch-mosaics with similarly rare Ultramafic Woodlands. Major threats include fire suppression, woody species encroachment, grazing, agriculture, and development.

Riverside Outcrop Barrens
Sparse vegetation of exposed, xeric outcrops within the flood zone of major Piedmont and mountain-region rivers. The very few documented examples of this group in Virginia are located along the Potomac, Shenandoah, and James Rivers, especially in gorges. Occurrences are known from several bedrock types, including dolomite, calcareous shale, charnockite, and acidic schists and gneisses. Habitats are subject to occasional flood-scouring, as well as edaphic stresses, with flood return intervals

ranging from about one to more than ten years. Lichens and mosses are the dominant life-forms of these outcrops, with vascular plants limited to crevices, gravel-filled depressions, and humus-covered shelves. Shrubs and herbs that occur in riverside barrens of various bedrock types include eastern red cedar (*Juniperus virginiana* var. *virginiana*), ninebark (*Physocarpus opulifolius* var. *opulifolius*), big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium* ssp. *scoparium*), field chickweed (*Cerastium arvense* ssp. *velutinum*), and riverbank goldenrod (*Solidago rupestris*). Species confined to basic or calcareous outcrops include hoptree (*Ptelea trifoliata* ssp. *trifoliata*), nodding onion (*Allium cernuum*), and plains muhly (*Muhlenbergia cuspidata*). Species confined to acidic schists and gneisses of the Potomac River gorge, west of Washington, D.C., include low serviceberry (*Amelanchier stolonifera*), fetterbush (*Leucothoe racemosa*), moss phlox (*Phlox subulata*), balsam ragwort (*Senecio pauperculus*), and sticky goldenrod (*Solidago racemosa*). Communities in this group are very rare and localized in Virginia and range-wide. Reference: Lea (2000).

Moss / Lichen Boulderfields

Non-vascular vegetation occupying exposed, minimally weathered boulderfields on mountain ridges of western Virginia. Boulderfield habitats have resulted from periglacial phenomena and the collapse of resistant strata from weathering and erosion of weaker underlying rocks . The most numerous and extensive exposed boulderfields are composed of sandstone or quartzite, with a few occurrences on metabasalt at higher elevations of the northern Blue Ridge. These habitats, where few vascular plants survive, are often densely populated by overlooked or cryptic species of lichens and moss. Dominant on boulders are umbilicate "rock tripe" lichens, including *Umbilicaria mamulata, U. muehlenbergii*, and *Lasalia papulosa*. Also common are small, round, tightly attached patches of the bright yellow-green lichen *Dimelaena oreina*. Sheltered surfaces where detritus collects are often colonized by mosses. The most common of these are broom-mosses (*Dicranum* spp.), but Hedwig's rockmoss (*Hedwigia ciliata*) and other species are also present. The Appalachian rock polypody fern (*Polypodium appalachianum*) occurs frequently on weathered edges. Progressive, long-term weathering of exposed boulderfields results in slow invasion by trees such as yellow birch (*Betula alleghaniensis*) and American mountain-ash (*Sorbus americana*) at higher elevations, and sweet birch (*Betula lenta*) at lower elevations. Open boulderfields are favored by timber rattlesnakes (*Crotalus horridus horridus*), which often locate their hibernacula in the rocky substrates. These small-patch community types are uncommon and are primarily threatened by air pollution and acid rain.

MARITIME ZONE COMMUNITIES

Ecological community groups with distributions and vegetation controlled by oceanic influences (*e.g*., deep sand deposits, salt spray, maritime microclimates). In Virginia, these are confined to narrow zones along both flanks of the Eastern Shore, the western shore of the Chesapeake Bay, and the Atlantic shore in extreme southeastern Virginia.

Maritime Dune Grasslands

Coastal graminoid communities of ocean- and bay-fronting dunes that are greatly influenced by storm surge activity. Communities of this group are characterized by a few well-adapted herbaceous species and exhibit zonation that is likely related to gradients of salt spray and soil moisture. The dominant plants are saltmeadow cordgrass (*Spartina patens*), American beachgrass (*Ammophila breviligulata*), sea oats (*Uniola paniculata),* bitter seabeach grass (*Panicum amarum*), beach panic grass (*Panicum amarulum*), and seaside little bluestem (*Schizachyrium scoparium* ssp. *littorale*). On steep dune slopes facing the ocean, American beachgrass forms narrow, almost monospecific stands. The crest of primary dunes and more gentle back slopes and terraces, however, are dominated by sea oats and/or bitter seabeach grass, with a slightly more diverse assemblage of low-cover species such as seaside goldenrod (*Solidago sempervirens* var. *sempervirens*), sea-beach evening-primrose (*Oenothera humifusa*), seaside spurge

(*Chamaesyce polygonifolia*), purple lovegrass (*Eragrostis spectabilis*), purple sandgrass (*Triplasis purpurea*), and dune sandbur (*Cenchrus tribuloides*). Away from the primary dune and salt spray, a series of smaller secondary dunes spread inward. These dunes are characteristically colonized by beach panic grass or seaside little bluestem. This zone contains the same sparse assemblage of species as the previous zone with the addition of saltmeadow cordgrass, which forms dense patches along terraces of the smaller dunes. Development and coastal erosion are the major threats to this community. Additionally, walking on these dunes reduces their stability and increases the chance of breaching during storm events. The exotic Japanese sedge (*Carex kobomugi*), initially planted to stabilize dune systems, has become an invasive pest on the southeastern Virginia coast. References: Clampitt (1991), Clovis (1968), Levy (1983), The Nature Conservancy (1997).

Maritime Scrub

Shrublands of somewhat protected maritime back dunes and leeward dune slopes. Communities in this group generally occupy inland edges of maritime dune systems in a zone sheltered from constant ocean salt spray. The vegetation is characterized by several tree, shrub and dwarf shrub species. Dominant scrubby species include northern bayberry (*Myrica pensylvanica*), live oak (*Quercus virginiana*, southeastern Virginia only), persimmon (*Diospyros virginiana*), and black cherry (*Prunus serotina* var. *serotina*). On the northern seacoast of Virginia, high-tide bush (*Baccharis halimifolia*) is also characteristic. Many woody species are significantly stunted in this habitat and, like the live oak, are often much broader than they are tall. Few herbaceous species are present under the shrub canopy, but frequent canopy gaps support most of the species found in the dune grasslands. In some remnant dunes and areas of dune blowouts, the dwarf shrub sand-heather (*Hudsonia tomentosa*) forms an assemblage with seaside goldenrod (*Solidago sempervirens*), bitter seabeach grass (*Panicum amarum*), Gray's flatsedge (*Cyperus grayi*), and beach pinweed (*Lechea maritima* var. *virginica*). This community type, present on Assateague Island and the southeastern Virginia coast, often occurs in a mosaic with maritime dune woodlands. Maritime shrublands are threatened by coastal development and by natural and anthropogenic disturbances that destroy the protective primary dune system. References: Clovis (1968), The Nature Conservancy (1997).

Maritime Dune Woodlands

Deciduous, coniferous, and evergreen broadleaf woodlands of back dunes protected from regular salt spray. Compared to maritime pine forests, these woodlands are more localized and restricted to xeric dune systems. Habitats are commonly on convex, rapidly drained dunes and less frequently on xeric sand flats. Floristic composition of communities in this group varies considerably with geography. Along the southeastern Virginia coast (City of Virginia Beach), live oak (*Quercus virginiana*), bluejack oak (*Quercus incana*), and sassafras (*Sassafras albidum*) dominate stands, with loblolly pine (*Pinus taeda*) and black cherry (*Prunus serotina* var. *serotina*) as less abundant associates. On the Eastern Shore (Accomack and Northampton Counties), a community type of widely spaced loblolly pine with scattered, scrubby oaks (*e.g*., *Q. nigra* and *Q. falcata*), dwarf-shrub patches of sand-heather (*Hudsonia tomentosa*), and large areas of exposed sand occurs on the highest back-dune systems. Another xeric back-dune community dominated by black cherry, prickly-pear (*Opuntia humifusa*), and seaside little bluestem (*Schizachyrium scoparium* ssp. *littorale*) has been documented in two Eastern Shore locations. Scattered herbaceous plants that occur in these woodlands include seabeach needlegrass (*Aristida tuberculosa*), oval-leaved panic grass (*Dichanthelium ovale* var. *ovale*), Canada frostweed (*Helianthemum canadense*), woolly ragwort (*Senecio tomentosa*), and narrow-leaved golden-aster (*Pityopsis graminifolia* var. *latifolia*). All communities in this group are considered globally and state rare. References: Clampitt (1991), The Nature Conservancy (1997).

Maritime Evergreen Forests
Species-poor mixed coastal forests with a prominent component of broadleaf evergreen trees. This group reaches its northernmost limits along the southeastern Virginia coast, where it is confined to areas on and near False Cape and Cape Henry (City of Virginia Beach). Habitats are back dunes and the leeward sides of stabilized dunes that are protected from the ocean salt spray. Live oak (*Quercus virginiana*) is the dominant species in mixtures with loblolly pine (*Pinus taeda*), Darlington's oak (*Q. hemisphaerica* var. *hemisphaerica*), and black cherry (*Prunus serotina* var. *serotina*). Characteristic understory plants include poison ivy (*Toxicodendron radicans* ssp. *radicans*), common greenbrier (*Smilax rotundifolia*), southern bayberry (*Myrica cerifera*), persimmon (*Diospyros virginiana*), American holly (*Ilex opaca* var. *opaca*), devilwood (*Osmanthus americanus* var. *americanus*), and highbush blueberry (*Vaccinium corymbosum*). Ground cover is sparse, consisting of a thin layer of dry leathery oak leaves and scattered forbs such as yellow jesamine (*Gelsemium sempervirens*) and narrow-leaved golden-aster (*Pityopsis graminifolia* var. *latifolia*). In Virginia, two state-rare moths, the orange panapoda (*Panapoda repanda*) and the owlet (noctuid) moth (*Metria amella),* feed on live oak in these communities. Most communities in this group are considered globally rare because of restricted ranges, narrow habitat requirements, and threats from coastal development. Reference: Clampitt (1991).

Maritime Loblolly Pine Forests
Pine-dominated forests of sheltered, oceanside and bayside dunes and sand flats generally protected from salt spray. Communities in this group are distributed along the length of the outer Coastal Plain maritime zone and barrier islands in Virginia, including the western shore of the Chesapeake Bay. Soils in these habitats often accumulate thick duff layers up to 15 cm (6 in) thick, which may be the result of a suppressed fire regime in some stands. The upper mineral soil horizon is dark sand or very sandy clay, and the water table may be relatively close to the surface. Forest overstories consist of nearly pure loblolly pine (*Pinus taeda*), with sparse to dense understories of red maple (*Acer rubrum*), black cherry (*Prunus serotina* var. *serotina*), and sassafras (*Sassafras albidum*). Shrubs, which vary greatly in cover, include southern bayberry (*Myrica cerifera*) and highbush blueberry (*Vaccinium corymbosum*). Muscadine grape (*Vitis rotundifolia*) and greenbriers (*Smilax rotundifolia* and *S. bona-nox*) are quite common throughout. Although the canopy and shrub strata can be quite dense, the herbaceous layer is usually sparse and floristically depauperate. Slender spikegrass (*Chasmanthium laxum*) is one of the few herbaceous plants that may be abundant. Because they are restricted to a narrow geographic range (Delaware to northern North Carolina) and to special habitats that are subject to development pressure, maritime pine forests are considered globally uncommon to rare. References: Clampitt (1991), Harvill (1967), Levy (1983), The Nature Conservancy (1997).

Maritime Mixed Forests
Mixed forests of sheltered back dunes along both flanks of the Eastern Shore (Accomack and Northampton Counties), as well as Cape Henry and False Cape in southeastern Virginia (City of Virginia Beach). Habitats are most frequently located on the leeward slopes of bay-side dunes or old ocean-side dunes well protected from salt spray and winds. Soils are well drained to rapidly drained, nutrient-poor sands and sandy loams. Overstories contain variable mixtures of loblolly pine (*Pinus taeda*), water oak (*Quercus nigra*), southern red oak (*Quercus falcata*), and black cherry (*Prunus serotina* var. *serotina*). American holly (*Ilex opaca* var. *opaca*) is a frequent understory tree. The shrub and herb layers are often covered with dense tangles of common greenbrier (*Smilax rotundifolia*) and muscadine grape (*Vitis rotundifolia*). These communities are known only from the barrier beach areas of Virginia and North Carolina and are probably globally uncommon or rare. Few mature stands have been documented and the restricted habitats are subject to major development pressure. References: Clampitt (1991), The Nature Conservancy (1997).

SANDY WOODLANDS OF THE COASTAL PLAIN AND OUTER PIEDMONT

Ecological community groups representing woodland vegetation of oligotrophic, fire-influenced or edaphically stressful, non-maritime sandy habitats at very low elevations.

Pine / Scrub Oak Sandhills

Pyrophytic mixed woodlands occurring on Coastal Plain sand ridges of southeastern Virginia. Communities in this group reach their northern range limit in Virginia, where they occur in small, highly localized patches. Suitable habitats are located primarily on slightly elevated sand deposits stretching along the eastern sides of the Blackwater and Nottoway Rivers in Sussex, Southampton, and Isle of Wight Counties and the City of Suffolk. Soils are coarse xeric sands, often overlying clay-rich subsoil that may perch water briefly and limit rooting depths. The original vegetation of these sites is presumed to have been composed of open longleaf pine (*Pinus palustris*) canopies, with open understories of oaks (*Quercus* spp.). Stand structure and successful reproduction of longleaf pine were presumably controlled by a natural regime of frequent low-intensity fires. Extant examples have been altered by heavy cutting and decades of fire suppression. Longleaf pine has been almost entirely replaced by loblolly pine (*Pinus taeda*), and most stands are now quite closed. Various combinations of turkey oak (*Quercus laevis*), sand post oak (*Q. margarettiae*), water oak (*Q. nigra*), bluejack oak (*Q. incana*), southern red oak (*Q. falcata*), blackjack oak (*Q. marilandica*), and sand hickory (*Carya pallida*) occur as canopy co-dominants and understory trees. Frequent shrubs include poison oak (*Toxicodendron pubescens*), farkleberry (*Vaccinium arboreum*), and deerberry (*V. stamineum*). Characteristic herbaceous species, which may be almost eliminated by canopy closure and accumulations of thick leaf litter, include silver bluestem (*Andropogon ternarius*), woolly three-awn grass (*Aristida lanosa*), hairsedge (*Bulbostylis ciliatifolia*), grass-like roselings (*Callisia graminea*), spurge-nettle (*Cnidoscolus stimulosus*), pineland tick-trefoil (*Desmodium strictum*), wild ipecac (*Euphorbia ipecacuanhae*), sundial lupine (*Lupinus perennis*), wavy-leaf noseburn (*Tragia urens*), and Baldwin's nailwort (*Paronychia baldwinii* ssp. *riparia*). Despite past and ongoing disturbances, pine / scrub oak sandhills are important communities for conservation and restoration in Virginia because of their regional rarity. References: Frost and Musselman (1987), Plocher (1999).

Fluvial Terrace Woodlands

A somewhat enigmatic group of communities occurring on flat, sandy terraces and islands along Coastal Plain rivers in eastern Virginia. These habitats are elevated well above the level of adjacent swamps and are characterized by xeric, sandy soils and open forest or woodland vegetation. Single occurrences have been documented along the Nottoway River (Sussex County), Chickahominy River (New Kent County), Dragon Swamp (Middlesex County), and Mattaponi River (Caroline County). At all four sites, hickories (*Carya pallida* and *C. alba*) are dominant trees, with drought-tolerant oaks (*Quercus falcata, Q. nigra, Q. marilandica, Q. alba*) present in smaller numbers. Shrubs occurring at all or most sites include sand post oak (*Q. margarettiae*), horse-sugar (*Symplocos tinctoria*), American holly (*Ilex opaca* var. *opaca*), and eastern red cedar (*Juniperus virginiana* var. *virginiana*). Typical herbs include sedges (*Carex albicans* var. *australis*, *C. pensylvanica*, and *C. tonsa*), Canada frostweed (*Helianthemum canadense*), butterfly-pea (*Clitoria mariana*), late goldenrod (*Solidago tarda*), and prickly-pear (*Opuntia humifusa*). The Dragon Run site is anomalous in the presence (despite low soil pH and base status) of several calciphiles such as eastern redbud (*Cercis canadensis* var. *canadensis*), wild columbine (*Aquilegia canadensis*), smooth rock-cress (*Arabis laevigata* var. *laevigata*), robin's-plantain (*Erigeron pulchellus* var. *pulchellus*), and elm-leaved goldenrod (*Solidago ulmifolia* var. *ulmifolia*). A full understanding of the status and compositional relationships of this group will require additional inventory and assessment.

Loblolly Pine Savannas

Coniferous woodlands occurring in military base training areas ("impact areas") that have been subject to frequent incendiary fires for at least 50 years. In Virginia, communities of this group cover hundreds of hectares at Fort A.P. Hill in the northern Coastal Plain (Caroline County) and Fort Pickett in the southern Piedmont (Dinwiddie and Nottoway Counties). Habitats at both sites are rolling uplands with sandy,

oligotrophic soils. Stand structure is typically savanna-like, with open or semi-closed canopies, sparse understory, and dense graminoid-dominated herb layers. Loblolly pine (*Pinus taeda*) is the overwhelmingly dominant tree, with only scattered oak (*Quercus* spp.) and hickory (*Carya* spp.) associates. Little bluestem (*Schizachyrium scoparium* ssp. *scoparium*) and broomsedges (*Andropogon virginicus*, *A. ternarius*, and *A. gyrans*) are dominant grasses. A variety of tick-trefoils (*Desmodium* spp.), bushclovers (*Lespedeza* spp.), goldenrods (*Solidago* spp.), thoroughworts (*Eupatorium* spp.), and other composites are common forb associates. Pine savannas at both military bases provide the only viable habitats in Virginia for the globally and state-rare Bachman's Sparrow (*Aimophila aestivalis*). Although communities of this group are strongly influenced by an artificial disturbance regime and may have originated through old-field succession, they are perhaps comparable to vegetation that occurred more widely outside the range of longleaf pine (*Pinus palustris*) under more natural pre-Columbian fire regimes. Natural pine savannas may have experienced, or originated following, less frequent but more intense fires than Acidic Oak-Hickory Savannas. Such a fire regime would have basally killed oaks and exposed mineral soil for pine establishment or regeneration. Reference: Maxwell (1910).

PALUSTRINE SYSTEM

ALLUVIAL FLOODPLAIN COMMUNITIES

Ecological community groups of alluvial habits with overland, non-tidal flooding regimes. Structurally and compositionally diverse vegetation is represented.

Bald Cypress – Tupelo Swamps

Seasonally to semipermanently flooded forests of backswamps, sloughs, and low terraces of Coastal Plain rivers and large streams. These swamp forests are distributed throughout southeastern Virginia, north to Dragon Swamp (Gloucester, King and Queen, and Middlesex Counties). Habitats are deeply flooded (up to 1 m) for part of the year; most retain at least some standing water throughout the growing season. Microtopography is often pronounced with small channels, swales, tree-base hummocks, and numerous bald cypress "knees." Tree canopies vary from mixed stands of bald cypress (*Taxodium distichum*), water tupelo (*Nyssa aquatica*), and swamp tupelo (*N. biflora*) to nearly pure stands of one species or another. The three dominants have complex competitive and successional relationships. As a rule, the two tupelos are less shade-tolerant than bald cypress and regenerate more readily by sprouting in cut-over stands. Thus, tupelos tend to become dominant when bald cypress stands are heavily logged. Green ash (*Fraxinus pennsylvanica*) and red maple (*Acer rubrum*) are occasional canopy associates and frequent understory trees. Carolina ash (*F. caroliniana*) is often dominant in the small tree and shrub layers, while vines of climbing hydrangea (*Decumaria barbara*) are often abundant. Herb layers vary from sparse to rather lush. Most herbaceous plants of bald cypress-tupelo swamps are tolerant of muck soils and fluctuating water levels, or are capable of becoming established on tree hummocks, stumps, and logs. A few of the typical herbs are lizard's-tail (*Saururus cernuus*), false nettle (*Boehmeria cylindrica*), Walter's St. John's-wort (*Triadenum walteri*), swamp beggar-ticks (*Bidens discoidea*), weak stellate sedge (*Carex seorsa*), giant sedge (*Carex gigantea*), taperleaf bugleweed (*Lycopus rubellus*), and pale mannagrass (*Torreyochloa pallida*). Although community types in this group are relatively common, high-quality examples are scarce and all stands provide valuable wildlife habitat and resources. Mature, hollow specimens of the dominant trees are known to provide nesting habitats for the globally uncommon, state-rare eastern big-eared bat (*Corynorhinus rafinesquii macrotis*) and southeastern myotis (*Myotis austroriparius*). Old-growth stands of bald cypress-tupelo swamp with trees up to 800 years old occur along the Blackwater River in Surry and Isle of Wight Counties. References: Fleming and Moorhead (1998), Parker and Wyatt (1975), Plunkett and Hall (1995).

Coastal Plain / Piedmont Bottomland Forests
A diverse group of temporarily and seasonally flooded forests, encompassing most bottomland sites of the Coastal Plain, except those occupied by Bald Cypress – Tupelo Forests. Some outer Piedmont bottomland forests with strong affinities to Coastal Plain vegetation are included. Because substantial quantitative data are currently lacking, this heterogeneous group may be split in the future. Characteristic tree species vary with habitat conditions. Seasonally flooded swamps are usually dominated by combinations of green ash (*Fraxinus pennsylvanica*), red maple (*Acer rubrum*), sweetgum (*Liquidambar styraciflua*), swamp tupelo (*Nyssa biflora*), water hickory (*Carya aquatica*), willow oak (*Q. phellos*), and overcup oak (*Q. lyrata*). Well-drained levees support swamp chestnut oak (*Q. michauxii*), cherrybark oak (*Q. pagoda*), laurel oak (*Quercus laurifolia*), sugarberry (*Celtis laevigata*), and American elm (*Ulmus americana*). Swamp cottonwood (*Populus heterophylla*) and river birch (*Betula nigra*) are often abundant in disturbed, cut-over stands. On small stream bottoms, where alluvial landforms and habitat conditions occur at very small scales, trees typical of both levees and swamps may occur in mixed stands. On exceptionally well-drained small stream bottoms, tulip-poplar (*Liriodendron tulipifera*) is often important. Small tree, shrub, and herbaceous composition is highly variable with geography and site conditions. References: Crouch (1990), Fleming and Moorhead (1998), Frost and Musselman (1987), Glascock and Ware (1979), McCoy and Fleming (2000), Parker and Wyatt (1975), Parsons and Ware (1982), Rheinhardt *et al*. (2000).

Floodplain Ponds and Pools
Semipermanently to permanently flooded, natural depression wetlands within the floodplains of major Coastal Plain and Piedmont streams. These wetlands are typically developed in abandoned oxbows and cut-off meanders, ranging in size from less than 0.01 hectare to about four hectares (0.2 to 10 acres). Community composition is probably influenced by a combination of environmental factors, including flooding regime, water depths, soil fertility, and degree of shading. Dominant vegetation varies from shrublands in shallower, semipermanently flooded ponds to submerged or floating aquatics in deeper ponds. Scattered bald cypress (*Taxodium distichum*), tupelos (*Nyssa aquatica* and *N. biflora*), or red maple (*Acer rubrum*) are sometimes rooted in large oxbow ponds. More often, shrublands dominated by buttonbush (*Cephalanthus occidentalis*) or swamp loosestrife (*Decodon verticillatus*) are established. In the more deeply flooded ponds, aquatic species prevail, with or without scattered shrubs and emergents such as Virginia chain fern (*Woodwardia virginica*), sedges (*Carex* spp.), and eastern mannagrass (*Glyceria septentrionalis*). Typical aquatics include common mermaid-weed (*Proserpinaca palustris*), bladderworts (*Utricularia* spp.), spatterdock (*Nuphar advena*), duckweeds (*Lemna* spp.), duckmeats (*Spirodela* spp.), northern water-starwort (*Callitriche heterophylla*), watershield (*Brasenia schreberi),* hornworts (*Ceratophyllum* spp.), waterweeds *(Elodea* spp.), American frog's-bit (*Limnobium spongia*), pondweeds (*Potamogeton* spp.), Carolina mosquito-fern (*Azolla caroliniana*), milfoils *(Myriophyllum* spp), and shade mudflower (*Micranthemum umbrosum*). At least two aquatic plants found in these communities, yellow water crowfoot (*Ranunculus flabellaris*) and featherfoil (*Hottonia inflata*), are state-rare or uncommon. Although apparently more often associated with beaver ponds (see Coastal Plain Semipermanent Impoundments and Piedmont/Mountain Semipermanent Impoundments), non-tidal emergent marshes are present in large oxbows of the Pamunkey River in eastern Virginia. Wetlands in this group are important breeding habitats for turtles and amphibians, including the state-rare mole salamander (*Ambystoma talpoideum*). Well-developed floodplain ponds and pools appear to be rather rare communities in need of much additional inventory and study.

Coastal Plain Semipermanent Impoundments
Aquatic and shoreline vegetation of both beaver ponds and long-established artificial ponds (*e.g.*, millponds) along Coastal Plain streams. Compared to communities in the Floodplain Ponds and Pools group, semipermanent impoundments are more subject to unpredictable disturbances from flooding, beaver activities, irregular water fluctuations, and breaching of dams. Over time, or more rapidly when

drained, these wetlands tend to fill with sediment and undergo invasion by emergent and woody vegetation. Community composition varies greatly with substrate and water depth. Emergent, non-tidal marshes are characteristic of abandoned but persistent beaver ponds. Dominant species of such marshes include smartweeds (*Polygonum* spp.), pickerelweed (*Pontederia cordata*), arrow-arum (*Peltandra virginica*), common rush (*Juncus effusus* var. *solutus*), three-way sedge *(Dulichium arundinaceum*), tussock sedge *(Carex stricta*), spikerushes (*Eleocharis* spp.), coastal mannagrass (*Glyceria obtusa*), marsh St. John's-wort (*Triadenum virginicum*), and eastern rose-mallow (*Hibiscus moscheutos* ssp. *moscheutos*). In deepwater impoundments, floating and submerged aquatic plants, especially American water-lily (*Nymphaea odorata*) and bladderworts (*Utricularia* spp.) are typical. Rare peaty or sandy ponds with abundant seepage inputs frequently support state-rare species such as water bulrush (*Schoenoplectus subterminalis*), Robbins' spikerush (*Eleocharis robbinsii*), horsetail spikerush (*Eleocharis equisetoides*), and big floating-heart (*Nymphoides aquatica*). Reference: McCoy and Fleming (2000).

Piedmont / Mountain Swamp Forests

Seasonally flooded deciduous forests of backswamps and sloughs along Piedmont and mountain-region rivers and large streams. Communities of this group are most common in the broad, clay-rich floodplain deposits of Piedmont Triassic basins, but occur locally throughout the central and western parts of Virginia. Habitats generally have some hummock-and-hollow microtopography, with maximum flooding depths in hollows of 50 to 70 cm (20 to 28 in). Soils are usually white- or orange-mottled clay loams and loamy clays, with moderately high base status. Characteristic trees of these swamps include pin oak (*Quercus palustris*), willow oak (*Q. phellos*), green ash (*Fraxinus pennsylvanica*), red maple (*Acer rubrum*), and sweetgum (*Liquidambar styraciflua*). Swamp white oak (*Q. bicolor*) is abundant in swamps of the northern Piedmont, while overcup oak (*Q. lyrata*) is a constituent in the southern Piedmont. Small trees and shrubs include deciduous hollies (*Ilex decidua* and *I. verticillata*), common elderberry (*Sambucus canadensis*), silky dogwood (*Cornus amomum* ssp. *amomum*), and American hornbeam (*Carpinus caroliniana*). High-climbing woody vines, including poison ivy (*Toxicodendron radicans*), grapes (*Vitis* spp.), and trumpet-creeper (*Campsis radicans*), are also typical. The herb layers of these communities are quite species-rich because of microtopographic diversity, but species tolerant of seasonal inundation are prevalent, including lizard's-tail (*Saururus cernuus*), false nettle (*Boehmeria cylindrica*), wood reedgrass (*Cinna arundinacea*), winged monkey-flower (*Mimulus alatus*), and various sedges (*e.g., Carex tribuloides, C. typhina, C. squarrosa, C. grayi*). Large, well-developed swamp forests are somewhat uncommon in the Piedmont and rare in the mountains. Some of them, as along the Roanoke River in southern Virginia, have been destroyed or hydrologically altered by the creation of large reservoirs.

Piedmont / Mountain Bottomland Forests

Temporarily and intermittently flooded forests, encompassing most river floodplain habitats of the Piedmont and major mountain valleys, except those occupied by swamp forests. Well-drained, sandy or silty river levees and terraces support forests of silver maple (*Acer saccharinum*), boxelder (*Acer negundo*), hackberry (*Celtis occidentalis*), black walnut (*Juglans nigra*), American elm (*Ulmus americana*), and sycamore (*Platanus occidentalis*), with understories of paw-paw (*Asimina triloba*) and spicebush (*Lindera benzoin*). Eastern cottonwood (*Populus deltoides*) is a frequent, early-successional pioneer of these habitats, while sycamore and river birch (*Betula nigra*) are early invaders of depositional river bars and coarse alluvium of small stream floodplains. Floodplain terraces that are less well drained usually support mixed stands of hydrophytic oaks (*e.g., Quercus phellos, Q. shumardii*), bitternut hickory (*Carya cordiformis*), sweetgum (*Liquidambar styraciflua*), green ash (*Fraxinus pennsylvanica*), and red maple (*Acer rubrum*). Small tree, shrub, and herbaceous composition is highly variable with geography and site conditions. Most Piedmont/Mountain Bottomland Forests have been severely impacted by clearing, grazing, agricultural run-off, and invasive exotic weeds. Many of these forests have been

destroyed and few, if any, of the remaining stands are in excellent or pristine condition. References: Lea (2000), Rawinski *et al*. (1996), Vanderhorst (2000).

Piedmont / Low Mountain Alluvial Forests
Temporarily flooded forests of smaller stream floodplains, where distinct alluvial landforms (*e.g*., levees, terraces, backswamps) occur at very small scales. This group encompasses forests along many small rivers and streams throughout the Piedmont and mountain-region valleys in Virginia. Microhabitats, flooding regimes, and floristic composition are diverse. Typical trees include sycamore (*Platanus occidentalis*), boxelder (*Acer negundo*), American elm (*Ulmus americana*), green ash (*Fraxinus pennsylvanica*), river birch (*Betula nigra*), red maple (*Acer rubrum*), sweetgum (*Liquidambar styraciflua*), yellow buckeye (*Aesculus flava*), black walnut (*Juglans nigra*), tulip-poplar (*Liriodendron tulipifera*), and black willow (*Salix nigra*). Shrubs include spicebush (*Lindera benzoin*), black haw (*Viburnum prunifolium*), American hornbeam (*Carpinus caroliniana*), American hazelnut (*Corylus americana*), and deciduous holly (*Ilex decidua*). Herbaceous composition varies greatly with site conditions and geography. Compared to Piedmont / Mountain Bottomland Forests, these communities occupy smaller, more topographically heterogeneous floodplains and contain a lower diversity of vegetation. Communities of this group are poorly documented in Virginia and are mostly in fair to poor condition because of extensive past clearing, grazing, catastrophic flooding, and invasive exotic weeds. References: Coulling (1999), Gemborys (1974), Hupp (1982), Hupp (1986).

Montane Alluvial Forests
Temporarily flooded deciduous and mixed forests occurring along relatively high-gradient small rivers and large streams in the mountains. Habitats generally consist of narrow floodplains with coarse, bouldery or cobbley deposition and rocky streambeds. Most of the lower, streamside terraces are probably flooded briefly at least annually. More powerful, catastrophic floods occur at irregular intervals and may be very destructive to stream channels and vegetation. The forests of these habitats are characterized by a mixture of bottomland and mesophytic species. Among the most common trees are sycamore (*Platanus occidentalis*), eastern hemlock (*Tsuga canadensis*), eastern white pine (*Pinus strobus*), white oak (*Quercus alba*), birches (*Betula alleghaniensis* and *B. lenta*), and tulip-poplar (*Liriodendron tulipifera*). Other trees that may be locally important are American beech (*Fagus grandifolia*), yellow buckeye (*Aesculus flava*), red maple (*Acer rubrum*), American elm (*Ulmus americana*) and, in southwestern Virginia only, sweetgum (*Liquidambar styraciflua*). Important shrubs include American hornbeam (*Carpinus caroliniana*), great-laurel (*Rhododendron maximum*), smooth alder (*Alnus serrulata*), willows (*Salix sericea* and *S. nigra*), and witch-hazel (*Hamamelis virginiana*). These floodplain habitats are relatively well drained and support a great variety of mostly mesophytic herbaceous species such as hog-peanut (*Amphicarpaea bracteata*), jack-in-the-pulpit (*Arisaema triphyllum*), green-and-gold (*Chrysogonum virginianum* var. *virginianum*), and golden ragwort (*Senecio aureus*). More frequently flooded and hydric microhabitats along the stream channels, however, usually support some wetland species, *e.g*., twisted sedge (*Carex torta*), mountain fringed sedge (*Carex gynandra*), fowl mannagrass (*Glyceria striata*), hooked buttercup (*Ranunculus recurvatus*), and marsh blue violet (*Viola cucullata*). Because mountain valleys were prime places for early settlers to build and farm, montane alluvial forests have been extensively destroyed in Virginia. References: Fleming and Moorhead (2000), Hupp (1982), Hupp (1986), Olson and Hupp (1986), Rawinski *et al*. (1994), Rawinski *et al*. (1996).

Piedmont / Mountain Semipermanent Impoundments
Aquatic and shoreline vegetation of both beaver ponds and persistent man-made impoundments along Piedmont and mountain-region streams. Compared to communities in the Floodplain Ponds and Pools group, semipermanent impoundments are more subject to unpredictable disturbances from flooding, beaver activities, irregular water fluctuations, and breaching of dams. Over time, or more rapidly when drained, these wetlands tend to fill with sediment and undergo invasion by emergent and woody

vegetation. Emergent, non-tidal marshes are characteristic of abandoned but persistent beaver ponds. Dominant species of such marshes are American bur-reed (*Sparganium americanum*), arrow-arum (*Peltandra virginica*), sedges (*Carex* spp.), lizard's-tail (*Saururus cernuus*), marsh seedbox (*Ludwigia palustris*), alternate-leaved seedbox (*Ludwigia alternifolia*), broad-leaved cattail (*Typha latifolia*), broad-leaved water-plantain (*Alisma subcordatum*), woolgrass (*Scirpus cyperinus*), woodland bulrush (*Scirpus expansus*), and rice cutgrass (*Leersia oryzoides*). Floating and submerged aquatic species such as spatterdock (*Nuphar advena*), watershield (*Brasenia schreberi*), pondweeds (*Potamogeton* spp.), northern water-starwort (*Callitriche heterophylla*), and duckweeds (*Lemna* spp.) occur in less common, deepwater impoundments. A variety of shrubs and trees may occupy the marginal zones. Piedmont / Mountain Semipermanent Impoundments lack a host of low-elevation species found in Coastal Plain Semipermanent Impoundments, tend to be more eutrophic, and support a lower diversity of communities and flora.

Sand / Gravel / Mud Bars and Shores

Seasonally flooded to intermittently exposed herbaceous and shrub vegetation occupying the draw-down shores, bars, and islands of rivers and large streams. Communities in this group are small, localized in distribution, and distinctive both environmentally and floristically. They are widely scattered throughout Virginia, but are most frequent and best developed along large rivers. Habitats are typically submerged during the winter and spring, but draw down during the summer and may be extensively exposed during the late summers and falls of dry years. A small subset of these communities is associated with diurnally exposed, dense clay mud flats on tidal freshwater river shores. Substrates consist of fine-textured to moderately coarse alluvium. The vegetation is variable but generally dominated by herbaceous species that are specially adapted to cycles of flooding and exposure. Seed banks or perennial rootstocks of these species are capable of maintaining their viability during long periods of submersion, quickly germinating or sprouting when favorable draw-down conditions occur. Flood-battered shrubs and tree saplings occur sparsely in these habitats. Species of relatively wide distribution on draw-down shores include creeping dayflower (*Commelina diffusa*), red-root flatsedge (*Cyperus erythrorhizos*), creeping lovegrass (*Eragrostis hypnoides*), dwarf bulrush (*Hemicarpha micrantha*), common water-willow (*Justicia americana*), thin-leaf flatsedge (*Kyllinga pumila*), false-pimpernels (*Lindernia* spp.), seedboxes (*Ludwigia* spp.), fall witch grass (*Panicum dichotomiflorum* var. *dichotomiflorum*), horse-tail paspalum (*Paspalum fluitans*), marsh yellow-cress (*Rorippa palustris* ssp. *fernaldiana*), and toothcup (*Rotala ramosior*). Species characteristic of Piedmont and mountain draw-down shores include scarlet ammannia (*Ammannia coccinea*), nodding beggar-ticks (*Bidens cernua*), spreading broomspurge (*Chamaesyce humistrata*), awned flatsedge (*Cyperus squarrosus*), dock-leaf smartweed (*Polygonum lapathifolium*), and Carolina leaf-flower (*Phyllanthus caroliniensis* ssp. *caroliniensis*). Species most typical of Coastal Plain draw-down shores include white-edged flatsedge (*Cyperus flavicomus*), coastal flatsedge (*Cyperus polystachyos* var. *texensis*), shade mudflower (*Micranthemum umbrosum*), lax hornpod (*Mitreola petiolata*), American lipocarpha (*Lipocarpha maculata*), Bosc's bluets (*Oldenlandia boscii*), warty panic grass (*Panicum verrucosum*), and coastal rose-pink (*Sabatia calycina*). Diagnostic plants of tidal mud flats include strap-leaf arrowhead (*Sagittaria subulata*), longstem waterwort (*Elatine americana*), eastern lilaeopsis (*Lilaeopsis chinensis*), and the state-rare species Parker's pipewort (*Eriocaulon parkeri*) and tropical water-hyssop (*Bacopa innominata*). References: Lea (2000), Ludwig (1996).

Rocky Bars and Shores

Seasonally flooded to intermittently exposed shrub and herbaceous vegetation of rock outcrops and boulder or cobble bars on the shores and islands of large, high-gradient streams. Communities in this group are scattered throughout the Virginia mountains and Piedmont, primarily along major rivers and their largest tributaries. Habitats are influenced by a frequent regime of powerful flood scouring, and soils consist of fine to coarse alluvial materials deposited among outcrops and boulders. Vegetation varies from densely shrubby to entirely herbaceous and sparse. Woody scrub, including battered sycamore (*Platanus occidentalis*) and river birch (*Betula nigra*), willows (*Salix caroliniana, S. nigra, S.*

sericea, and *S. eriocephala*), silky dogwood (*Cornus amomum* ssp. *amomum* and ssp. *obliqua*), buttonbush (*Cephalanthus occidentalis*), and viburnums (*Viburnum* spp.), is relatively common on stable bars and outcrops. Herbaceous composition is highly variable and includes species common to both Sand / Gravel / Mud Bars (*e.g*., common water-willow [*Justicia americana*]) and somewhat more stable Riverside Prairies (*e.g*., big bluestem [*Andropogon gerardii*]). A well-marked herbaceous variant of this group, known from bouldery banks and bars along a number of mountain streams, is dominated by twisted sedge (*Carex torta*). Substantial data on the composition and environmental dynamics of rocky bar and shore communities in Virginia has yet to be collected. References: Hupp (1983b), Hupp (1986), Fleming and Moorhead (1996), Lea (2000), Vanderhorst (2000).

Riverside Prairies
Temporarily flooded, sparse shrub and dense grassland vegetation of stabilized outcrop or boulder bars along the shores of major mountain and Piedmont rivers. Communities in this group are globally and state-rare. In Virginia, most of the few known occurrences are located in the Potomac River gorge west of Washington, D.C. and along the James River near the Blue Ridge. Habitats supporting Riverside Prairies are elevated above mean water levels and are flooded-scoured at least once annually. Because of rockiness and limited alluvial deposition, soils are relatively shallow and site moisture conditions range from mesic to somewhat xeric. The vegetation is a lush assemblage of warm-season grasses and forbs, with scattered woody scrub such as stunted green ash (*Fraxinus pennsylvanica*), silky dogwood (*Cornus amomum* ssp. *amomum* and ssp. *obliqua*), and willows (*Salix* spp.). Dominant grasses are usually big bluestem (*Andropogon gerardii*), indian grass (*Sorghastrum nutans*), and switchgrass (*Panicum virgatum*). Other characteristic plants include blue wild indigo (*Baptisia australis* var. *australis*), freshwater cordgrass (*Spartina pectinata*), eastern Sampson's snakeroot (*Orbexilum pedunculatum* var. *psoralioides*), northern obedient-plant (*Physostegia virginiana* ssp. *virginiana*), violet bushclover (*Lespedeza violacea*), whorled rosinweed (*Silphium trifoliatum* var. *trifoliatum*), Culver's-root (*Veronicastrum virginicum*), western sunflower (*Helianthus occidentalis* ssp. *occidentalis*), American purple vetch (*Vicia americana* ssp. *americana*), narrow-leaved mountain-mint (*Pycnanthemum tenuifolium*), flattened spikerush (*Eleocharis compressa*), clasping-leaved dogbane (*Apocynum sibiricum*), smooth veiny peavine (*Lathyrus venosus*), and heart-leaved golden-alexanders (*Zizia aurea*). References: Lea (2000), Rawinski *et al*. (1996).

River-Scour Woodlands
Temporarily flooded deciduous woodlands occupying rocky or bouldery bars along the shores of large river floodplains in the Piedmont and mountains. These communities have been documented or observed in Virginia along the Potomac, James, and Maury Rivers. Additional occurrences are likely along these rivers, the New River, and the Roanoke River, but communities in this group are probably naturally rare. Requisite habitat conditions occur in high-gradient river sections with abundantly exposed bedrock, boulders, or gravel and a regime of frequent, powerful flood-scouring and sediment deposition. Very little is known about stand composition, but the overstory consists of moderately to widely spaced, often battered or flood-trained specimens of sycamore (*Platanus occidentalis*), river birch (*Betula nigra*), green ash *(Fraxinus pennsylvanica)*, swamp white oak (*Quercus bicolor*), and other trees. Shrubs include silky dogwood (*Cornus amomum* ssp. *amomum* and ssp. *obliqua*), American hornbeam (*Carpinus caroliniana*), ninebark (*Physocarpus opulifolius* var. *opulifolius*), and willows (*Salix* spp.). At this time, the herbaceous flora cannot be reliably characterized. These communities are threatened by rampantly invasive weeds such as purple loosestrife (*Lythrum salicaria*) and Johnson-grass (*Sorghum halapense*), which are readily dispersed and established in high-energy alluvial environments. Reference: Lea (2000).

NON-ALLUVIAL WETLANDS OF THE MOUNTAINS

Ecological community groups of groundwater-controlled, non-alluvial wetlands in the mountain region. Structurally and compositionally diverse vegetation is represented.

Montane Basic Seepage Swamps

Saturated deciduous forests of gently sloping stream headwaters, large spring seeps, and lateral areas in ravines and stream bottoms where groundwater emerges at the base of slopes. These communities are locally scattered throughout western Virginia in areas underlain by metabasalt (greenstone), base-rich granite, calcareous shale, and limestone. Habitats usually have considerable cover of bouldery, cobbley, and gravelly alluvium; braided seeps and stream channels; moss (except *Sphagnum*)-covered hummocks; and muck-filled depressions. Soils range from strongly acidic to circumneutral, with moderately high calcium and magnesium levels. Tree layers are mixed, with variable combinations of red maple (*Acer rubrum*), white ash (*Fraxinus americana*), black ash (*Fraxinus nigra*), tulip-poplar (*Liriodendron tulipifera*), and birches (*Betula* spp.). Spicebush (*Lindera benzoin*) is usually the most abundant shrub. Herbaceous cover is usually lush, and often features patch-dominance of skunk-cabbage (*Symplocarpus foetidus*), American false-hellebore (*Veratrum viride*), and/or sedges (especially *Carex bromoides* and *C. prasina*). Additional characteristic herbs include marsh-marigold (*Caltha palustris*), water-carpet (*Chrysosplenium americanum*), swamp saxifrage (*Saxifraga pensylvanica*), lettuce saxifrage (*S. micranthidifolia*), marsh blue violet (*Viola cucullata*), and various ferns. Most Virginia populations of the globally rare bog bluegrass (*Poa paludigena*), as well as of the globally rare Blue Ridge Mountain amphipod (*Stygobromus spinosus*), are associated with these swamps. Reference: Fleming (1999).

Mountain / Piedmont Acidic Seepage Swamps

Saturated deciduous forests of gently sloping stream headwaters, large spring seeps, and ravine bottoms underlain by sandstone, quartzite, or base-poor granite. Certain basin wetlands that are saturated or seasonally saturated by perched groundwater support similar vegetation and probably belong in this group as well. These communities are locally scattered throughout the western Virginia mountains and Piedmont foothills, up to about 900 m (3000 ft) elevation. Hummock-and-hollow microtopography, braided streams, areas of coarse gravel and cobble deposition, muck-filled depressions, and abundant *Sphagnum* mats are typical habitat features. Soils are very strongly to extremely acidic, with low base status. Composition is variable over the range of this group, and several community types are probably represented. Red maple (*Acer rubrum*), blackgum (*Nyssa sylvatica*), tulip-poplar (*Liriodendron tulipifera*), and pitch pine (*Pinus rigida*) are typical trees, while winterberry (*Ilex verticillata*), swamp azalea (*Rhododendron viscosum*), highbush blueberries (*Vaccinium corymbosum* and *V. fuscatum*) are abundant shrubs. Skunk-cabbage (*Symplocarpus foetidus*) and American false-hellebore (*Veratrum viride*) may be as dominant in these communities as in Montane Basic Seepage Swamps; herbs and low shrubs more abundant in or restricted to acidic swamps include cinnamon fern (*Osmunda cinnamomea*), bristly dewberry (*Rubus hispidus*), kidneyleaf grass-of-parnassus (*Parnassia asarifolia*), yellow fringed orchid (*Platanthera ciliaris*), common tree clubmoss (*Lycopodium obscurum*), white-edged sedge (*Carex debilis*), and long sedge (*Carex folliculata*). Like the very similar Coastal Plain / Piedmont Acidic Seepage Swamps, these communities support populations of the rare, beautiful, and federally listed swamp-pink (*Helonias bullata*). References: Allard and Leonard (1943), Carr (1939), Fleming and Van Alstine (1999).

High-Elevation Seepage Swamps

Saturated, coniferous or mixed forests of gently sloping stream headwaters, large spring seeps, and ravine bottoms at elevations above 900 m (3000 ft). These communities are locally scattered in the higher mountains of western Virginia on various geologic substrates and soils, almost all of which are strongly to extremely acidic. Habitats feature pronounced hummock and hollow microtopography, with braided streams, muck-filled depressions, and lush bryophyte cover. Eastern hemlock (*Tsuga canadensis*), yellow

birch (*Betula alleghaniensis*), and red maple (*Acer rubrum*) are the most common trees. Locally, red spruce (*Picea rubens*) or eastern white pine (*Pinus strobus*) may be co-dominants. Shrub layer composition and density is variable; deciduous hollies (*Ilex verticillata* and *I. montana*), several blueberries (particularly *Vaccinium corymbosum, V. simulatum,* and *V. angustifolium*), great-laurel (*Rhododendron maximum*), mountain-laurel (*Kalmia latifolia*), speckled alder (*Alnus incana* ssp. *rugosa*), and witch-hazel (*Hamamelis virginiana*) may be abundant. Characteristic herbs of these swamps include whorled aster (*Aster acuminatus*), flat-top white aster (*Aster umbellatus*), marsh-marigold (*Caltha palustris*), little prickly sedge (*Carex echinata* ssp. *echinata*), finely-nerved sedge (*Carex leptonervia*), rough sedge (*Carex scabrata*), three-seed sedge (*Carex trisperma* var. *trisperma*), slender wood reed-grass (*Cinna latifolia*), slender mannagrass (*Glyceria melicaria*), cinnamon fern (*Osmunda cinnamomea*), American false-hellebore (*Veratrum viride*), and smooth white violet (*Viola macloskeyi* ssp. *pallens*). Communities in this group are naturally rare due to the scarcity of flat or gentle, wet habitats in the higher Appalachians. Beavers have partially destroyed fine examples of these swamps at several sites. References: Rawinski *et al*. (1994), Rawinski *et al*. (1996).

Appalachian Bogs

Saturated shrub and herbaceous vegetation of gently sloping zones of groundwater discharge along valley floors and headwaters streams in the mountain region of Virginia. Habitats supporting bogs are usually less than 0.4 hectare (one acre) in size but rarely range up to 4 hectares (10 acres) in the southern Blue Ridge (Mount Rogers area). Fewer than twenty occurrences have been documented in the state. Soils, which vary from mineral to superficial or deep peat, are extremely acidic and support thick growths of *Sphagnum* and other mosses. The term "bog," as applied to these wetlands, is a technical misnomer, since not all of these habitats are true peatlands and none is an ombrotrophic system. This term, however, is now so widely used in the southeastern United States as a descriptor for open, acidic seepage wetlands that we have adopted it here for consistency. The ecological dynamics of these naturally rare communities are not well understood, and many examples are currently suffering from shrub and tree invasions. Factors that may have been responsible for creating and maintaining open bogs include fire, grazing, beavers, and deep deposition of unstable soils. Bog vegetation is frequently a mosaic of shrub patches and herbaceous openings. Several compositional variants associated with geography and elevation have been documented in Virginia. Species common to most variants include great-laurel (*Rhododendron maximum*), Catawba rhododendron (*R. catawbiense*), silky willow (*Salix sericea*), smooth alder (*Alnus serrulata*), cinnamon fern (*Osmunda cinnamomea*), tawny cotton-grass (*Eriophorum virginicum*), Atlantic sedge (*Carex atlantica* ssp. *atlantica*), and brown beakrush (*Rhynchospora capitellata*). Species more restricted to low-elevation (below 900 m [3000 ft]) bogs of the Ridge and Valley and Cumberland Mountains include round-leaved sundew (*Drosera rotundifolia*), bushy bluestem (*Andropogon glomeratus*), tuberous grass-pink (*Calopogon tuberosus*), yellow fringed orchid (*Platanthera ciliaris*), and Nuttall's reed-grass (*Calamagrostis coarctata*). Species more restricted to higher-elevation (mostly above 900 m [3000 ft]) bogs of the southern Blue Ridge, Allegheny Mountains, and/or the highest mountains of the Ridge and Valley include stunted red spruce (*Picea rubens*), long-stalked holly (*Ilex collina*), northern wild raisin (*Viburnum nudum* var. *cassinioides*), Carolina sheep-laurel (*Kalmia carolina*), large cranberry (*Vaccinium macrocarpon*), rough goldenrod (*Solidago patula* var. *patula*), Cuthbert's turtlehead (*Chelone cuthbertii*), bog goldenrod (*Solidago uliginosa* var. *uliginosa*), little prickly sedge (*Carex echinata* ssp. *echinata*), narrow-leaf bur-reed (*Sparganium chlorocarpum*), linear-leaved willow-herb (*Epilobium leptophyllum*), narrow-panicled rush (*Juncus brevicaudatus*), three-seed sedge (*Carex trisperma* var. *trisperma*), Ruth's sedge (*Carex ruthii*), and thyme-leaved bluets (*Houstonia serpyllifolia*). References: Chappell (1972), Musselman (1970), Ogle (1982), Fleming and Moorhead (1996).

High-Elevation Seeps

Saturated herbaceous wetlands occurring on relatively steep, usually bouldery upper slopes at sites of groundwater discharge. These communities are scattered in the higher mountains of western Virginia,

above 900 m (3000 ft) elevation. The habitats are typically narrow and partially shaded by tree species rooted in adjacent upland forests. A few occurrences encompass large spring seeps on high-elevation cliffs. Vegetation is similar to the herbaceous component of high-elevation seepage swamps, but is usually more forb-rich. Common species include Oswego-tea (*Monarda didyma*), cut-leaved coneflower (*Rudbeckia laciniata*), spotted jewelweed (*Impatiens capensis*), rough goldenrod (*Solidago patula* var. *patula*), rough-leaved goldenrod (*Solidago rugosa*), white turtlehead (*Chelone glabra*), water-carpet (*Chrysosplenium americanum*), golden ragwort (*Senecio aureus*), American false-hellebore (*Veratrum viride*), marsh blue violet (*Viola cucullata*) and, in the southern Blue Ridge, umbrella-leaf (*Diphyllea cymosa*). Graminoids, including bluejoint reedgrass (*Calamagrostis canadensis*), Bailey's sedge (*Carex baileyi*), and mountain fringed sedge (*Carex gynandra*), may be prominent locally. The distribution, compositional variation, and ecological dynamics of high-elevation seeps in Virginia are poorly known and need intensive study.

Mountain Ponds
Seasonally to semipermanently flooded shrub and herbaceous vegetation of basin wetlands situated on broad ridge crests, landslide benches and, more rarely, mountain-foot alluvial fans of the Ridge and Valley and Blue Ridge provinces. These very rare natural ponds range up to about 0.4 hectare (one acre) in size and are thought to have formed from the sagging or solution of underlying bedrock strata. Hydrologic regime is variable from pond to pond, and many sites exhibit pronounced seasonal water-level fluctuations. Most mountain ponds are open or partly shaded by trees rooted in drier marginal soils. Vegetation structure varies from shrubland to herbaceous or a patch-mosaic of the two; composition often exhibits distinct concentric zonation. Characteristic plants of semipermanently flooded ponds or zones include buttonbush (*Cephalanthus occidentalis*), three-way sedge (*Dulichium arundinaceum*), broadleaf arrowhead (*Sagittaria latifolia*), northeastern bulrush (*Scirpus ancistrochaetus*), inflated sedge (*Carex vesicaria*), bladderworts (*Utricularia* spp.) and, at one site, the long-range northern disjunct water sedge (*Carex aquatilis* var. *aquatilis*). Species more typical of seasonally flooded ponds or zones include winterberry (*Ilex verticillata*), highbush blueberry (*Vaccinium corymbosum*), common greenbrier (*Smilax rotundifolia*), swamp beggar-ticks (*Bidens discoidea*), silvery sedge (*Carex canescens* ssp. *disjuncta*), hop sedge (*Carex lupulina*), tussock sedge (*Carex stricta*), sharp-scaled mannagrass (*Glyceria acutiflora*), eastern mannagrass (*Glyceria septentrionalis*), slender St. John's-wort (*Hypericum mutilum*), and rushes (*Juncus* spp.). Mountain ponds are important breeding habitats for amphibians and odonates (dragonflies and damselflies). Many of the known occurrences are protected on U.S. Forest Service land, but several privately owned ponds remain vulnerable to anthropogenic disturbances. References: Fleming and Van Alstine (1999), Fleming and Moorhead (2000).

Shenandoah Valley Sinkhole Ponds
Intermittently to permanently flooded basin wetlands on broad, acidic alluvial fan deposits stretching along the western foot of the Blue Ridge in Augusta, Rockingham, and Page Counties. Local solution of deep underlying carbonate rocks and reworking of surficial material by streams have resulted in the development of numerous natural ponds varying in size from less than 0.04 hectare (0.1 acre) to over 1.0 hectare (2.4 acres). The extraordinary combination of solution features overlain by acidic colluvium and alluvium has created wetlands with edaphic conditions similar to habitats in the Coastal Plain. Pollen profiles from bottom sediments from two Augusta County ponds demonstrate the continuous existence of wetlands over the past 15,000 years. Soils vary from organic to clay-rich; low pH, calcium, and magnesium levels combined with high aluminum levels may impair the assimilation of macronutrients by plants. The most prevalent, and possibly endemic, community of the ponds is a seasonally flooded vegetation type characterized by scattered pin oak (*Quercus palustris*) and herbaceous species such as warty panic grass (*Panicum verrucosum*), tall flat panic grass (P. *rigidulum* var. *rigidulum*), and least spikerush (*Eleocharis acicularis*), which are well adapted to a regime of seasonal flooding and draw-down on mineral soils. Ponds that have a longer seasonal or semipermanent flooding regime are vegetated with buttonbush (*Cephalanthus occidentalis*), common mermaid-weed (*Proserpinaca*

palustris), mild water pepper (*Polygonum hydropiperoides*), pale mannagrass (*Torreyochloa pallida*), creeping spikerush (*Eleocharis smallii*), and other floating or emergent species. Most unusual is Spring Pond, a cold, permanently flooded pond with water levels constantly replenished by groundwater inputs. Dominants here are golden-club (*Orontium aquaticum*), seven-angled pipewort (*Eriocaulon aquaticum*), and water bulrush (*Schoenoplectus subterminalis*). The flora of Shenandoah Valley sinkhole ponds is noteworthy for its high percentage of rarities and disjuncts with various biogeographic affinities. Virginia sneezeweed (*Helenium virginicum*) is nearly endemic to these habitats, while Virginia quillwort (*Isoetes virginica*) is a state endemic also found in the Piedmont. Northern plants found here include toothed flatsedge (*Cyperus dentatus*), slender sedge (*Carex lasiocarpa* var. *americana*), northern St. John's-wort (*Hypericum boreale*), and Torrey's bulrush (*Schoenoplectus torreyi*). Notable Coastal Plain disjuncts include Barratt's sedge (*Carex barrattii*), dwarf burhead (*Echinodorus tenellus*), black-fruited spikerush (*Eleocharis melanocarpa*), Robbins' spikerush (*E. robbinsii*), and maidencane (*Panicum hemitomon*). The fauna of these wetlands is also remarkable, with disjunct populations of the state-listed tiger salamander (*Ambystoma tigrinum*) and a very diverse assemblage of odonates (dragonflies and damselflies) containing a number of state-rare and/or disjunct species. Clearly, the Shenandoah Valley sinkhole ponds comprise one of Virginia's most unusual and conservation-worthy ecosystems. Although some ponds are located on U.S. Forest Service land, most remain unprotected and threatened by development, hydrologic alterations, off-road vehicles, and trash dumping. References: Craig (1969), Fleming and Van Alstine (1999), Rawlinson and Carr (1937).

Calcareous Fens and Seeps

Shrub and herbaceous wetlands of calcareous hillside or foot-slope spring seeps and seepage zones in small stream bottoms. These small-patch wetlands are widely scattered in carbonate rock districts of western Virginia, primarily in valleys of the Ridge and Valley province. Habitats typically have irregular or hummock-and-hollow microtopography, with areas of muck and abundant gravel or travertine marl deposits in the seepage rills. Soils, which are derived from underlying limestone or dolomite, are slightly to moderately alkaline with high calcium levels. Strictly defined, fens are minerotrophic wetlands with organic soils > 40 cm deep. Because they usually have only superficial organic soil layers, most of the Virginia communities in this group are technically "seeps," although we retain the term "fen" due to its wide application to various base-rich seepage wetlands in the southeastern United States. The vegetation of these wetlands is often a patch-mosaic of shrubs and herbaceous openings. Common shrubs include willows (*Salix* spp.), smooth alder (*Alnus serrulata*), swamp rose (*Rosa palustris*), alder buckthorn (*Rhamnus alnifolia*), and chokeberries (*Aronia* spp.). Herbaceous species that are more or less diagnostic of calcareous fens or seeps include several sedges (*e.g.*, *Carex flava*, *C. hystricina*, *C. interior*, *C. suberecta*), showy lady's-slipper (*Cypripedium reginae*), small-headed rush (*Juncus brachycephalus*), bog twayblade (*Liparis loeselii*), large-leaved grass-of-parnassus (*Parnassia grandifolia*), swamp lousewort (*Pedicularis lanceolata*), and hairlike beakrush (*Rhynchospora capillacea*). The ecological factors that keep fens and seeps open are not well understood, and many examples appear to be threatened by shrub and tree invasion. Ditching, grazing, and exotic weeds are additional threats to these naturally rare wetlands, most of which are unprotected and are high priorities for conservation. References: Artz and Krouse (1967), Carr (1939), Fleming (1999), Fleming and Van Alstine (1999), Ogle (1989).

Mesic and Wet-Mesic Prairies

Tall grasslands on moderately well drained to somewhat poorly drained floodplain terraces in mountain valleys of the Ridge and Valley region. These communities are comparable to "tall-grass prairies" of midwestern states and are known from only a few sites in western Virginia. Their original, pre-colonial extent and the ecological dynamics which maintained them (*e.g.*, fire, grazing) are now conjectural. Some of the present-day occurrences may be artifacts of post-settlement clearing and grazing. Although these communities are included in the Palustrine system, some examples may not be wetlands in the strict sense. The hydrology of our few examples appears to vary from rather well-drained to seasonally saturated or even briefly flooded. Surficial soils vary from sandy-gravelly to mottled loamy-clayey, and

from slightly acidic to moderately alkaline. The vegetation is dominated by the tall, warm-season grasses big bluestem (*Andropogon gerardii*) and indian grass (*Sorghastrum nutans*). Associated species with prairie affinities include willow aster (*Aster praealtus* var. *angustior*), rigid sedge (*Carex tetanica*), eastern indian-paintbrush (*Castilleja coccinea)*, rattlesnake-master (*Eryngium yuccifolium* var. *yuccifolium*), dense blazing-star (*Liatris spicata* var. *spicata*), Virginia mountain-mint (*Pycnanthemum virginianum*), and Culver's-root (*Veronicastrum virginicum*). Conversion to agricultural fields, cattle grazing, invasive exotic weeds, and woody succession represent serious threats to these small, remnant prairies.

Wet Prairies and Prairie Fens

Herbaceous wetlands on large stream or river floodplain terraces constantly saturated by perched groundwater or seepage from adjacent slopes. These very rare communities are limited in Virginia to a few sites in valleys of the Ridge and Valley region. Most of the remaining occurrences, two of which are protected, are located along the South River in Augusta County. Surficial soils consist of calcareous, blackish, clay-rich organic matter overlying dense clay and grayish sand at depths of 30 to 40 cm (12 to 16 in). Vegetation is generally graminoid-dominated; patch-dominance of sedges (*e.g*., *Carex stricta, C. interior, C. buxbaumii, C. prairea, C. trichocarpa, C. emoryi*), baltic rush (*Juncus balticus* var. *littoralis*), freshwater cordgrass (*Spartina pectinata*), switchgrass (*Panicum virgatum*) and, at a single known Virginia site, holy grass (*Hierachloe odorata*) is typical. Many state-rare and unusual forbs are also components, including queen-of-the-prairie (*Filipendula rubra*), smooth loosestrife (*Lysimachia quadriflora*), spotted joe-pye-weed (*Eupatorium maculatum*), winged loosestrife (*Lythrum alatum* var. *alatum*), hooded skullcap (*Scutellaria galericulata*), blueflag iris (*Iris versicolor*), and vetchling (*Lathyrus palustris*). Reed canary grass (*Phalaris arundinacea*) is a native perennial grass that frequently becomes invasive in disturbed wet prairies.

Calcareous Spring Marshes and Muck Fens

Herbaceous wetlands of groundwater-saturated sloughs, abandoned meanders, depressions, and spring overflows on large stream or river floodplain terraces. Restricted to a few sites in carbonate rock districts of the Ridge and Valley region, these very rare habitats are highly threatened by impoundments and hydrological alterations, grazing, and agricultural pollution. Hydric muck soils are calcareous and more or less permanently saturated or flooded by perched groundwater or seepage inputs. Vegetation is marsh-like and characterized by coarse emergent species: arrow-arum (*Peltandra virginica*), bur-reeds (*Sparganium eurycarpum* and *S. americanum*), water smartweed (*Polygonum amphibium* var. *emersum*), lake-bank sedge (*Carex lacustris*), hop sedge (*Carex lupulina*), smooth bur-marigold (*Bidens laevis*), sweetflag (*Acorus calamus*), marsh-marigold (*Caltha palustris*), skunk-cabbage (*Symplocarpus foetidus*), spotted jewelweed (*Impatiens capensis*), and broad-leaved cattail (*Typha latifolia*). Buckbean (*Menyanthes trifoliata*) and water horsetail (*Equisetum fluviatile*) are components at two sites each, representing the only occurrences of these species in Virginia. A most unusual site in Clarke County consists of a two-hectare (five-acre) marsh developed in the overflow of powerful artesian springs. The marsh here is dominated by broad-leaved cattail and the state-rare, northern disjunct beaked sedge (*Carex utriculata*), while deep channels support the similarly disjunct flatstem pondweed (*Potamogeton zosteriformis*). Although two occurrences of this community group are located on natural area preserves, several others remain unprotected and vulnerable.

Mafic Fens and Seeps

Shrub and herbaceous wetlands of hillside or foot-slope spring seeps and groundwater-saturated small stream bottoms, in areas underlain by mafic or ultramafic igneous rocks. In Virginia, these small-patch wetlands are known primarily from The Glades region of the southern Blue Ridge plateau (Grayson County), with an outlying site at Big Meadows in the northern Blue Ridge (Madison County). Habitats typically have irregular microtopography, with superficial to substantial peat accumulations. Soils, derived from underlying amphibolite, gabbro, metabasalt, or similar rocks, are strongly to slightly acidic,

with high magnesium and iron levels and low calcium-to-magnesium ratios. Communities in this group that lack significant organic soils are technically "seeps," although the term "fen" is widely applied to various mafic or calcareous seepage wetlands in the southeastern United States. The vegetation of these wetlands range from tall shrublands to wholly herbaceous but is often a patch-mosaic of shrubs and herbaceous openings. Smooth alder (*Alnus serrulata*), stiff dogwood (*Cornus racemosa*), and meadowsweets (*Spiraea alba* var. *latifolia* and *S. tomentosa*) are particularly characteristic shrubs. The herbaceous flora of mafic fens contains many state-rare and unusual species, including several Coastal Plain–mountain disjuncts. Herbs that are particularly diagnostic of or abundant in these habitats include Canada burnet (*Sanguisorba canadensis*), large-leaved grass-of-parnassus (*Parnassia grandifolia*), bluejoint reedgrass (*Calamagrostis canadensis* var. *canadensis*), shortleaf sneezeweed (*Helenium brevifolium*), bog goldenrod (*Solidago uliginosa* var. *uliginosa*), sterile sedge (*Carex sterilis*), field sedge (*Carex conoidea*), hairy fimbry (*Fimbristylis puberula* var. *puberula*), white beakrush (*Rhynchospora alba*), marsh muhly (*Muhlenbergia glomerata*), and twig rush (*Cladium mariscoides*). Ditching, grazing, exotic weeds, and woody succession are serious threats to these naturally rare wetlands, most of which remain unprotected. The processes that maintain these systems in open condition are poorly understood. Reference: Ogle (1982).

Mafic Woodland Seeps

Saturated mixed woodlands of headwaters stream bottoms and large slope-base seeps in areas underlain by mafic or ultramafic igneous rocks. This is a very restricted group of naturally rare wetlands known in Virginia only from The Glades and Buffalo Mountain areas of the southern Blue Ridge. Hummock-and-hollow microtopography, braided streams, areas of coarse gravel and cobble deposition, and muck-filled depressions are characteristic of the stream bottom habitats. Soils are similar to those of mafic fens and evidently quite oligotrophic. Vegetation of these wetlands is typically a woodland or open forest containing a peculiar mix of typical seepage swamp species, mafic indicators, and species commonly associated with acidic wetlands. Composition is closely related to Mafic Fens and Seeps, with which these woodlands often co-occur. The canopy is dominated by combinations of red maple (*Acer rubrum*), eastern white pine (*Pinus strobus*), pitch pine (*P. rigida*), and tulip-poplar (*Liriodendron tulipifera*). Small trees and shrubs include broad-leaved meadowsweet (*Spiraea alba* var. *latifolia*), ninebark (*Physocarpus opulifolius* var. *opulifolius*), mountain-laurel (*Kalmia latifolia*), maleberry (*Lyonia ligustrina* var. *ligustrina*), smooth alder (*Alnus serrulata*), spicebush (Lindera benzoin), and alder buckthorn (*Rhamnus alnifolia*). Abundant or typical herbs are large-leaved grass-of-parnassus (*Parnassia grandifolia*), Canada burnet (*Sanguisorba canadensis*), royal fern (*Osmunda regalis* var. *spectabilis*), cinnamon fern (*Osmunda cinnamomea*), woodland bulrush (*Scirpus expansus*), rough goldenrod (*Solidago patula* var. *patula*), and bog goldenrod (*S. uliginosa* var. *uliginosa*). All the documented occurrences are small and have been disturbed to some degree by logging and/or grazing.

Spray Cliffs

Constantly wet rock faces within the spray or splash zone of waterfalls, or sheltered cliffs saturated with permanent seepage. Communities in this group have been well documented in North Carolina, but have not been studied in Virginia. A few examples, scattered over the entire mountain region of the state, are known from qualitative reports. At this time, very little can be said about the ecological dynamics or floristic composition of these occurrences. Based on casual observations, mosses and liverworts are usually the dominant plants, with vascular species more sparsely rooted in crevices and on moss- or humus-covered shelves. Among the more characteristic or abundant vascular plants are brook saxifrage (*Boykinia aconitifolia*), small enchanter's nightshade (*Circaea alpina* ssp. *alpina*), little-leaved alumroot (*Heuchera parviflora* var. *parviflora*), rock clubmoss (*Huperzia porophila*), saxifrages (*Saxifraga caroliniana* and *S. micranthidifolia*), mountain meadowrue (*Thalictrum clavatum*), and various lithophytic ferns. Very few waterfalls in Virginia are large and constant enough to provide requisite conditions for spray cliff communities. Good examples, therefore, should be high priorities for

protection. A full understanding of Virginia's spray cliff vegetation and its relationship to similar vegetation further south in the Appalachians will require comprehensive bryophyte inventories.

Inland Salt Marshes
Seasonally flooded basin wetlands fed by saline springs in a small, southwestern Virginia valley near Saltville, Smyth County. The unique habitat at this site has been greatly reduced by industrial salt mining, hydrologic alterations, and grazing. However, small remnant marshes remain, supporting a very rare type of emergent vegetation composed largely of several remarkably disjunct halophytes. The salinity of water in these marshes varies over time from entirely fresh to polyhaline. Dominants are saltmarsh bulrush (*Schoenoplectus robustus*), black-grass rush (*Juncus gerardii* var. *gerardii*) and, on a few small exposed mud flats, small spikerush (*Eleocharis parvula*). Also present are hastate orach (*Atriplex prostrata*), jointed glasswort (*Salicornia virginica*), foxtail barley (*Hordeum jubatum*), broad-leaved cattail (*Typha latifolia*), hard-stemmed bulrush (*Schoenoplectus acutus*), spotted jewelweed (*Impatiens capensis*), eastern rose-mallow (*Hibiscus moscheutos* ssp. *moscheutos*), and several exotics. Similar but somewhat compositionally different communities are known from inland salt flats in New York and Michigan. It appears likely that the community type represented at Saltville is endemic to this site. Reference: Ogle (1981).

NON-ALLUVIAL WETLANDS OF THE COASTAL PLAIN AND PIEDMONT
Ecological community groups of groundwater-controlled, non-alluvial wetlands in the Coastal Plain and Piedmont. Structurally and compositionally diverse vegetation is represented.

Coastal Plain Depression Ponds
Mostly seasonally flooded basin wetlands of nearly flat Coastal Plain uplands with fluctuating, seasonally perched water tables. The best-documented examples of this group in Virginia are the Grafton Ponds, located on The Peninsula in York County, but other sizeable complexes occur on Coastal Plain terraces in Dinwiddie, Surry, Isle of Wight, Gloucester, and Matthews Counties. Most of these seasonal ponds are believed to be sinkhole features that formed through dissolution of underlying carbonate-rich shell marl deposits. The marl deposits are too deep to influence soil or water chemistry of the ponds, which are strongly acidic in most examples. A few ponds in extreme southeastern Virginia appear to have originated from deep peat burn-outs. Pond vegetation varies from nearly forested to entirely herbaceous, representing a sizeable number of distinct community types. Depth and duration of seasonal inundation are apparently the most important factors influencing community composition and the degree to which woody species become established. Dry-season fires in adjacent uplands may spread into ponds and may be another factor limiting the invasion of woody species, although fire frequencies throughout the region have been much reduced in recent decades. Typical trees occurring in wooded ponds are red maple (*Acer rubrum*), sweetgum (*Liquidambar styraciflua*), swamp tupelo (*Nyssa biflora*), blackgum (*Nyssa sylvatica*), willow oak (*Quercus phellos*), overcup oak (*Q. lyrata*), and bald cypress (*Taxodium distichum*). Shrubs that dominate some ponds include buttonbush (*Cephalanthus occidentalis*), swamp loosestrife (*Decodon verticillatus*), persimmon (*Diospyros virginiana*), and fetterbush (*Leucothoe racemosa*). A few of the characteristic herbs are glaucous sedge (*Carex glaucescens*), cypress-swamp sedge (*C. joorii*), pocosin sedge (*C. striata* var. *brevis*), long-tubercled spikerush (*Eleocharis tuberculosa*), creeping rush (*Juncus repens*), eastern narrowleaf seedbox (*Ludwigia linearis*), globe-fruited seedbox (*Ludwigia sphaerocarpa*), tall flat panic grass (*Panicum rigidulum* var. *rigidulum*), warty panic grass (*P. verrucosum*), mermaid-weeds (*Proserpinaca palustris* and *P. pectinata*), short-bristled hornedrush (*Rhychospora corniculata* var. *corniculata*), slender plumegrass (*Saccharum baldwinii*), woolgrass (*Scirpus cyperinus*), and pale mannagrass (*Torreyochloa pallida* var. *pallida*). Coastal Plain depression ponds are relatively rare, small-patch communities that provide important habitat for the state-rare chicken turtle (*Deirochelys reticularia*) and three state-listed amphibians: Mabee's salamander

(*Ambystoma mabeei*), tiger salamander (*Ambystoma tigrinum*), and barking tree frog (*Hyla gratiosa*). In addition, the globally rare plants Harper's fimbristylis (*Fimbristylis perpusilla*) and pondspice (*Litsea aestivalis*) are confined to these habitats in Virginia. References: Fleming and Moorhead (1998), Rawinski (1997).

Natural Lake Draw-Down Shores
Seasonally flooded woodlands along the shores of Lake Drummond, a 1287 ha (3180 ac) basin in the Great Dismal Swamp. Because this is the only natural lake in the Virginia Coastal Plain, this ecological group consists of a single community type. Similar communities apparently occur around other natural or artificial impoundments in the Coastal Plain south of Virginia. Vegetation of the well-documented Lake Drummond occurrence is dominated by very open stands of bald cypress (*Taxodium distichum*), with buttonbush (*Cephalanthus occidentalis*) dominating a sparse shrub layer. When water levels draw down, large areas of exposed sand support colonies of creeping rush (*Juncus repens*), squarestem spikerush (*Eleocharis quadrangulata*), warty panic grass (*Panicum verrucosum*), sedges (*Fimbristylis* spp. and *Cyperus* spp.), and other herbaceous plants well adapted to long periods of submersion. The natural hydrologic regime supporting this community has been altered by inputs from several ditches and regulation of water levels by the U.S. Army Corps of Engineers. Reference: Fleming and Moorhead (1998).

Non-Riverine Pine – Hardwood Forests
Saturated mixed forests of poorly drained, outer Coastal Plain terraces. In Virginia, these communities are extensive from Surry and Isle of Wight Counties south to the City of Suffolk on the west and the North Landing River (City of Virginia Beach) on the east. Scattered examples are also known from the northern Coastal Plain. Habitats are flat, with seasonally perched water tables and frequent shallow depressions which pond water intermittently. Soils are silt, sand, and clay loams, often with a thin (< 30 cm [12 in]) organic mantle. The prevalent vegetation of these flatwoods is dominated by mixtures of loblolly pine (*Pinus taeda*), red maple (*Acer rubrum*), and sweetgum (*Liquidambar styraciflua*), frequently with scattered pond pine (*P. serotina*). Small trees and shrubs include sweetbay (*Magnolia virginiana*), blackgum (*Nyssa sylvatica*), red bay (*Persea palustris*), and coastal dog-hobble (*Leucothoe axillaris*). South of the James River, giant cane (*Arundinaria gigantea* ssp. *tecta*) typically dominates the shrub layer in patchy to very dense colonies. Herbaceous species are sparse. For the most part, forests of this composition appear to be successional stands that have replaced once-extensive "canebrakes" (*i.e.*, giant cane savannas with scattered pond pine) following the virtual elimination of fire in the region. Similar occurrences may have replaced non-riverine wet hardwood forests or Atlantic white-cedar forests following heavy cutting or catastrophic fires. A few stands, dominated by loblolly pine and hydrophytic oaks and lacking giant cane, appear to be more successionally stable. Although modified communities in this group are not conservation priorities, they provide opportunities for ecological restoration of now-extirpated canebrake vegetation. In addition, several rare species, including the globally rare Virginia least trillium (*Trillium pusillum* var. *virginianum*) and large populations of the state-rare bird Swainson's warbler (*Limnothlypis swainsonii*) are associated with non-riverine pine-hardwood forests. Giant cane is believed to be the host plant for several state and globally rare insects. References: Fleming and Moorhead (1998), Frost (1995), Levy and Walker (1979).

Non-Riverine Wet Hardwood Forests
Saturated to shortly seasonally flooded deciduous forests of poorly drained Coastal Plain terraces. These include broad, outer Coastal Plain interfluves, as well as the outermost, never-flooded alluvial terraces of major rivers inland. In Virginia, these communities range locally from inland portions of the Eastern Shore south through much of southeastern Virginia. Habitats are flat, with seasonally perched water tables and frequent shallow depressions which pond water intermittently. Soils are silt, sand, and clay loams, sometimes with very thin organic horizons. Mixtures of hydrophytic oaks (*Quercus* spp.) characterize forests of this group. Dominants, varying regionally, include swamp chestnut oak *(Q.*

michauxii), cherrybark oak (*Q. pagoda*), willow oak (*Q. phellos*), laurel oak (*Q. laurifolia*), water oak (*Q. nigra*), and pin oak (*Q. palustris*). Cutting and other disturbances result in higher proportions of sweetgum (*Liquidambar styraciflua*), red maple (*Acer rubrum*), and other intolerant trees. Small trees and shrubs include American hornbeam (*Carpinus caroliniana* ssp. *caroliniana*), giant cane (*Arundinaria gigantea ssp. tecta*), American holly (*Ilex opaca* var. *opaca*), coastal dog-hobble (*Leucothoe axillaris*), and highbush blueberries (*Vaccinium* spp.). Herb layers tend to be depauperate, but usually contain netted chain fern (*Woodwardia areolata*) and a variety of sedges, *e.g.*, *Carex abscondita*, *C. debilis* var. *debilis*, *C. intumescens*. Large, rhizomatous colonies of the sedges *Carex striata* var. *brevis*, *C. bullata*, and *C. barrattii* occasionally dominate. Communities of this group have been greatly reduced in extent or modified by extensive agricultural clearing, logging, conversion to pine silvicultures, and hydrologic alterations such as ditching and draining. Most, if not all, community types in this group are now globally uncommon to rare. Associated rare species include the globally rare Virginia least trillium (*Trillium pusillum* var. *virginianum*), the federally listed Dismal Swamp southeastern shrew (*Sorex longirostris fisheri*), and the state-listed canebrake rattlesnake (*Crotalus horridus atricaudatus*). References: Dabel and Day (1977), Day (1985), Fleming and Moorhead (1998), Frost (1995), Train and Day (1982).

Non-Riverine Swamp Forests
Seasonally flooded mixed or deciduous forests occurring on poorly drained peatlands of the Coastal Plain. These communities are most abundant on terraces of the embayed region of extreme southeastern Virginia and northeastern North Carolina, but occur occasionally further inland. Habitats are non-riverine wetland flats with deep or shallow organic soils and seasonal flooding to depths of 30 cm (12 in) by elevated water tables. Hummock-and-hollow microtopography is typical. Dominant trees are bald cypress (*Taxodium distichum*), swamp tupelo (*Nyssa biflora*), and red maple (*Acer rubrum*). Red maple now greatly dominates most stands because of extensive past logging, catastrophic fires, and ditching. Red bay (*Persea palustris*) and sweet pepperbush (*Clethra alnifolia*) are abundant in the lower woody layers. Also abundant are high-climbing vines of greenbriers (*Smilax* spp.), poison ivy (*Toxicodendron radicans*), climbing hydrangea (*Decumaria barbara*), supplejack (*Berchemia scandens*), Virginia creeper (*Parthenocissus quinquefolia*), and muscadine grape (*Vitis rotundifolia*). Netted chain fern (*Woodwardia areolata*) and Virginia chain fern (*W. virginica*) are among the few herbs that occur regularly. Non-riverine swamp forest is the characteristic vegetation in and near the Great Dismal Swamp in Virginia. Its dense, vine-rich aspect gave the Swamp much of its historical reputation as a dark, mysterious, or dreadful place. Although most stands are now much altered, The Nature Conservancy has protected an impressive old-growth occurrence with bald cypress up to 1.75 m (5 ft 9 in) in diameter at Gum Swamp (City of Chesapeake). Communities in this group are globally uncommon to rare and provide habitat for the federally listed Dismal Swamp southeastern shrew (*Sorex longirostris fisheri*) and two rare bats. References: Dabel and Day (1977), Day (1985), Dean (1969), Fleming and Moorhead (1998), Frost (1995), Frost and Musselman (1987), Levy and Walker (1979), Train and Day (1982).

Longleaf Pine and Mixed Pine Flatwoods
Saturated, fire-influenced forests on sandy flats of the southeastern Virginia Coastal Plain. These communities reach their northern range limits in Virginia, where they are now limited to a few small, remnant areas along the east side of the Blackwater River in Isle of Wight County and the City of Suffolk. Site hydrology is variable. Our examples are typically seasonally saturated but become rather dry for substantial periods of the year. Slightly lower-lying swales within the flatwoods are permanently saturated. An open forest or savanna structure was formerly maintained by a natural regime of frequent, low- to moderate-intensity fires. Because of repeated heavy cutting, extensive planting of loblolly pine (*Pinus taeda*) monocultures, and suppression of fires, natural pine flatwoods and their most characteristic tree, longleaf pine (*Pinus palustris*), have been eliminated from large areas of southeastern Virginia. The best extant fragments are dominated by mixed stands of longleaf, loblolly, and pond (*Pinus serotina*) pines, with a scattered understory of red maple (*Acer rubrum*), sweetbay (*Magnolia virginiana*), and other small trees. Dense, mostly ericaceous shrub layers of sheep-laurels (*Kalmia angustifolia* and *K.*

carolina), dangleberry (*Gaylussacia frondosa*), staggerbush (*Lyonia mariana*), small black blueberry (*Vaccinium tenellum*), creeping blueberry (*V. crassifolium*), inkberry (*Ilex glabra*), Canada serviceberry (*Amelanchier canadensis*), and giant cane (*Arundinaria gigantea* ssp. *tecta*) are characteristic. Herbs are generally sparse, but include bracken fern (*Pteridium aquilinum* var. *pseudocaudatum*), pixie-moss (*Pixidanthera barbulata* var. *barbulata*), and fasciculate beakrush (*Rhynchospora fascicularis* var. *distans*). Virginia's Longleaf / Mixed Pine Flatwoods lack wiregrass (*Aristida stricta* and *A. beyrichiana*) and other pyrophytic grasses characteristic of similar communities further south and are thus thought to represent a rare compositional variant. One stand, at Blackwater Ecological Preserve (near Zuni, Isle of Wight County), is being managed with prescribed burning, but the remaining occurrences are in critical need of protection and restoration. Frost and Musselman (1987), Plocher (1999).

Coastal Plain / Piedmont Seepage Bogs

Saturated shrub and herbaceous vegetation of oligotrophic spring-heads, seepage slopes, and less frequently small, headwater stream bottoms. Sites are scattered throughout the Coastal Plain (except the maritime zone) and eastern Piedmont, typically on lower or toe slopes, where groundwater is forced to the surface by impermeable clay layers. Surficial soils are usually peaty or sandy, very acidic, infertile, and covered by dense mats of *Sphagnum* mosses. The term "bog," as applied to these wetlands, is a technical misnomer, since not all of these habitats are true peatlands and none is an ombrotrophic system. This term, however, is now so widely used in the southeastern United States as a descriptor for open, acidic seepage wetlands that we have adopted it here for consistency. Although early botanical explorers of Virginia frequently reported open boggy habitats, natural examples of these communities have nearly been extirpated by decades of fire suppression, hydrologic alterations (ditching, draining, and impoundments), or outright destruction. The elimination of fire as an ecological process has allowed many former bogs to become overgrown with shrubs and trees. Good examples remain in military base training ("impact") areas at Quantico Marine Base (Fauquier and Prince William Counties), Fort A.P. Hill (Caroline County), and Fort Pickett (Nottoway County), where habitats have been subject to frequent incendiary burning for at least 50 years. Artificially maintained bog habitats are frequent in powerline clearings. The vegetation of seepage bogs is usually a mosaic of shrubs and graminoid-dominated herbaceous patches. Typical woody species include sweetbay (*Magnolia virginiana*), poison sumac (*Toxicodendron vernix*), highbush blueberries (*Vaccinium corymbosum*, *V. fuscatum*, and *V. formosum*), possum-haw (*Viburnum nudum* var. *nudum*), and smooth alder (*Alnus serrulata*). Among the most abundant herbaceous species, at least locally, are twisted spikerush (*Eleocharis tortilis*), beakrushes (*Rhynchospora* spp.), panic grasses (*Dichanthelium dichotomum* var. *dichotomum* and var. *ensifolium*), hairy umbrella-sedge (*Fuirena squarrosa*), meadow-beauties (*Rhexia* spp.), clubmosses (*Lycopodiella alopecuroides* and *L. appressa*), sundews (*Drosera* spp.), tawny cotton-grass (*Eriophorum virginicum*), bushy bluestem (*Andropogon glomeratus*), Nuttall's reed-grass (*Calamagrostis coarctata*), yellow-eyed-grasses (*Xyris* spp.), yellow milkwort (*Polygala lutea*), and vervain thoroughwort (*Eupatorium pilosum*). A large number of state-rare plants and several state-rare odonates (dragonflies and damselflies) are associated with seepage bogs.

Coastal Plain / Piedmont Acidic Seepage Swamps

Saturated deciduous or mixed forests of small headwaters stream bottoms and seeping toe-slopes with acidic, nutrient-poor soils. Communities in this group are scattered throughout the more dissected, inner Coastal Plain and outer Piedmont in habitats where seepage discharged at ground surface is drained away as stream flow. Characterized by diffuse drainage with braided channels and *Sphagnum*-covered hummocks in a sandy or peaty substrate, these habitats are generally wet and somewhat protected from fire. Dominant canopy species are red maple (*Acer rubrum*) and blackgum (*Nyssa sylvatica*), with tulip-poplar (*Liriodendron tulipifera*) and loblolly pine (*Pinus taeda*) also locally important. Common small trees and shrubs are sweetbay (*Magnolia virginiana*), sweet pepperbush (*Clethra alnifolia*), highbush blueberries (*Vaccinium* spp.), swamp azalea (*Rhododendron viscosum*), and possum-haw (*Viburnum nudum* var. *nudum*). Herbaceous species that could be considered more or less diagnostic (within the

Coastal Plain context) include skunk-cabbage (*Symplocarpus foetidus*), kidneyleaf grass-of-parnassus (*Parnassia asarifolia*), Collins' sedge (*Carex collinsii*), twining bartonia (*Bartonia paniculata* ssp. *paniculata*), and the federally listed swamp-pink (*Helonias bullata*). Several uncommon odonates (dragonflies and damselflies) depend on forested seeps for breeding habitat. Coastal Plain / Piedmont seepage swamps are relatively small in size and threatened by beaver activities, agricultural pollutants, hydrologic disturbances, and logging. The treatment of these communities and the very similar Mountain / Piedmont Acidic Seepage Swamps as separate ecological groups may be revised in the future. References: McCoy and Fleming (2000), Rawinski (1995).

Coastal Plain Basic Seepage Swamps
Saturated deciduous forests occurring in the bottoms of Coastal Plain ravines that have downcut into Tertiary shell deposits or limesands. These are naturally rare, small-patch communities known from the dissected inner Coastal Plain of Surry, Isle of Wight, York, and James City Counties. There is at least one outlying occurrence in Lancaster County. Habitats consist of mucky, braided ravines bottoms saturated by constant groundwater seepage, and soils with high base status. Hummock-and-hollow microtopography is prevalent, and exposed shells are common in springs and rills. Green ash (*Fraxinus pennsylvanica*), red maple (*Acer rubrum*), and tulip-poplar (*Liriodendron tulipifera*) are common canopy trees in most occurrences, but a subset of ravines on the south side of the James River features the unusual co-dominance of bald cypress (*Taxodium distichum*). Small trees and shrubs include stiff dogwood (*Cornus foemina*), spicebush (*Lindera benzoin*), and southern bayberry (*Myrica cerifera*). A number of remarkable mountain disjuncts have been documented in the herbaceous flora of these communities, including marsh-marigold (*Caltha palustris*), rigid sedge (*Carex tetanica*), Kentucky lady-slipper (*Cypripedium kentuckiense*; state-rare), bog twayblade (*Liparis loeselii*; state-rare), swamp lousewort (*Pedicularis lanceolata*), and American false-hellebore (*Veratrum viride*). Reaching their northern limits are the southern species Florida adder's-mouth (*Malaxis spicata*), shadow-witch orchid (*Ponthieva racemosa*), and drooping bulrush (*Scirpus lineatus*). Other characteristic herbs include lizard's-tail (*Saururus cernuus*), golden ragwort (*Senecio aureus*), blackfruit clearweed (*Pilea fontana*), smooth bur-marigold (*Bidens laevis*), Carolina buttercup (*Ranunculus hispidus* var. *nitidus*), brome sedge (*Carex bromoides*), and wood reedgrass (*Cinna arundinacea*). The damp, fertile habitats are particularly susceptible to invasion by the exotic grass *Microstegium vimineum*. The globally rare Tidewater interstitial amphipod (*Stygobromus araeus*) appears to be closely associated with groundwater in shell marl deposits. Communities in this group are not well documented or protected and should be high priorities for future inventory and conservation.

Upland Depression Swamps
Forested, seasonally flooded depression wetlands of nearly level Piedmont uplands with clay hardpans or shallow bedrock. Impeded soil drainage in these habitats results in standing water during the early part of the growing season, followed by a period of draw-down. Hydroperiods may vary from one depression to the next. In Virginia, these wetlands are scattered throughout the eastern and central Piedmont. They are most numerous in Triassic basins and areas underlain by mafic rocks or acidic slates. Canopy cover ranges from complete to very open. In northern Virginia, pin oak (*Quercus palustris*), swamp white oak (*Q. bicolor*), red maple (*Acer rubrum*) and, to a lesser extent, willow oak (*Q. phellos*) are characteristic. In the central and southern Piedmont, willow oak, sweetgum (*Liquidambar styraciflua*), and overcup oak (*Q. lyrata*) are typical. Shrub composition is variable but usually includes an abundance of climbing common greenbrier (*Smilax rotundifolia*). The herb layer is often sparse; common species include sedges (*Carex* spp.), manna-grasses (*Glyceria* spp.), and rushes (*Juncus* spp). Sphagnum mosses (*Sphagnum* spp.) frequently form large patches on slightly raised hummocks. Upland depression swamps are isolated wetlands subject to major disturbances and alterations from logging, draining, and development. Most community types in the group are considered state-rare.

SATURATED PEATLANDS OF THE COASTAL PLAIN

Ecological community groups of fire-influenced, groundwater controlled, non-alluvial, Coastal Plain wetlands with deep organic soils and a saturated hydrologic regime. This class is represented in Virginia by woodland and forest vegetation, although shrublands are components further south.

Pond Pine Woodlands and Pocosins

Coniferous, pyrophytic woodlands of saturated, oligotrophic, Coastal Plain peatlands. Although no doubt more widespread in the pre-settlement Virginia landscape, only a few remnants of these communities are currently found in the extreme southeastern part of the state. The largest extant occurrences are in the Great Dismal Swamp National Wildlife Refuge (Cities of Suffolk and Chesapeake) and on remote peat flats beyond the range of wind-tidal flooding along the North Landing River (City of Virginia Beach). Pond Pine Woodlands and Pocosins have high biomass and consist largely of inflammable woody plants that are specially adapted to frequent, intense burning. All present-day examples in Virginia suffer to some extent from a reduction in fire frequencies or complete suppression of fires. Stand physiognomy and composition reflect responses to gradients of fire frequency and peat depth. Stands known as "high pocosins" are associated with deeper organic soils and more frequent fires; these have only scattered, stunted pond pines (*Pinus serotina*) emergent from nearly impenetrable evergreen shrub thickets dominated by shining fetterbush (*Lyonia lucida*), inkberry (*Ilex glabra*), Carolina sheep-laurel (*Kalmia carolina*), and laurel-leaf greenbrier (*Smilax laurifolia*). Stands associated with superficial peat and/or longer periods without fire often develop nearly closed canopies of larger pond pines, understories of red maple (*Acer rubrum*), sweetbay (*Magnolia virginiana*), and red bay (*Persea palustris*), and less dense shrub layers that contain more deciduous species. Few herbaceous species except Virginia chain fern (*Woodwardia virginica*) thrive in pond pine woodlands. Communities in this group are globally rare, rapidly declining, and scarcely viable due to fragmentation and the absence of sustaining fire frequencies. References: Dean (1969), Facazio *et al*. (1998), Fleming and Moorhead (1998), Frost (1995), Stevens and Patterson (1998).

Peatland Atlantic White-Cedar Forests

Coniferous forests of saturated, oligotrophic, Coastal Plain peatlands. These communities are endemic to terraces of the embayed region of extreme southeastern Virginia and northeastern North Carolina. Habitats are non-riverine wetland flats with deep organic soils (*e.g*., Great Dismal Swamp, Cities of Suffolk and Chesapeake) and remote peat flats beyond the range of wind-tidal flooding along the North Landing River (City of Virginia Beach). Atlantic white-cedar forests usually occupy relatively wet peatlands subject to infrequent catastrophic fires. Dense, even-aged stands become established when such fires remove most vegetation and debris, exposing suitable mineral-soil seedbeds. Throughout their maturation, these stands accumulate extensive dead wood and inflammable duff, making them increasingly susceptible to another stand-killing fire. Atlantic white-cedar (*Chamaecyparis thyoides*) dominates the canopy, sometimes with red maple (*Acer rubrum*), swamp tupelo (*Nyssa biflora*), or pines (*Pinus serotina* and *P. taeda*) as minor associates. Red bay (*Persea palustris*), sweetbay (*Magnolia virginiana*), sweet pepperbush (*Clethra alnifolia*), sweet gallberry (*Ilex coriacea*), inkberry (*Ilex glabra*), shining fetterbush (*Lyonia lucida*), and poison ivy (*Toxicodendron radicans*) are common small trees and shrubs. Cinnamon fern (*Osmunda cinnamomea*) and Virginia chain fern (*Woodwardia virginica*) are common herbs, while *Sphagnum* spp. and other mosses abundantly cover the ground. Peatland Atlantic white-cedar forests are globally rare and now reduced to small remnants of their former distribution by extensive logging and fire reduction. Atlantic white-cedar is the larval host of the rare butterfly Hessel's hairstreak (*Mitoura hesseli*), which has been recorded in the Great Dismal Swamp. References: Dabel and Day (1977), Day (1985), Dean (1969), Fleming and Moorhead (1998), Frost (1995), Stevens and Patterson (1998), Train and Day (1982).

Streamhead Pocosins
Mixed, fire-influenced woodlands of small streamheads, seepage slopes, and bottomland terraces influenced by groundwater inputs and extremely acidic soils. These communities are restricted to the inner Coastal Plain and reach their northern range limit in southeastern Virginia. Only two extant sites are documented in the state, both on high, ancient terraces of the Blackwater River in Southampton County and the City of Suffolk. The vegetation of streamhead pocosins is similar to that of Peatland Atlantic White-Cedar Forests and Pond Pine Woodlands and Pocosins. Atlantic white-cedar (*Chamaecyparis thyoides*), loblolly pine (*Pinus taeda*), pond pine (*Pinus serotina*), red maple (*Acer rubrum*), and sweetbay (*Magnolia virginiana*) comprise an open canopy over an extremely thick shrub complex of shining fetterbush (*Lyonia lucida*), swamp cyrilla (*Cyrilla racemiflora*), sweet pepperbush (*Clethra alnifolia*), Carolina sheep-laurel (*Kalmia carolina*), dusty zenobia (*Zenobia pulverulenta*), inkberry (*Ilex glabra*), greenbriers (*Smilax* spp.), and several deciduous heaths. Cinnamon fern (*Osmunda cinnamomea*), Virginia chain fern (*Woodwardia virginica*), and netted chain fern (*Woodwardia areolata*) dominate the herb layer. Because they are generally wet and do not carry fire well, streamhead pocosins probably burn infrequently when fires on adjacent uplands spread into them during dry periods. Communities of this group are state-rare, fire-suppressed, and in urgent need of protection.

NON-TIDAL MARITIME WETLANDS
Ecological community groups of mostly groundwater-controlled wetlands subject to oceanic influences (*e.g.*, deep sand deposits, salt spray, maritime microclimates). In Virginia, these are confined to narrow zones along both flanks of the Eastern Shore, the western shore of the Chesapeake Bay, and the Atlantic shore in extreme southeastern Virginia.

Sea-Level Fens
Maritime seepage wetlands confined to a few sites with an unusual combination of environmental conditions for this region. Only four occurrences are known in Virginia, all of them on the Eastern Shore (Accomack County). Habitats are situated just above highest tide levels, at the bases of slopes where abundant groundwater discharges along the upper edges of estuarine bays. The hydrology of these sites is best characterized as saturated, although shallow standing water and small, muck-filled pools are locally present at all sites. Soils are organic and nutrient-poor. The vegetation exhibits characteristics of both inland seepage bogs and oligohaline tidal marshes. Stands are generally a physiognomic mosaic of open woodland, scrub, and herbaceous patches. Woody species include red maple (*Acer rubrum*), blackgum (*Nyssa sylvatica*), sweetbay (*Magnolia virginiana*), and southern bayberry (*Myrica cerifera*). Characteristic herbs include twig rush (*Cladium mariscoides*), beaked spikerush (*Eleocharis rostellata*), white beakrush (*Rhynchospora alba*), few-flowered beakrush (*R. oligantha*), spoon-leaved sundew (*Drosera intermedia*), ten-angled pipewort (*Eriocaulon decangulare*), coinleaf (*Centella erecta*), brown-fruited rush (*Juncus pelocarpus*), and bladderworts (*Utricularia* spp.). These communities are extremely rare and local throughout their known range along the Atlantic Coast from New Jersey to Virginia. Many state-rare plants are associated with the Virginia occurrences. Chronic sea-level rise, with associated intrusions of tidal flooding and salinity, comprises a serious threat to the long-term viability of all sea-level fens.

Maritime Wet Grasslands
Graminoid-dominated seasonal wetlands of maritime dune systems. In Virginia, these wetlands are confined to the barrier beaches of the Eastern Shore (Accomack and Northampton Counties) and southeastern Virginia (City of Virginia Beach). Encompassing swales and low hollows between secondary dunes, habitats are characterized by perched water tables and shallow seasonal flooding. The swales are predominantly influenced by fresh water from rainstorms, but some may be periodically

flooded by salt water from ocean storm surges. A thin, organically enriched, surficial soil layer contributes to moisture retention. Hydrologic regime and distance from salt spray appear to exert considerable influence on floristic composition. Typically, occurrences are densely vegetated by one or more species of grasses (*e.g*., saltmeadow cordgrass [*Spartina patens*]); rushes (e.g., *Juncus scirpoides, J. dichotomus, J. acuminatus, J. megacephalus,* or *J. canadensis*); or sedges (*e.g*., *Cyperus odoratus, Fimbristylis caroliniana, Fuirena pumila,* or *Schoenoplectus pungens var. pungens*). In smaller, temporarily flooded swales where rushes are dominant, small slender goldenrod (*Euthamia caroliniana*), long-leaved aster (*Aster novi-belgii* var. *elodes*), yellow-eyed grass (*Xyris jupacai*) and zigzag bladderwort (*Utricularia subulata*), may also characteristic. Swales further inland contain additional assemblages of species including dwarf umbrella-sedge (*Fuirena pumila*), ladies'-tresses (*Spiranthes* spp.), spoon-leaved sundew (*Drosera intermedia),* southern bog clubmoss (*Lycopodellia appressa*), white-top fleabane (*Erigeron vernus*), whorled nutrush (*Scleria verticillata*), and white-topped sedge (*Rhynchospora colorata*). Considerable compositional variation related both to regional distribution and site-specific topography needs intensive study. All types within the group are uncommon to rare, small-patch communities existing in fragile settings. They also support several state rare insects including a tiger beetle (*Cicindella trifasciata ascendens*) and a dragonfly (*Anax longipes*). In common with most maritime communities, threats to this group include development and sea-level rise. Reference: The Nature Conservancy (1997).

Maritime Shrub Swamps
Seasonally flooded shrublands of sheltered, maritime dune hollows where water is present throughout most of the year. Perched water tables and intermittent to seasonal flooding characterize the hydrology. Both groundwater and surface water are typically fresh (< 0.5 ppt), although salt water may pool in these areas after episodic storm surges during events such as hurricanes. Soils are stratified, with a thin layer of muck up to 10 cm (4 in) thick over wet sand. Species composition of these communities changes rapidly from the southeastern coast to the Eastern Shore. Southern areas characteristically contain southern bayberry (*Myrica cerifera*), along with inkberry (*Ilex glabra*), and highbush blueberry (*Vaccinium corymbosum*). Inkberry and highbush blueberry are less important in this group northward on the Eastern Shore. Climbing vines of poison ivy (*Toxicodendron radicans* var. *radicans*) are abundantly intertwined with the shrubs in most occurrences of these swamps. Herb layers are rich in ferns, including royal fern (*Osmunda regalis* var. *spectabilis*), marsh fern (*Thelypteris palustris* var. *pubescens*), netted chain fern (*Woodwardia areolata*) and Virginia chain fern (*Woodwardia virginica*), but also include a variety of forbs such as whorled water-pennywort (*Hydrocotyle verticillata* var. *verticillata*). The geographic distribution and conservation status of communities in this group are currently obscure and need intensive study. Reference: The Nature Conservancy (1997).

Maritime Swamp Forests
Seasonally flooded, or less frequently saturated, maritime wetland forests occurring in large, protected, interdune swales or along sluggish streams just inland from estuarine zones. In Virginia, occurrences are scattered along the outer Coastal Plain from The Eastern Shore (Accomack and Northampton Counties) to Cape Henry and False Cape (City of Virginia Beach). The status of these communities on the western shore of the Chesapeake Bay is less clear. Habitats are generally characterized by hummock-and-hollow microtopography, with mucky to sandy, mottled soils and sizeable areas of seasonally standing water. The apparent nutrient status and flooding regimes of soils in these habitats are highly variable and probably relate to the wide compositional variation in documented stands. Dominant canopy trees include red maple (*Acer rubrum*), sweetgum (*Liquidambar styraciflua*), blackgum (*Nyssa sylvatica*), black willow (*Salix nigra*), sweetbay (*Magnolia virginiana*) and, in the Cape Henry/False Cape area, bald cypress (*Taxodium distichum*) and Atlantic white-cedar (*Chamaecyparis thyoides*). Shrubs are diverse but usually include highbush blueberries (*Vaccinium corymbosum, V. fuscatum, V. formosum*), southern bayberry (*Myrica cerifera*), red bay (*Persea palustris*), and greenbriers (*Smilax* spp.). Herb layers range from floristically depauperate, with dominance by Virginia chain fern (*Woodwardia virginica*) or low

shrubs, to species-rich with a diversity of marsh and swamp species. The ecological dynamics of communities in this group, as well as their distinction from inland swamp forests, are poorly understood. Like other communities of the maritime zone, they are subject to potential disturbance by storm surges, salt spray, and shifting dunes. Maritime Swamp Forests are uncommon to rare in Virginia and are subject to encroaching development, logging, and agricultural pollutants. References: Harvill (1967), The Nature Conservancy (1997).

Interdune Wet Pine Woodlands
A little-known group of oligotrophic, maritime coniferous wetlands needing much additional study. In Virginia, there is a well documented example from the Eastern Shore (Assateague Island, Accomack County) and several poorly documented occurrences on False Cape (City of Virginia Beach). These communities occupy swales in sheltered back dunes that are protected from salt spray except during major storm surges. Habitats frequently exhibit hummock-and-hollow microtopography. Soils vary from saturated, with perched water tables, to shallowly seasonally flooded during wet periods. A thin organic layer, frequently covered by dense mats of *Sphagnum* mosses, is usually present at the soil surface. On Assateague Island the vegetation is an open stand of young, salt-spray-stunted loblolly pine (*Pinus taeda*), with a very sparse shrub layer. Large cranberry (*Vaccinium macrocarpon*) forms dense mats locally beneath the pines. Elsewhere, scattered herbs include saltmeadow cordgrass (*Spartina patens*), tall flat panic grass (*Panicum rigidulum* var. *rigidulum*), and switchgrass (*Panicum virgatum*) in shallow pools and depressions, and bushy bluestem (*Andropogon glomeratus* var. *glomeratus*), marsh St. John's-wort (*Triadenum virginicum*), beakrushes (*Rhychospora* spp.), twisted yellow-eyed-grass (*Xyris torta*), savanna thoroughwort (*Eupatorium leucolepis*), and spoon-leaved sundew (*Drosera intermedia*) in wet sand and *Sphagnum* mats. Somewhat similar woodlands occur on False Cape but need additional assessment. Community types in this group apparently have a narrow geographic range from New Jersey to Virginia or North Carolina, and likely are globally rare.

Interdune Ponds
Seasonally to semipermanently flooded, maritime herbaceous wetlands occupying deep interdune basins and swales. In Virginia these wetlands are distributed very locally in a zone behind barrier beaches from the Eastern Shore (Accomack and Northampton Counties) to Cape Henry and False Cape (City of Virginia Beach). This group includes both freshwater ponds, in which rainwater and groundwater quickly dilutes infrequent salt-water inputs, and slightly brackish ponds subject to more frequent salt water inputs. The latter, which appear to have salinity regimes that vary over time from entirely fresh to slightly mesohaline, are probably best characterized as oligohaline ponds. Community composition varies with geography, topographic position, exposure to storm surges and salt spray, hydroperiod, and soil properties. Seasonally flooded, freshwater ponds usually contain large cover of bulrushes (*e.g., Scirpus cyperinus, Schoenoplectus pungens var. pungens, Schoenoplectus tabernaemontani*), grasses (*e.g., Panicum virgatum, Panicum rigidulum* var. *condensum, Spartina patens*), and/or squarestem spikerush (*Eleocharis quadrangulata*). Rare freshwater ponds, or their marginal zones, are dominated by nearly pure stands of twig rush (*Cladium mariscoides*). Seasonally flooded oligohaline ponds may be dominated by narrow-leaved cattail (*Typha angustifolia*), eastern rose-mallow (*Hibiscus moscheutos* ssp. *moscheutos*), or saltmarsh bulrush (*Schoenoplectus robustus*), compositionally resembling Tidal Oligohaline Marshes. Semipermanently flooded oligohaline ponds are dominated by coastal water-hyssop (*Bacopa monnieri*), white spikerush (*Eleocharis albidum*), and sago pondweed (*Potamogeton pectinatus*). All of the community types in this group are very locally distributed, small-patch wetlands that are considered rare in Virginia. Clarification of their global status must await refinements in classification. Reference: The Nature Conservancy (1997).

Estuarine Fringe Pine Forests
Saturated to seasonally flooded pine and pine-hardwood forests occurring in back-dune depressions of barrier islands and on terrace flats bordering estuaries further inland. The overall range of this group is

from southern New Jersey to North Carolina. In Virginia, these communities are locally scattered along the Chesapeake Bay (both shores) and its major estuarine tributaries, as well as around Back Bay and estuarine tributaries of Currituck Sound in the southeastern corner of the state. Occasionally, stands occupy slightly elevated "islands" within the upper portions of salt marshes. Habitats are level flats with shallow water tables and hummock-and-hollow microtopography. Areas of seasonally ponded water and organic muck are present; elsewhere, soils are heavily mottled sands. Loblolly pine (*Pinus taeda*) is the usual dominant canopy tree, sometimes with hardwood associates. Southern bayberry (*Myrica cerifera*) and vines of common greenbrier (*Smilax rotundifolia*) and poison ivy (*Toxicodendron radicans*) are usually abundant. In southern areas (*e.g.*, on False Cape), pond pine (*Pinus serotina*) and inkberry (*Ilex glabra*) are characteristic woody associates. Wetland species such as cinnamon fern (*Osmunda cinnamomea*), royal fern (*O. regalis* var. *spectabilis*), switchgrass (*Panicum virgatum*), and smartweeds (*Polygonum* spp.) dominate species-poor herb layers. A distinctive variant occurring in southeastern Virginia and North Carolina has a dense understory of giant cane (*Arundinaria gigantea* ssp. *tecta*). Estuarine Fringe Pine Forests are similar to and often intergrade with non-wetland Maritime Loblolly Pine Forests and Maritime Evergreen Forests. Community types in this group are probably all globally uncommon to rare because of their restriction to the mid-Atlantic Coast and vulnerability to development pressure. References: Fleming and Moorhead (1998), The Nature Conservancy (1997).

RIVERINE SYSTEM

Riverine Aquatic Beds

Floating and submergent herbaceous vegetation of flowing streams with water depths that exclude emergent species but permit bottom rooting of aquatic species. These communities are poorly inventoried in Virginia, but are known to occur in rocky shallows along many of the major mountain and Piedmont rivers. They are particularly well developed in base-rich waters of the Shenandoah River and its two forks, the James River, and portions of the Roanoke River. Characteristic species include grass-leaf mud-plantain (*Heteranthera dubia*), American eel-grass (*Vallisneria americana*), pondweeds (*Potamogeton* spp.), waterweeds (*Elodea canadensis* and *E. nuttallii*), and waternymphs (*Najas* spp.). Horn-leaf riverweed (*Podostemum ceratophyllum*) is often abundantly rooted on shallowly submerged boulders and rock outcrops. Sluggish shoreline eddies and pools often support mats of floating duckweeds (*Lemna* spp.), duckmeats (*Spirodela* spp.), and Carolina mosquito-fern (*Azolla caroliniana*). Water pollution is a serious threat that can cause major declines or die-offs of aquatic vegetation in this group.

ESTUARINE SYSTEM

TIDAL WETLANDS

Ecological community groups of regularly or irregularly flooded, lunar tidal wetlands and irregularly flooded, wind-tidal wetlands. Structurally and compositionally diverse vegetation is represented.

Tidal Freshwater Marshes

A diverse group of herbaceous wetlands subject to regular diurnal flooding along upper tidal reaches of inner Coastal Plain rivers and tributaries. Freshwater marshes occur in the uppermost portion of the estuarine zone, where the inflow of saltwater from tidal influence is diluted by a much larger volume of freshwater from upstream. Strictly speaking, freshwater conditions have salt concentrations < 0.5 ppt, but pulses of higher salinity may occur during spring tides or periods of unusually low river discharge. The most common species are arrow-arum (*Peltandra virginica*), dotted smartweed (*Polygonum punctatum*),

wild rice (*Zizania aquatica* var. *aquatica*), pickerelweed (*Pontederia cordata*), rice cutgrass (*Leersia oryzoides*), tearthumbs (*Polygonum arifolium* and *P. sagittatum*), and beggar-ticks (*Bidens* spp.). Locally, sweetflag (*Acorus calamus*) and southern wild rice (*Zizaniopsis miliacea*) may form large dominance patches. Species diversity and vegetation stature vary with salinity, duration of inundation, and disturbance; the most diverse marshes occupy more elevated surfaces in strictly freshwater regimes. Mud flats that are fully exposed only at low tide support nearly monospecific stands of spatterdock (*Nuphar advena*), although cryptic submerged aquatic species may also be present. Tidal freshwater marshes are best developed on sediments deposited by large meanders of the Pamunkey and Mattaponi Rivers, although outstanding examples also occur along the Potomac, Rappahannock, Chickahominy, and James Rivers. These communities provide the principal habitat for the globally rare plant sensitive joint-vetch (*Aeschynomene virginica*). Chronic sea-level rise is advancing the salinity gradient upstream in rivers on the Atlantic Coast, leading to shifts in vegetation composition and the conversion of some tidal freshwater marshes into oligohaline marshes. Tidal Freshwater Marshes are also threatened by the invasive exotic marsh dewflower (*Murdannia keissak*). Several communities in this group are chiefly restricted to the Chesapeake Bay drainage basin and are considered globally rare or uncommon. References: Parker and Wyatt (1975), Perry and Atkinson (1997), Perry and Hershner (1999), McCoy and Fleming (2000).

Tidal Oligohaline Marshes

Primarily graminoid-dominated wetlands of slightly brackish zones along tidal rivers and streams of the Coastal Plain. Oligohaline conditions are defined as salt concentrations between 0.5 and 5 ppt, although pulses of higher salinity may occasionally occur. Big cordgrass (*Spartina cynosuroides*) is the most characteristic and abundant species and often forms extensive, tall stands. Associates include a mix of species characteristic of freshwater marshes, such as dotted smartweed (*Polygonum punctatum*) and arrow-arum (*Peltandra virginica*), and species more tolerant of higher salinities, such as eastern rose-mallow (*Hibiscus moscheutos* ssp. *moscheutos*) and seashore mallow (*Kosteletzkya virginica*). In somewhat more saline environments and sites subject to longer periods of flooding, saltmarsh cordgrass (*Spartina alterniflora*) and saltmarsh bulrush (*Schoenoplectus robustus*) dominate lower, less diverse communities. Some oligohaline marshes contain dense colonies of shoreline sedge (*Carex hyalinolepis*) or, more commonly, narrow-leaved cattail (*Typha angustifolia*), the latter of which may be increasing in extent as the result of fire suppression and eutrophication. Dredge spoils and other disturbed areas often support dense, nearly monospecific colonies of common reed (*Phragmites australis*); this highly aggressive, invasive species constitutes a serious threat to tidal marshes throughout the Coastal Plain. The diurnally tidal communities in this group are compositionally distinct from more diverse oligohaline marshes in extreme southeastern Virginia that are subject to irregular wind tides. References: Perry and Atkinson (1997), The Nature Conservancy (1997).

Wind-Tidal Oligohaline Marshes

Herbaceous wetlands subject to irregular wind-tidal flooding along the shores of estuaries that have been cut off from oceanic influences by the closure of inlets. In Virginia, these communities are limited to the embayed region in the extreme southeastern part of the state, where they are confined to the North Landing and Northwest Rivers (tributaries of Currituck Sound) and Back Bay. Although these systems are no longer influenced by lunar tides, wind-driven currents may produce as much as 1 m (3 ft) variation in water levels and contribute to a salinity regime that fluctuates between completely fresh and about 5 ppt . Vegetation consists of a mixture of freshwater species and species more typical of mesohaline marshes. Patch-dominance of the tall marsh graminoids big cordgrass (*Spartina cynosuroides*), black needlerush (*Juncus roemerianus*), and cattails (*Typha latifolia* and *T. angustifolia*) is common, although diverse tall marshes with big cordgrass, sawgrass (*Cladium jamaicense*), switchgrass (*Panicum virgatum*), marsh horned beakrush (*Rhynchospora macrostachya* var. *colpophila*), eastern rose-mallow (*Hibiscus moscheutos* ssp. *moscheutos*), and other species also occur. More locally distributed are patches of diverse short-statured marshes characterized by creeping spikerush (*Eleocharis fallax*), beaked

spikerush (*E. rostellata*), twig rush (*Cladium mariscoides*), Olney three-square (*Schoenoplectus americanus*), bull-tongue arrowhead (*Sagittaria lancifolia* ssp. *media*), pickerelweed (*Pontederia cordata*), dotted smartweed (*Polygonum punctatum*), Canada rush (*Juncus canadensis*), and a large number of minor associates. Shallow, muck-filled pools within the marshes are dominated by American water-lily (*Nymphaea odorata*). Community types of the mid-Atlantic wind-tidal marshes have a very limited distribution, are considered globally uncommon to rare, and support a large number of state-rare plants and animals. Threats include ditching, water pollution, boat wakes, and destruction by nutria (*Myocastor coypus*), a naturalized exotic mammal. References: Fleming and Moorhead (1998), Frost (1995), Priest and Dewing (1991).

Tidal Mesohaline and Polyhaline Marshes

Salt marshes characterized by very low species diversity and low plant stature. Mesohaline conditions comprise salt concentrations between 5 and 18 ppt, whereas polyhaline conditions range from 18 to 30 ppt. Two community types are prevalent. Lower, more regularly tidal surfaces with somewhat lower salinity feature taller marsh dominated by saltmarsh cordgrass (*Spartina alterniflora*), often with saltgrass (*Distichlis spicata*) or saltmarsh bulrush (*Schoenoplectus robustus*). Shorter-statured salt marshes or salt meadows dominated by saltgrass and saltmeadow cordgrass (*Spartina patens*) generally occur on slightly elevated surfaces where tides may be less regular and where soils may concentrate salts. Salt meadows occasionally have a moderately diverse assemblage of associates, including black grass rush (*Juncus gerardii* var. *gerardii*), woody glasswort (*Sarcocornia perennis*), sea-oxeye (*Borrichia frutescens*), sea-lavender (*Limonium carolinianum*), glassworts (*Salicornia virginica* and *S. bigelovii*), sea rose-pink (*Sabatia stellaris*), salt-marsh false foxglove (*Agalinis maritima*), and narrow-leaved loosestrife (*Lythrum lineare*). Another common community type features strong dominance by black needlerush (*Juncus roemerianus*), which often forms extensive stands. The abundance of this species, which also occurs in oligohaline marshes, may have increased as a result of contemporary reductions in fire frequency in salt marshes. Although mesohaline and polyhaline marshes occur in narrow fringes along tidal rivers in the inner Coastal Plain and on the western shore of the Chesapeake Bay, they are best developed in Northampton and Accomack Counties, where they occupy several thousand hectares of essentially flat plains, especially on the Atlantic shore. Some of the higher and more interior salt marshes are only irregularly tidal, but are compositionally indistinguishable from diurnally tidal communities. References: Clovis (1968), Harvill (1967), Levy (1983), Perry and Atkinson (1997), The Nature Conservancy (1997).

Tidal Shrub Swamps

Tidally flooded and wind-tidally flooded shrublands of freshwater to oligohaline rivers and embayments. This group comprises diverse vegetation that frequently occurs in fringes or ecotones between emergent tidal wetlands and swamp forests or uplands. Examples also occur on depositional islands in large meanders of tidal rivers. Several compositional variants have been documented, including 1) buttonbush (*Cephalanthus occidentalis*)-dominated shrublands of tidal freshwater systems; 2) swamp rose (*Rosa palustris*)-dominated shrublands of tidal freshwater systems; 3) black willow (*Salix nigra*)-dominated shrublands of tidal freshwater systems; 4) smooth alder (*Alnus serrulata*)-dominated shrublands of tidal oligohaline systems; and 5) southern bayberry (*Myrica cerifera*) and/or Carolina willow (*Salix caroliniana*)-dominated shrublands of lunar-tidal and wind-tidal oligohaline systems. The herbaceous flora associated with these communities is very diverse and typically contains species characteristic of both tidal marshes and swamp forests. The ecological dynamics, state-wide distribution, and conservation status of communities in this group are poorly known. References: Fleming and Moorhead (1998), McCoy and Fleming (2000).

Tidal Bald Cypress Forests and Woodlands

Coniferous or mixed swamp forests and woodlands occurring along the upper tidal reaches of rivers in southeastern Virginia. Examples are documented from the Dragon Swamp / Piankatank River (Gloucester, King and Queen, and Middlesex Counties), the Chickahominy River (Charles City, James

City, and New Kent Counties), the James River (Isle of Wight and Surry Counties), and the wind-tidal Northwest River (City of Chesapeake). At some sites, these communities occur in ecotones between tidal marshes and non-tidal backswamps or uplands. Bald cypress (*Taxodium distichum*) dominates the open to very open canopy, with or without hardwood associates such as swamp tupelo (*Nyssa biflora*), water tupelo (*Nyssa aquatica*), and green ash (*Fraxinus pennsylvanica*). Stand structure and canopy cover range from closed forest to very open woodland. Shrub and herb layers are variable but generally contain a mixture of species characteristic of both marshes and swamps. Some well-developed tidal bald cypress forests appear floristically similar to palustrine bald cypress-tupelo swamps. Other stands have a nearly monospecific herb dominance by shoreline sedge (*Carex hyalinolepis*). In a unique, possibly fire-influenced, savanna-like stand on the Northwest River, the herbaceous dominants, in rough seasonal order, are silvery sedge (*Carex canescens* ssp. *disjuncta*), spikerushes (*Eleocharis fallax and E. rostellata*), marsh rattlesnake-master (*Eryngium aquaticum* var. *aquaticum*), and wild rice (*Zizania aquatica* var. *aquatica*). The environmental dynamics, compositional variation, and state-wide distribution of this group are poorly known and need intensive study. Reference: Fleming and Moorhead (1998).

Tidal Hardwood Swamps

Predominately deciduous forests restricted to narrow zones subject to regular flooding along upper tidal reaches of inner Coastal Plain rivers and tributaries. These habitats are influenced by lunar tides up to 1 m (3 ft), but diluting freshwater flows from upstream keep salinity levels below 0.5 ppt. Tidal hardwood swamps occur along all of the major eastern Virginia rivers from the James River northward. Communities in this group are structurally complex, with semi-open canopies and diverse multiple lower strata. Pumpkin ash (*Fraxinus profunda*), swamp tupelo (*Nyssa biflora*), red maple (*Acer rubrum*), and green ash (*Fraxinus pennsylvanica*) are dominant trees. Shrub layers are mixed and extraordinarily diverse. Climbing vines such as poison ivy (*Toxicodendron radicans* ssp. *radicans*), Virginia creeper (*Parthenocissus quinquefolia*), and greenbriers (*Smilax* spp.) are also common. Herb layers are rich with a wide variety of wetland ferns, graminoids, and forbs. An influential feature of tidal swamp habitats is a pronounced hummock-and-hollow microtopography, where raised areas above the highest tide level provide stable substrates for the establishment of trees and microhabitats for more mesophytic forest herbs. These swamp forests also support cryptic animal species such as the prothonatory warbler (*Protonataria citrae*) and the two-toed amphiuma (*Amphiuma means*), as well as more noticeable species including the bald eagle (*Haliaeeatus leucocephala*). Tidal hardwood swamps are considered globally uncommon to rare and are threatened by sea-level rise and the invasive exotic forb, marsh dewflower (*Murdannia keisak*). References: Doumlele *et al*. (1985), McCoy and Fleming (2000), Rheinhardt (1992).

Estuarine Fringe Swamp Forests

Mixed forests subject to irregular wind-tidal flooding along the North Landing and Northwest Rivers, estuarine tributaries of Currituck Sound. Although these systems are no longer influenced by lunar tides because of inlet closures, they are subject to wind-driven currents that produce as much as 1 m (3 ft) variation in water levels and contribute to a salinity regime that fluctuates between completely fresh and about 5 ppt. These forests border the wind-tidal marshes along the lower portions of the two rivers, extending well upstream of the limit of marshes in narrowing channel-side belts. They may represent a long-term seral stage in succession from marsh to swamp forest. Habitats have a pronounced hummock-and-hollow microtopography, with an average flooding depth 40 cm (16 in) above the hollow bottoms. Soils are coarse, fibric peats that appear indistinguishable from adjacent marsh peats. Bald cypress (*Taxodium distichum*), swamp tupelo (*Nyssa biflora*), and loblolly pine (*Pinus taeda*) are the dominant canopy trees in variable combinations. Sweetbay (*Magnolia virginiana*) and red bay (*Persea palustris*) are scattered understory trees, while southern bayberry (*Myrica cerifera*) dominates the shrub layer. The herb layer is diverse, containing species characteristic of both marshes and swamps, but royal fern (*Osmunda regalis* var. *spectabilis*) often dominates. This group differs from Estuarine Fringe Pine Forests, which also contain loblolly pine, southern bayberry, and royal fern, in its tidally flooded

hydrologic regime (vs. non-tidal saturated hydrology) and the prevalence of numerous, flooding-tolerant swamp species. As currently defined, Estuarine Fringe Swamp Forests appear to be globally rare endemics of the embayed region of southeastern Virginia and northern North Carolina. Reference: Fleming and Moorhead (1998).

Tidal Freshwater and Oligohaline Aquatic Beds

Hydromorphic herbaceous vegetation of small guts, shallow tributary creeks, and large marsh pools along freshwater and oligohaline sections of tidal rivers. Mean water depths of these habitats are too great for emergent aquatics. Communities of this group are best documented in extreme southeastern Virginia, along the wind-tidal Northwest and North Landing Rivers and tributaries of Back Bay. Similar habitats and vegetation also appear to be present in freshwater, lunar-tidal guts of the upper Pamunkey and Mattaponi Rivers, tributaries of the York River. Habitats may be subject to water level fluctuations > 1 m (3 ft) and to regular or intermittent exposure at extreme low tides. Vegetation consists entirely of floating and submerged aquatics. Common hornwort (*Ceratophyllum demersum*) is the most important and abundant species. Bladderworts (*Utricularia* spp.), western waterweed (*Elodea nuttallii*), common duckmeat (*Spirodela polyrrhiza*), and sword bogmat (*Wolffiella gladiata*) are associates. The southeastern Virginia habitats with water < 60 cm (24 in) deep have sparse to dense surface covers of American water-lily (*Nymphaea odorata*) or, at one site, American lotus (*Nelumbo lutea*). The dynamics of tidal, aquatic communities dominated by vascular plants are complex and poorly understood. The distribution and abundance of vascular plants in these habitats are probably controlled by responses to water chemistry, water clarity and light penetration, the impact of currents and boat wakes, and herbivory by aquatic animals. Freshwater and oligohaline aquatic beds are important breeding and foraging sites for many invertebrates, numerous crustaceans, and some fish. The naturalized exotic plant hydrilla (*Hydrilla verticillata*) is a rampant invader of shallow, freshwater aquatic habitats in eastern Virginia. Because hydrilla readily outcompetes native aquatic plants, it poses a serious threat to the integrity of freshwater aquatic communities. Reference: Fleming and Moorhead (1998).

Tidal Mesohaline and Polyhaline Aquatic Beds

Hydromorphic herbaceous vegetation of shallow estuarine bays, tidal creeks, and salt marsh pools. Habitats have salt concentrations > 5 ppt and are permanently flooded by tidal waters or occasionally exposed at extreme low tides. Species richness is very low, with one to a few submerged vascular aquatics present. These consist primarily of beaked ditch-grass (*Ruppia maritima*), common eel-grass (*Zostera marina*), horned pondweed (*Zannichellia palustris*), and sago pondweed (*Potamogeton pectinatus*). Aquatic algae are frequent to abundant associates. Although these communities are scattered throughout the eastern Virginia maritime zone, at present there are few data on their composition, distribution, and ecological dynamics in this region.

Salt Flats

Regularly to irregularly tidal, sparsely to sometimes densely vegetated depressions and flats, also known as "salt pannes." Typically occurring as small patches within a matrix of mesohaline or polyhaline marsh, these habitats usually accumulate salt through evaporation of diurnal flooding inputs. Hyperhaline salt flats often contain large areas of barren, compacted peat and support only a scattering of saltgrass (*Distichlis spicata*) and the most salt-tolerant perennial and annual, succulent halophytes: glassworts (*Sarcocornia perennis, Salicornia virginica*, and *Salicornia bigelovii*), saltmarsh sand-spurry (*Spergularia salina*), tall sea-blite (*Suaeda linearis*), and sea-lavender (*Limonium carolinianum*). Occasional occurrences contain dense stands of mixed glassworts and, at one Virginia site, seaside plantain (*Plantago maritima*). Stunted saltmarsh cordgrass (*Spartina alternifolia*) usually forms a narrow ecotone between the flat and surrounding marsh. Several algae are also characteristic associates. In Virginia, salt flat communities are best represented on the Eastern Shore (Accomack and Northampton Counties), where they occur frequently within the very large, Atlantic shore salt marshes. References: Clovis (1968), Levy (1983), The Nature Conservancy (1997).

Salt Scrub
Halophytic, shrub-dominated vegetation characterized by high-tide bush (*Baccharis halimifolia*) and marsh-elder (*Iva frutescens*). Saltgrass (*Distichlis spicata*), saltmeadow cordgrass (*Spartina patens*), southern bayberry (*Myrica cerifera*), and eastern rose-mallow (*Hibiscus moscheutos* ssp. *moscheutos*) are common associates. These communities are found in saline environments throughout the outer Coastal Plain and along lower reaches of major rivers on the inner Coastal Plain. Although salt scrub does occur in tidal habitats, it more commonly occupies higher, only irregularly flooded landscape positions in a mosaic with lower, diurnally flooded salt marsh. Salt scrub stands often occur in maritime environments, where they are influenced especially by high winds and salt spray. References: Levy (1983), The Nature Conservancy (1997).

MARINE SYSTEM

Upper Beaches and Overwash Flats
Sparsely vegetated ocean shores and flats behind breached foredunes. These habitats are situated just above the mean high tide limit, but are flooded by high spring tides and storm surges. Constant salt spray and rainwater maintain generally moist conditions. Substrates consist of unconsolidated sand and shell sediments that are constantly shifted by winds and floods. Dynamic disturbance regimes largely limit vegetation to pioneering, salt-tolerant, succulent annuals. American searocket (*Cakile edentula* ssp. *edentula*) and Carolina saltwort (*Salsola caroliniana*) are usually most numerous and characteristic. Other scattered associates include sea-purslane (*Sesuvium maritimum*), sea-beach knotweed (*Polygonum glaucum*), bushy knotweed (*Polygonum ramosissimum* var. *prolificum*), sea-blites (*Suaeda linearis* and *S. maritima*), and sea-beach orach (*Atriplex pentandra*). In Virginia, these communities are distributed along the ocean side of the Eastern Shore (Accomack and Northampton Counties) and on Cape Henry and False Cape (City of Virginia Beach). Upper beach / overwash flat habitats are critical to several globally rare, federally listed species, including the northeastern beach tiger beetle (*Cidindela dorsalis dorsalis*). The threatened plant seabeach amaranth (*Amaranthus pumilus*) occurred historically on overwash flats in both Eastern Shore counties. The loggerhead sea turtle (*Caretta caretta*) and the piping plover (*Charadrius melodus melodus*) utilize beaches and overwash flats for nesting. Extensive construction of high, artificial dunes along the Atlantic coast has reduced the extent of these habitats by increasing oceanside beach erosion and eliminating the disturbance regime that creates and maintains overwash flats. References: Clampitt (1991), The Nature Conservancy (1997).

GLOSSARY OF SELECTED TERMS

Definitions were generally adopted or paraphrased from the following sources: Allaby (1990), Allen (1990), Anderson *et al*. (1998), Cowardin *et al*. (1979), Driscoll *et al*. (1984), Frye (1986), Golet *et al*. (1993), Helm (1985), Johnson (1985), Mitsch and Gosselink (1986), Skinner and Porter (1987), and USDA Forest Service (1996).

acidic – having a pH value < 7.0, often indicating moderate or low fertility; in practice, the following degrees of soil acidity are recognized by the USDA: < pH 4.5 = extremely acidic; pH 4.5 to 5.0 = very strongly acidic; pH 5.1 to 5.5 = strongly acidic; pH 5.6 to 6.0 = moderately acidic; pH 6.1 to 6.5 = slightly acidic. See also *circumneutral*, *alkaline*.

alkaline – having a pH value > 7.0; in practice, the following degrees of soil alkalinity are recognized by the USDA: pH 7.4 to 7.8 = mildly alkaline; pH 7.9 to 8.4 = moderately alkaline; soils with pH > 8.4 have not been sampled by DCR-DNH ecologists and probably do not occur in Virginia. See also *acidic*, *circumneutral*.

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

alluvial fan – a body of alluvium forming a segment of a cone that radiates downslope from a point where a stream emerges from a narrow valley onto a less sloping surface (*e.g*., at the foot of a mountain).

alluvium – unconsolidated sand, silt, clay, or gravel deposited by running water; see also *colluvium*.

amphibolite – a metamorphic, mafic rock composed predominately of hornblende and other silicate minerals rich in iron and magnesium. See also *mafic*.

annual – a plant species that completes its life-cycle in one growing season.

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

backswamp – a depressed area of a floodplain between the elevated levee bordering a channel and a valley side or terrace.

bar – an elongated, ridge-like landform generated by waves and currents, and composed of sand, gravel, or other alluvial materials; usually runs parallel to the shore with water on two sides.

barren – an exposed, usually rocky, non-forested habitat in which shallow soils and drought-stress limit the establishment and growth of woody plants; typically dominated by warm-season perennial grasses.

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

basin wetland – a depression wetland with no or limited surface outlet.

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.

bog – in strict usage, an ombrotrophic peatland with organic soils > 40 cm deep; more generally (in the southeastern United States), any non-forested, oligotrophic wetland with groundwater-controlled hydrology. See *fen*, *peatland*, *oligotrophic*, *ombrotrophic*, and see Weakley and Schafale (1994) for additional discussion.

boreal – of or pertaining to subpolar and cold-temperate areas.

boulderfield – a sheet of coarse, loose, rock fragments mantling a slope; a collective term including talus, scree, block fields, and bouldery colluvium.

brackish – of or pertaining to water having salt concentrations between 0.5 and 30 parts per thousand; collective term encompassing *oligohaline*, *mesohaline*, and *polyhaline* regimes (which see).

breached foredune – an ocean-fronting dune that has been partly eroded or removed by ocean winds and water.

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

calcareous – having high levels of calcium carbonate; applied to both soils and rock; in practice, DCR-DNH ecologists consider soils with calcium levels of >1200 parts per million to be calcareous.

calciphile – a plant restricted to or particularly characteristic of calcareous substrates.
carbonate rock – collective term for limestone and dolomite.
circumneutral – having a pH ~ 7.0; in practice, soils with pH 6.6 to 7.3 are considered circumneutral. See also *acidic*, *alkaline*.
charnockite – a granitic rock containing abundant pyroxene, a dark silicate mineral.
colluvium – unconsolidated earth materials deposited on steep slopes by direct gravitational action and local unconcentrated run-off. See also *alluvium*.
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.
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 phytosociological studies and the National Vegetation Classification.
composite – a plant of the Aster or Sunflower Family (*Asteraceae*).
crustose lichen - a lichen adhering closely to, and difficult or impossible to separate from, its substrate; crustose lichens abundantly cover most exposed rock outcrops. See *lichen*.
detritus – litter formed from fragments of dead material, *e.g*., leaf litter or pieces of wood.
diabase – an intrusive, mafic, volcanic rock composed largely of plagioclase feldspar and dark silicate minerals; similar to, and intermediate in texture between, gabbro and basalt.
diurnally flooded – alternately flooded and exposed by tidal water on a daily basis.
dolomite – a sedimentary rock composed of calcium and magnesium carbonate. See also *limestone*.
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.
duff – the matted, partly decomposed organic surface layer of forest soils.
ecotone – a transitional area where characteristics of adjacent communities or environments are intermingled or gradational.
edaphic – of or pertaining to the influence of soils on living organisms, particularly plants.
embayment – a broad ocean inlet or estuarine river and the landforms enclosing it.
endemic –geographically restricted; a species or taxonomic group restricted to a particular geographic region.
ephemeral seepage – brief groundwater outflow resulting from precipitation.
ericaceous – of the Heath Family (*Ericaceae*). See *ericad*.
ericad – a plant of the Heath Family (*Ericaceae*); for example, blueberries (*Vaccinium* spp.), rhododendrons (*Rhododendron* spp.), and mountain-laurel (*Kalmia latifolia*).
estuarine – pertaining to a body of water that has a connection (open, partly obstructed, or sporadic) to the ocean and where fresh water from overland drainage is mixed with oceanic salt water; usually characterized by tidal activity; the Estuarine System, as defined in this report, extends upstream to the inland limits of tidal flooding, thus including a zone of strictly freshwater tidal habitats on coastal rivers.
eutrophic – enriched with nutrients; applied both to naturally fertile environments and to those that have been enriched by anthropogenic disturbances.
fen – in strict usage, a minerotrophic, enriched peatland with organic soils > 40 cm deep; more generally (in the southeastern United States), applied to similar wetlands lacking, or with only superficial, organic soils. See *bog*, *minerotrophic*, *peatland*, *oligotrophic*, and see Weakley and Schafale (1994) for additional discussion.
fibric peat – partially decomposed organic material whose original structure is still visible.
flora – all the plants that make up the vegetation of a specified area. See also *vegetation*.
floristic – of or pertaining to the flora of an area and the geographic patterns of distribution represented by its taxa. See also *floristics*.

floristics – the study of a flora and the geographic distributions of its taxa.
fluvial – of, pertaining to, or produced by rivers.
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 ventral surface is visible; foliose lichens are attached to rocks and other substrates by numerous fine structures called rhizines; see *lichen*.
forb – a broad-leaved herbaceous plant.
forest – vegetation dominated by trees (= 6m [20 ft] 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.
freshwater – of or pertaining to water with salt concentrations of < 0.5 parts per thousand.
gabbro – an intrusive igneous, mafic rock composed primarily of plagioclase feldspar and pyroxene.
geomorphic – of or pertaining to processes that change the form of the earth (*e.g.*, volcanic activity, running waters, glaciers).
gneiss – a metamorphic, foliated rock composed predominately of feldspar and showing color banding or alignment of mineral grains.
graminoid – grasses and grass-like plants (*e.g.*, sedges and rushes).
granite – an igneous rock composed predominately of feldspar and quartz.
granodiorite – a granitic rock composed of plagioclase feldspar, quartz, and various dark silicate minerals, including hypersthene, augite, biotite, hornblende, and garnet; contains a lower proportion of silica than true granite.
greenstone – a metamorphosed basalt composed predominantly of plagioclase, chlorite, epidote, and albite.
groundwater – water occurring below the earth's surface in bedrock and soil.
halophyte – a plant restricted to or particularly characteristic of saline environments.
hardpan – a dense, clay subsoil layer that impedes internal drainage and root penetration.
heath - a plant of the Heath Family (*Ericaceae*); an Ericad; for example, blueberries (*Vaccinium* spp.), rhododendrons (*Rhododendron* spp.), and mountain-laurel (*Kalmia latifolia*).
herbaceous vegetation – vegetation dominated by herbs having = 5 % total cover; such vegetation with herb cover from 5 to 25% is referred to as sparse herbaceous vegetation.
herbivory – the consumption of plants by animals.
hibernacula – overwintering den sites used by animals such as bats, snakes, and insects that hibernate in a state of torpor.
hydric – wet.
hydromorphic – structurally adapted for life in aquatic habitats.
hydroperiod – the specific flooding cycle of a wetland habitat; usually applied to the more or less regular periodicity of seasonally flooded wetlands.
hydrophytic – pertaining to plants or vegetation adapted to wetland environments.
hyperhaline – of or pertaining to water with salt concentrations > 40 parts per thousand, or to wetland soils that contain > 15% exchangeable sodium, a level that interferes with the growth of most plants; usually applied to Salt Flats ("salt pannes"), depressions that accumulate salt through evaporation of tidal inputs.
igneous – formed by solidification of magma within the earth's crust or of lava on the surface.
interfluve – the elevated area between two drainageways that sheds water to them.
intermittently exposed – substrate usually flooded, but exposed occasionally and without detectable seasonal periodicity.
intermittently flooded - substrate usually exposed, but surface water present occasionally and without detectable seasonal periodicity.
interstice – an intervening space or crevice.
irregularly flooded - flooded by tidal water less often than daily but at least once annually.

landslide bench - a sag between resistant and less resistant sedimentary bedrock units in areas of catastrophic slope failure and landsliding; expressed physiographically as a sub-level, mid-slope area.

leeward – on or toward the side sheltered from the wind.

levee – a low ridge or embankment of sand and coarse silt, built up by a stream on its flood plain and located adjacent to its channel.

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. See *crustose lichen*, *foliose lichen*, *umbilicate lichen*.

limesand – sand containing significant quantities of calcium carbonate derived from finely weathered shell material.

limestone – a sedimentary rock composed predominantly of the mineral calcium carbonate (calcite). See also *dolomite*.

lithophyte – a vascular plant confined to or particularly characteristic of rock habitats (outcrop crevices, shelves, ledges).

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. See *non-vascular*.

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. See also *ultramafic*.

magnesiophile - a plant restricted to or particularly characteristic of magnesium-rich substrates, *e.g*., soils derived from dolomite or mafic rocks.

marine – of or pertaining to the ocean and its waves and currents; the Marine System, as defined in this report, extends from the outer edge of the continental shelf shoreward 1) to the landward limit of tidal inundation on beaches and 2) to the oceanward limit of water bodies with salinities < 30 parts per thousand.

maritime – living or situated near an ocean; of or pertaining to an environment under oceanic influences.

marl – lime-rich clay containing a high proportion of soft calcium carbonate.

marsh – a eutrophic, non-forested wetland characterized by emergent herbaceous plants and a hydrologic regime of overland or tidal flooding. See *eutrophic*.

meander –one of a series of sinuous loops, with sine-wave form, in the course of a stream channel.

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

mesohaline – of or pertaining to water with salt concentrations from 5 to 18 parts per thousand.

mesophytic – of or pertaining to plants or vegetation adapted to environments of intermediate moisture conditions.

metabasalt – metamorphosed basalt, a fine-grained igneous rock composed largely of plagioclase feldspar, pyroxene, and volcanic glass. See *greenstone*, a metabasalt underlying extensive portions of the northern Blue Ridge and western Piedmont foothills.

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.

metasiltstone – metamorphosed siltstone. See *siltstone*.

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.

minerotrophic – receiving water that has passed through mineral soil; usually applied to groundwater-fed, enriched peatlands (true fens). See *fen*, *ombrotrophic*.

monadnock – an isolated hill or range of hills, resulting from erosion of the surrounding terrain; usually underlain by relatively resistant rocks.

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. See *non-vascular*.

mudstone – a sedimentary rock formed by hardening of silt and clay in approximately equal proportions.

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.

ombrotrophic – of or pertaining to wetlands, usually peatlands, that are fed by rainwater.

oligohaline – pertaining to water with salt concentrations from 0.5 to 5.0 parts per thousand.

oligotrophic – infertile. See also *eutrophic*.

oxbow – a closely looping stream meander having an extreme curvature such that only a neck of land is left between the two parts of the stream.

palustrine – of or pertaining to non-tidal wetlands; the Palustrine System, as defined in this report, includes all non-tidal wetlands dominated by woody plants and herbaceous emergents.

peat – an organic soil or deposit, often formed under anaerobic conditions associated with waterlogging.

peatland – a wetland with organic soils > 40 cm deep.

perched water table – groundwater whose surface, while normally well below ground, is periodically or seasonally elevated close to or above the soil surface.

perennial – a plant species with a life-cycle that lasts at least two growing seasons.

periglacial – specifically, of or pertaining to an area adjacent to a contemporary or Pleistocene glacier; more generally, any environment where the action of freezing and thawing is currently, or was during the Pleistocene, the dominant surface process.

pH – a value on the scale 0 to 14 that gives a measure of the acidity or alkalinity of a medium. See also *acidic*, *alkaline*, and *circumneutral*.

phenology – the study of periodicity of leafing, flowering, and fruiting in plants; leaf phenology refers broadly to the habit and duration of foliage.

physiognomy – the form and structure of vegetation.

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

pocosin – an ombrotrophic, saturated peatland supporting pyrophytic woodland vegetation dominated by pond pine (*Pinus serotina*) and various evergreen shrubs. See *ombrotrophic*, *pyrophytic*.

polyhaline – of or pertaining to water with salt concentrations from 18 to 30 parts per thousand.

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

quartzite –metamorphosed sandstone. See *sandstone*.

regularly flooded – alternately flooded and exposed by tidal water on a daily basis.

relict – an organism or community that has survived while related ones have become extinct; often applied to plants or vegetation that formerly had much wider distributions and have survived locally through periods of unfavorable conditions in a region.

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

rhyolite – a volcanic rock composed predominantly of quartz and feldspar.

rill – a small streamlet or rivulet.

riverine – of or pertaining to waters enclosed by channel banks; the Riverine System, as defined in this report, includes all non-tidal wetlands and deepwater habitats contained within stream channels, except those dominated by woody plants or herbaceous emergents.

saline – in common parlance, pertaining to or characterized by salt; in strict, formal usage, this term is applied only to terrestrial and inland wetland environments, whereas the term *haline* is applied to environments under the influence of oceanic salts.

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.

savanna – a sparse woodland with little or no understory and a dense, graminoid-dominated herb layer.

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

scrub – vegetation dominated by shrubs. See *shrubland*.

seasonally flooded – surface water present for extended periods during the growing season, but absent by the end of the growing season in most years.

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.

semipermanently flooded – surface water present throughout the growing season in most years except during droughts.

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

serpentinite – a metamorphic, ultramafic rock composed primarily of serpentine, a magnesium silicate mineral indicative of low-grade metamorphism.

shale - a fine-grained sedimentary rock composed of mud, silt, and clay grains and characteristically splitting into thin layers.

shrubland – vegetation dominated by woody plants < 6m (20 ft) tall and having = 5% total cover; such vegetation with shrub cover from 5 to 25% is referred to as a sparse shrubland.

siltstone – a sedimentary rock formed by hardening of silt particles intermediate in size between clay and sand.

slate – a fine-grained metamorphic rock that splits cleanly into thin slabs; metamorphosed shale.

slough – a linear depression or meander channel in a floodplain, usually with a seasonally or semipermanently flooded hydrology.

soapstone – a massive, metamorphic, ultramafic rock composed primarily of talc and serpentine.

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.

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.

swale – a slight depression in a generally level landscape; or, in the case of an interdune swale, a long, narrow, trough-like depression between two beach ridges.

swamp – a forested or shrub-dominated wetland with a hydrologic regime of seasonal, semipermanent, permanent, or tidal flooding; contrast with *seepage swamp*, which has a saturated, groundwater-controlled hydrology. See *seasonally flooded*, *semipermanently flooded*.

temporarily flooded – surface water, usually flowing, present for brief periods during the growing season, but water table normally lies well below the surface; applied to floodplain wetlands.

terrace – one of a series of platforms flanking and more or less parallel to a stream channel; originally formed near the level of the stream and representing the dissected remnants of an abandoned floodplain, stream bed, or valley floor produced during a former stage of erosion or deposition.

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

Tertiary – the first period of the Cenozoic Era of geological time, from approximately 2 million to 65 million years ago.

toe slope – the geomorphic unit that forms the outermost, gently inclined surface at the base of a hillslope.

travertine – limestone deposited around caverns, or in hot springs and waterfalls.

Triassic – the earliest period of the Mesozoic Era, from approximately 213 million to 248 million years ago.

ultramafic – derived from igneous rocks with little feldspar and large amounts of mafic minerals; compared to mafic rocks, ultramafic rocks contain larger quantities of heavy metals and were formed deeper in the earth's mantle; examples include serpentinite, soapstone, and talc-tremolite schist. See also *mafic*.

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.

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. See also *flora*.

woodland – vegetation dominated by trees (= 6m [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).

xeric – dry; drought-prone.

xerophyte – a plant or vegetation type adapted to dry environments.

LITERATURE CITED AND ADDITIONAL REFERENCES

This section is divided into three parts: 1) a partial list of published literature on Virginia vegetation and related topics; 2) unpublished technical reports and academic studies concerning Virginia vegetation; and 3) general references cited in the introduction and glossary.

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Appendix: A Brief Summary of Procedures for Collection and Analysis of Vegetation Data

This appendix provides a rudimentary introduction to the procedures DCR-DNH employs in the collection of field data and development of ecological community classifications. A more detailed explanation and discussion of these procedures will be presented in a future document.

Data Collection

DCR-DNH ecologists are committed to a rigorous, quantitative approach to vegetation sampling, analysis, and classification, from the use of standard sampling protocols in the field to the application of numerically intensive, state-of-the-art methods of data analysis. This emphasis is consistent with both a long history of vegetation investigations in North America and Europe and the contemporary development of national standards for vegetation classification and of a national plots database. Quantitative data explicitly recognize differences in abundance and biomass among coexisting plant species. Moreover, data collected from sample units of known, standard size provide a consistent basis for comparing stands of disparate vegetation and facilitate sharing of data among users to an extent not possible with mere species lists or data collected from an area of indefinite size. Patterns in composition and structure of ecological communities are dependent on the scale of observation, and a sampling protocol that specifies a particular scale reduces both the likelihood of obscuring patterns across multiple scales and sampler bias in determining whether particular species are recorded. Similarly, numerical methods of analysis offer objective means of generating and evaluating a classification of vegetation and enable the detection of patterns that might otherwise remain unapparent. The collection and analysis of quantitative data to support ecological classification should be viewed neither as panaceas nor ends in their own right. Rather, they are important as tools to further conservation, but they provide a critical objective, scientific context for doing so.

Data collection follows standard protocols developed by DCR-DNH and refined over the past decade. The fundamental components of these protocols are identical within the agency and consistent with sampling techniques employed by a wide range of other users. For inventory purposes and most contract projects, data are collected from plots $\geq$ 400 m^2 in forests and woodlands and $\geq$ 100 m^2 in shrubland and herbaceous vegetation. On natural area preserves and other managed areas that require permanently marked plots for long-term monitoring, modular plots up to 1000 m^2 that contain nested subplots are sampled more intensively to provide information about vegetation structure, composition, and species richness at multiple spatial scales. In all cases, within each plot all vascular plants present are recorded and the total individual cover of each taxon (defined as the vertical projection of all above-ground biomass) is estimated and assigned to one of nine cover classes representing a range of percentage values. Vegetation structure is assessed by estimating the cover of each woody species at six vertical (height) strata, and (consistently since 1998) stem diameters are measured for all woody stems = 2.5 cm at breast height (1.4 m). A standard set of environmental data is collected, including elevation, aspect, degree of slope, coverage of different types of surface substrate, soil characteristics, and qualitative measures of soil moisture and hydrology. A soil sample is now routinely collected from each plot in order to document soil chemistry. All sampling locations are now recorded using a global positioning system (GPS) unit and mapped using ArcView GIS (ESRI 1992-99). Frequently, the sampling protocol also includes photographic documentation and cursory examination of tree increment cores to deduce stand age and history. An example of a completed plot data form follows this summary.

Data Analysis and Classification

Prior to 1997, data analysis and classification were conducted using traditional Braun-Blanquet methodology, in which a tabular array of vegetation samples and species is iteratively rearranged to isolate samples of similar composition and species of similar affinities. A narrow focus on individual landscapes or self-contained data sets often resulted in the proliferation of largely redundant vegetation types that overlapped considerably in composition, but differed in name and local distribution. In

addition, significant community occurrence records were referenced under a statewide classification system based on putative classes of soil fertility (Rawinski 1992). The fine-scale approach employed for individual landscapes and the trophic-based, coarse-scale approach adopted statewide recognized classification units at different conceptual scales that were not fully integrated.

Since 1997, numerical methods have been employed to generate classifications, and increasing emphasis is now placed on circumscribing units across their full distributional range in Virginia. This new approach makes use of several integrated applications to manage, manipulate, and analyze data. Microsoft Access provides a database platform for permanently archiving digital compositional data, environmental data, and metadata, as well as a powerful and flexible tool for efficiently assembling any desired set of plots for analysis. Adhering to the principle that the recognition of vegetation types should be based on total floristic composition, DCR-DNH ecologists employ both agglomerative hierarchical and non-hierarchical cluster analysis to generate classifications. Subsequently, non-metric multidimensional scaling ordination is performed to assess the classification and identify those environmental gradients and site conditions most strongly associated with variation in species composition. Both cluster analysis and ordination are implemented in PC-ORD (Version 4.16; McCune and Mefford 1999). Once vegetation types are identified, several summary statistics are calculated to evaluate the consistency and distinctiveness of the type and to aid in selecting nominal taxa. Species-specific values for constancy (the proportion of plots assigned to a vegetation type in which a species occurs), fidelity (the degree to which a species is restricted to a particular type), and mean cover identify the most characteristic and dominant species for each type. Macros, written in Microsoft Visual Basic code and executed in Excel, automate the computation of these statistics and allow several types or multiple clustering levels to be evaluated rapidly. Additional macros facilitate the interface between data tables and queries in Access and spreadsheets in Excel and compute summary information from tree diameter measurements. An additional software application, VTAB Ecosystem Reporter, is used to update obsolete botanical nomenclature, merge taxa into higher-level groupings, compute mean cover values for large data sets, and manage cover data of woody plants by vertical strata.

Community Nomenclature

The nomenclature of community types is similar to standards adopted for the NVC, which uses the scientific names of up to six characteristic species. Although they cannot serve as complete surrogates for detailed descriptions, the names of community types are constructed to facilitate both distinguishing among types and identifying them readily in the field. As a rule, species are listed in descending order of importance and structural position (*i.e.*, canopy species are listed first, followed by understory species, then herbs and low shrubs). Nominal species in the same stratum are separated by a dash (–) while different strata are separated by a slash (/). The typical physiognomy (*i.e.*, forest, woodland, shrubland, etc.) and hydrologic regime (for wetland communities) are included at the end of the formal community type name. A common name equivalent contains the ecological group name followed by a modifier. For example,

> ***Acer rubrum – Fraxinus nigra* / *Carex bromoides – Caltha palustris* Saturated Forest**
> Montane Basic Seepage Swamp (Red Maple – Black Ash / Brome Sedge – Marsh-Marigold Type)