

# PIEDMONT AND COASTAL PLAIN MESIC FORESTS

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## PIEDMONT AND COASTAL PLAIN MESIC FORESTS THEME

**Concept:** Piedmont and Coastal Plain Mesic Forests occur on slopes or flats that are moist but well drained, not affected by flooding, and with only brief or very local saturated soil. Their canopy is dominated or codominated by mesophytic deciduous hardwoods such as *Fagus grandifolia*, *Quercus rubra*, *Liriodendron tulipifera*, and *Quercus nigra*.

**Distinguishing Features:** Most of these forests are distinguished from others in the Piedmont and Coastal Plain by dominance by *Fagus grandifolia*, *Quercus rubra*, and *Liriodendron tulipifera* in upland sites. If *Quercus alba*, *Quercus nigra*, or other oaks are abundant, it is in combination with *Fagus* or other mesophytic species. These mesic forests are distinguished from smaller Piedmont and Mountain Floodplain communities by lacking any appreciable presence of alluvial species (e.g., *Fraxinus pennsylvanica*, *Platanus occidentalis*, *Betula nigra*) and lacking evidence of regular flooding. In the upper Piedmont, where Mountain Cove Forests may be present, Piedmont and Coastal Plain Mesic Forests are distinguished by the absence of the more diverse set of Mountain Cove Forest species (e.g., *Tilia americana* var. *heterophylla*, *Betula lenta*, *Aesculus flava*, *Magnolia acuminata*), and by an association with other Piedmont rather than Mountain communities. Rare examples in the Coastal Plain lack all of these species and are dominated by an uncharacteristic combination of other upland oaks (*Quercus alba*, *Quercus nigra*) with wetland species such as *Chamaecyparis thuyoides* on steep bluffs.

Low Elevation Cliffs and Rock Outcrops and Piedmont and Mountain Glades and Barrens are distinguished from Piedmont and Coastal Plain Mesic Forests by having more open vegetation, with less tree cover than a typical forest canopy, with openness caused by rock cover, shallow soil, or long term slope instability.

Within Piedmont and Coastal Plain Mesic Forests, the most common communities are distinguished by the floristic differences associated with Piedmont and Coastal Plain locations, and by soil nutrient levels as they are indicated by flora and vegetation.

**Sites:** Piedmont and Coastal Plain Mesic Forests occur on well drained but moist areas. Most occur on steep slopes, bluffs, or in ravines in dissected uplands, where slope aspect or topographic sheltering create a cool microclimate and limit spread of fire. They may also occur on relict river terraces in areas that no longer flood. In the Coastal Plain, they may occur on moist but well-drained flats or low ridges surrounded by extensive Coastal Plain Nonalluvial Wetland Forests.

**Soils:** Most Piedmont and Coastal Plain Mesic Forests occur on moist Ultisols. A few on steep slopes have Inceptisols, and a few occur on Alfisols. Soils may occasionally have substantial amounts of rock or be punctuated by rock outcrops, but rock cover is not enough to change the vegetation cover and structure from that typical of forests.

**Hydrology:** Sites are moist most of the time but are not saturated other than locally or briefly. In most examples, water can move into the site from adjacent higher areas but drains away and does not accumulate.

**Vegetation:** Piedmont and Coastal Plain Mesic Forests generally have well-developed tree canopies that are usually dominated by a mix of several tree species, including *Fagus grandifolia*, *Quercus rubra*, and *Liriodendron tulipifera*. A variety of other species may be present, including *Acer floridanum*, *Quercus nigra*, *Carya spp.*, *Quercus alba*, and *Pinus taeda* or *Pinus echinata*. Rarely, a few wetland trees such as *Quercus michauxii*, *Quercus pagoda*, or *Chamaecyparis thyoidea* may be present. A few communities have dense shrub layers but most are open beneath the understory and have dense or sparse herb layers.

**Dynamics:** Piedmont and Coastal Plain Mesic Forests, like most of North Carolina's hardwood forests, naturally occur primarily as old-growth, uneven-aged stands. Trees up to several centuries old are common in uncut forests. Most tree reproduction is in small, less often medium size, canopy gaps created by the death of one or a few trees, resulting in a fine-scale mosaic of tree ages across the forest and relative stability of the forest cover over large areas. Wind, lightning, and ice damage are important sources of mortality. Lightning creates gaps at a relatively steady rate but probably is less frequent in the sheltered settings of bluffs and ravines than it is on ridges. Large wind storms may create numerous gaps at once, while leaving the majority of canopy cover intact. Wind disturbance may be more severe nearer the coast, where hurricanes are more intense. Gap formation rates have not been studied in as much detail as they have for Mountain Cove Forests but probably are similar.

Mesic forests occur in landscapes that were naturally subject to fire at least fairly frequently. The moist conditions, limited flammability of mesophytic tree litter (Kreye, et al. 2013, Kreye, et al. 2018), and occurrence in dissected and sloping topography where fire would usually be spreading downhill all contribute to limiting fire penetration and to reducing its intensity when it did occur. The process recently termed "mesophication" (Nowacki and Abrams 2008), which is believed to be altering upland oak forests, is a natural characteristic of the mesic forest communities. The thin bark of most of the dominant species also suggests that fire was not an important natural influence, though any intense fire that did occur would be a significant natural disturbance.

Fire may have been an important natural determinant of the boundaries of mesic forests. With the removal of fire from the landscape, individuals of mesophytic species are able to establish in drier, more fire-prone locations. This may eventually lead to a shift in the community boundary. Caution is needed in interpreting this extent of this phenomenon, however. Seedlings and saplings of mesophytic trees may be present in dry areas but fail to mature due to stress or because of periodic drought-caused mortality.

Mesic forests often contain a mix of trees that have very different tolerances of shade, from the very shade-tolerant *Fagus* to the intolerant *Liriodendron*. Occasional fire penetration might be a disturbance that would favor such coexistence but may not be necessary. Skeen, Carter, and Ragsdale (1980) argue that the canopy gaps produced by the death of one or several large old-growth trees would be sufficient to allow regeneration of *Liriodendron*.

Nutrient levels and soil chemistry vary among the different mesophytic forest communities, but the moist conditions favor decomposition of litter. In addition to transport of nutrients into these communities from uphill, rapid recycling of litter may promote more fertile conditions than in drier communities with comparable geologic substrate.

**Comments:** Mesic forests are one of the few community themes that are shared between the Piedmont and Coastal Plain, where differences in fire frequency, hydrology, and substrates generally create substantial differences among most communities. The limited role of fire and the lack of extremes in moisture levels lead to more similarities than differences in mesic forests, despite the differences in geology. It may be said that the mesic forests are the most Piedmont-like of Coastal Plain communities. Nevertheless, mesic hardwood forests in the Coastal Plain occur in small patches in unusual topography, while in those in the Piedmont are a regular and extensive part of the typical landscape mosaic.

In the Piedmont, mesic forests were treated by Peet and Christensen (1980) as part of their study of typical forest patterns. In the Coastal Plain, the relationship of our mesic hardwood forests to the concept of southern mixed forest or beech-magnolia forest has been a subject of discussion (Nesom and Treiber 1977, Ware 1978).

**References:**

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## KEY TO PIEDMONT AND COASTAL PLAIN MESIC FORESTS

1. Community with a dense shrub layer, either a low-diversity layer dominated by *Kalmia latifolia*, *Rhododendron catawbiense*, or occasionally *Symplocos tinctoria*, or a high-diversity layer containing a mix of wetland and upland species.

2. Shrub layer low in diversity, dominated by *Kalmia latifolia*, *Rhododendron catawbiense*, or occasionally *Symplocos tinctoria*; canopy generally of *Fagus grandifolia*, *Quercus* spp., and *Liriodendron tulipifera*; occurring in either the Piedmont or Coastal Plain .....

..... **Piedmont/Coastal Plain Heath Bluff**

2. Shrub layer high in diversity, containing multiple wetland species such as *Cyrilla racemiflora*, *Clethra alnifolia*, and *Lyonia lucida* as well as upland species such as *Kalmia latifolia* and *Hamamelis virginiana*; canopy generally a mix of upland and wetland species, such *Quercus nigra*, *Quercus alba*, and *Chamaecyparis thyoides*; occurring in the Sandhills Region along the Little River or similar deeply entrenched streams draining to the Cape Fear River..... **Cape Fear Valley Mixed Bluff Forest**

1. Community with low to moderate shrub cover, with most of the above species sparse or absent.

3. Community with flora indicating higher soil pH and base saturation than is typical, with at least several species such as *Actaea racemosa*, *Sanguinaria canadensis*, *Asarum canadense*, *Adiantum pedatum*, *Collinsonia canadensis*, *Botrypus virginianus*, *Elymus hystrix*, *Lindera benzoin*, *Aesculus sylvatica*, *Cercis canadensis*, *Fraxinus americana*, and *Juglans nigra* (some of these species are common in floodplains but indicate more basic conditions when occurring in uplands).

4. Community in the Piedmont, underlain by substrate of mafic rock or older calcium-rich sedimentary rock; lacking species typical of the Coastal Plain; potentially containing species confined to more inland areas, such as *Dicentra cucullaria*, *Cubelium concolor*, *Collinsonia canadensis*, *Cardamine concatenata*, and *Staphylea trifoliata* ..... **Basic Mesic Forest (Piedmont Subtype)**

4. Community in the Coastal Plain, underlain by Tertiary limestone, alluvial terrace deposits, or other base-rich unconsolidated sediments; containing species typical of the Coastal Plain such as *Stewartia malacodendron*, *Quercus michauxii*, and often small numbers of wetland species such as *Persea palustris*, *Ilex glabra*, *Arundinaria tecta*, *Osmundastrum cinnamomeum*, and *Lorinseria areolata*, while lacking the above inland species..... **Basic Mesic Forest (Coastal Plain Subtype)**

3. Community lacking multiple species indicating higher soil pH and base saturation such as those listed above; flora consists of more widely tolerant mesophytic species such as *Polystichum acrostichoides*, *Hexastylis* spp., *Hamamelis virginiana*, and *Fagus grandifolia*

5. Community in the Piedmont, underlain by felsic igneous or metamorphic rocks or by older sedimentary rocks; generally lacking species more typical of the Coastal Plain. ....

..... **Mesic Mixed Hardwood Forest (Piedmont Subtype)**

5. Community in the Coastal Plain, underlain by acidic unconsolidated sediments or younger acidic sedimentary rocks; generally containing species typical of the Coastal Plain and scarce in the Piedmont, such as *Persea palustris*, *Stewartia malacodendron*, *Quercus nigra*, *Ilex glabra*, *Gaylussacia frondosa*, *Arundinaria tecta*, *Osmundastrum cinnamomeum*, and *Lorinseria areolata*.....

..... **Mesic Mixed Hardwood Forest (Coastal Plain Subtype)**

## MESIC MIXED HARDWOOD FOREST (PIEDMONT SUBTYPE)

**Concept:** Mesic Mixed Hardwood Forests are forests of moist but not wet sites lacking indicators of unusually high pH or base-rich soils. They are characterized by vegetation dominated or codominated by *Fagus grandifolia*, but lacking the more diverse flora of Basic Mesic Forests or Montane Cove Forests. The Piedmont Subtype covers examples on Piedmont substrates, where *Quercus rubra* and other characteristic Piedmont species are present and characteristic Coastal Plain species are absent or scarce.

**Distinguishing Features:** Mesic Mixed Hardwood Forest is distinguished from Basic Mesic Forest by lower species richness and by lacking the species that in the Piedmont and Coastal Plain are indicators of higher pH soils (e.g. *Actaea racemosa*, *Asarum canadense*, *Adiantum pedatum*, *Sanguinaria canadensis*, *Cynoglossum virginianum*, *Cubelium (Hybanthus) concolor*, and *Actaea pachypoda*). *Ostrya virginiana*, *Carpinus caroliniana*, *Fraxinus americana*, *Lindera benzoin*, and *Aesculus sylvatica* tend to be common in Basic Mesic Forest and scarce in Mesic Mixed Hardwood Forest. Many of the same indicators are present in Rich Cove Forest, but a number of additional montane species are also present, including the additional trees *Aesculus flava*, *Tilia americana* var. *heterophylla*, *Halesia tetraptera*, and *Betula lenta*. A smaller set of species distinguishes Mesic Mixed Hardwood Forest from Acidic Cove Forest. These include *Betula lenta*, *Tsuga canadensis*, *Rhododendron maximum*, and *Leucothoe fontanesiana*.

Mesic Mixed Hardwood Forest is distinguished from Piedmont Levee Forest (Beech Subtype), Piedmont Headwater Stream Forest, Piedmont Alluvial Forest, and other floodplain communities, which may contain similar tree species, by the absence of evidence of flooding and by the lack of characteristic floodplain plant species such as *Platanus occidentalis*, *Fraxinus pennsylvanica*, *Betula nigra*, *Lindera benzoin*, *Xanthorhiza simplicissima*, *Elymus virginicus*, and *Elymus hystrix*.

The Piedmont Subtype is distinguished from the Coastal Plain Subtype by a number of species that occur primarily in the Coastal Plain, at least in mesic uplands. Coastal Plain species include *Quercus nigra*, *Stewartia malacodendron*, *Symplocos tinctoria*, *Gaylussacia frondosa*, *Ilex glabra*, and *Clethra alnifolia*. *Quercus rubra* is generally a good indicator of Piedmont flora. However, a number of species considered typical of the Piedmont occur as disjunct populations in the Coastal Plain in Mesic Mixed Hardwood Forests, including *Podophyllum peltatum*, *Epifagus virginiana*, and *Hamamelis virginiana*. Some of the indicators occur at low density, and standard plot samples may capture few of them, making classification based on data from individual plots difficult.

**Synonyms:** *Fagus grandifolia* - *Quercus rubra* / *Cornus florida* / *Polystichum acrostichoides* - *Hexastylis virginica* Forest (CEGL008465).

Ecological Systems: Southern Piedmont Mesic Forest (CES202.342).

**Sites:** Most examples occur on steep slopes, bluffs, or ravines in dissected uplands along streams, where slope aspect or topographic sheltering create a cool microclimate and limit spread of fire. They may also occur on relict river terraces in areas that no longer flood.

**Soils:** Examples occur on a wide range of soils, most of which are Typic Kanhapludults or Typic Hapludults. The most frequent series mapped in known occurrences are Pacolet, Cecil, Tatum,

and Georgeville, among the most extensive soils in the Piedmont. A few are mapped as Wilkes (Typic Hapludalf) or Goldston (Typic Dystrudept). More occurrences may be on inclusions within their map units.

**Hydrology:** Sites are moist but well drained.

**Vegetation:** Forests generally are dominated by *Fagus grandifolia*. *Quercus alba* and *Liriodendron tulipifera* are often abundant and sometimes codominant. Less frequent canopy species include *Quercus rubra*, *Carya tomentosa*, and *Quercus velutina*. CVS data show the most abundant understory tree species to be *Cornus florida*, *Acer rubrum*, *Oxydendrum arboreum*, *Liquidambar styraciflua*, and *Nyssa sylvatica*, with *Acer floridanum*, *Ulmus alata*, *Ostrya virginiana*, and other species less frequent. Shrubs generally are sparse. *Euonymus americana* is the only frequent species, and *Viburnum prunifolium*, *Viburnum rafinesquianum*, *Viburnum acerifolium*, or *Vaccinium pallidum* occur in some examples. A few vine species are frequent, especially *Muscadinia rotundifolia* and small individuals of *Smilax glauca* and *Parthenocissus quinquefolia*. Herbs may be sparse to dense. Some examples have large beds of *Polystichum acrostichoides*, while other don't. Other herbs with high constancy in CVS data, though low cover, include *Galium circaezans*, *Maianthemum racemosum*, *Hexastylis arifolia*, *Chimaphila maculata*, *Goodyera pubescens*, *Uvularia perfoliate*, and *Hylodesmum nudiflorum*.

**Range and Abundance:** The equivalent association is ranked G3G4, but G4 likely is appropriate. These communities occur throughout the Piedmont and are one of the most frequently recorded communities in the state. Many examples were protected by steep topography from past agricultural clearing and more recent development, and some are steep enough to be unlikely to be logged. However, many examples are of limited size because of the dissected terrain and many are bordered by more altered sites.

**Associations and Patterns:** Mesic Mixed Hardwood Forests may be regarded as matrix-forming communities; they make up a significant minority of the landscape mosaic in most Piedmont landscapes, though individual patches may be small. Mesic Mixed Hardwood Forests grade to Dry-Mesic Oak–Hickory Forest uphill and to floodplain communities downhill. Piedmont/Coastal Plain Heath Bluff, Basic Mesic Forest, or Piedmont Cliff communities may be associated with them along slopes.

**Variation:** Examples vary with the transition to adjacent communities and with biogeography. Examples farther west in the Piedmont may have more montane species, though a few disjunct montane species are known even in the eastern Piedmont. Examples also seem to vary significantly in species richness, with some moderately rich and some with only a few strongly dominant species. Harry LeGrand, in several Natural Heritage Program reports, proposed recognition of a distinct subtype on steeper bluffs. This initially does not appear consistently distinguishable but is recognized as a variant to allow use of the concept and to seek further evidence.

1. Typic Variant most closely fits the description of the subtype. Its canopy may be strongly dominated by *Fagus* or may be more mixed. Plants of deep soils generally are present, especially

*Polystichum acrostichoides*, but also *Podophyllum peltatum*, *Tiarella cordifolia*, *Cardamine angustata*, *Geranium maculatum*, and *Erythronium umbilicatum*.

2. Bluff Variant occurs on steeper slopes. *Fagus* typically is strongly dominant, and several species typical of shallow soil and greater drainage are present. These include *Hydrangea arborescens*, *Cunila origanoides*, *Epigaea repens*, *Solidago arguta*, *Hexastylis minor*, and *Silene virginica*.

**Dynamics:** Dynamics are similar to the theme in general.

**Comments:** Mesic Mixed Hardwood Forests have consistently been distinguished in local analyses of vegetation data in the Piedmont (Peet and Christensen 1980, Oosting 1942). Numerous CVS plots exist for this subtype.

A few Mesic Mixed Hardwood Forests in the Coastal Plain may fit this subtype better than the Coastal Plain Subtype. The NVC association synonymized to this subtype is recognized as extending into the Coastal Plain in northern Virginia.

**Rare species:** *Magnolia macrophylla*.

**References:**

- Oosting, H.J. 1942. An ecological analysis of the plant communities of Piedmont, N.C. *American Midland Naturalist* 28: 1-126.
- Peet, R.K., and N.L. Christensen. 1980. Hardwood forest vegetation of the North Carolina Piedmont. *Veroeff. Geobot. Inst. ETH, Stiftung Rubel, Zurich.* 69. Heft: 14-39.



## MESIC MIXED HARDWOOD FOREST (COASTAL PLAIN SUBTYPE)

**Concept:** Mesic Mixed Hardwood Forests are forests of moist but not wet sites lacking indicators of unusually high pH or base-rich soils. They are characterized by vegetation dominated or codominated by *Fagus grandifolia* or other mesophytic hardwoods. The Coastal Plain Subtype covers the examples on Coastal Plain substrates, where a distinct component of Coastal Plain flora occurs. They may occur on steep north-facing bluffs, on moist upland flats associated with nonriverine wetlands, or on mesic ridges within river floodplains.

**Distinguishing Features:** Mesic Mixed Hardwood Forests are distinguished from Basic Mesic Forests by lower species richness and by lacking the species that in the Piedmont and Coastal Plain are indicators of higher pH soils (e.g. *Actaea racemosa*, *Asarum canadense*, *Adiantum pedatum*, *Sanguinaria canadensis*, *Cynoglossum virginianum*, *Cubelium (Hybanthus) concolor*, and *Actaea pachypoda*). *Ostrya virginiana*, *Carpinus caroliniana*, *Fraxinus americana*, *Lindera benzoin*, and *Aesculus pavia* tend to be common in Basic Mesic Forest and scarce in Mesic Mixed Hardwood Forest.

The Coastal Plain Subtype is distinguished from the Piedmont Subtype by occurrence in the Coastal Plain and by accompanying floristic differences. Distinctive species of the Coastal Plain Subtype include *Quercus nigra*, *Stewartia malacodendron*, *Symplocos tinctoria*, *Gaylussacia frondosa*, and a variety of shrubs and herbs that more typically occur in wetlands, such as *Arundinaria tecta*, *Ilex glabra*, *Persea palustris*, *Lorinseria areolata*, and *Osmundastrum cinnamomeum*. A few Coastal Plain Small Stream Swamp communities may share some of the mesophytic hardwoods, but generally will have a substantial component of wetland species or floodplain species. *Nyssa biflora* is usually present in floodplains. However, a few bottomland species such as *Quercus michauxii* may frequently occur in Mesic Mixed Harwood Forest.

**Synonyms:** *Fagus grandifolia* - *Quercus (alba, nigra)* / *Symplocos tinctoria* – (*Stewartia malacodendron*) Forest (CEGL007211).

Ecological Systems: Southern Atlantic Coastal Plain Mesic Hardwood Forest (CES203.242).

**Sites:** Mesic Mixed Hardwood Forests occur on upland areas protected from fire. They are primarily on north-facing river bluffs and ravine slopes, less commonly on upland flats or islands surrounded by peatland or swamp communities.

**Soils:** These communities occur on a great variety of soils, with 30 different series map units recorded with occurrences. Among the more frequently mapped soils are Craven (Aquic Hapludult), Winton (Aquic Hapludult), Norfolk (Typic Kandiudult), Roanoke (Typic Endoaquult), Wagram (Arenic Kandiudult), Conetoe (Arenic Hapludult), and Wickham (Typic Hapludult). Less frequently recorded series include Spodic Paleudults, Aquic Quartzipsamments, Typic Humaquepts, Udipsamments, and Dystrochrepts.

**Hydrology:** Moisture levels are mesic overall, though local small areas with seepage are common in the Coastal Plain Subtype. These communities are often on the best-drained sites in the vicinity, located between wet floodplains or swamps below and wetlands of upland flats above. However, they also often are associated with drier upland communities.

**Vegetation:** The Coastal Plain Subtype forests are dominated by *Fagus grandifolia*, sometimes codominant with *Quercus alba* or *Quercus nigra*, *Liquidambar styraciflua*, *Liriodendron tulipifera*, or *Pinus taeda*. Other canopy species sometimes abundant in CVS plots include *Quercus michauxii*, *Quercus laurifolia*, *Quercus pagoda*, *Carya tomentosa*, *Carya glabra*, *Carya pallida*, and *Quercus shumardii*. The understory is often well developed and may be dominated by *Ilex opaca*, *Carpinus caroliniana*, *Nyssa sylvatica*, *Acer rubrum*, or *Cornus florida*. *Stewartia malacodendron*, *Acer floridanum*, *Oxydendrum arboreum*, or *Magnolia tripetala* may be abundant in some examples. The shrub layer is generally open and may include *Hamamelis virginiana*, *Lindera benzoin*, *Symplocos tinctoria*, *Euonymus americana*, *Clethra alnifolia*, *Asimina parviflora*, *Callicarpa americana*, *Vaccinium* spp., *Gaylussacia frondosa*, *Arundinaria tecta*, and a wide variety of other occasional species. Vines may be abundant, particularly *Muscadinia rotundifolia* or *Smilax rotundifolia*. *Parthenocissus quinquefolia*, *Smilax glauca*, and *Bignonia capreolata* are also frequent. The herb layer may be sparse to dense. *Polystichum acrostichoides* sometimes forms dense beds, and *Athyrium asplenoides*, *Parathelypteris noveboracensis*, or *Mitchella repens* are extensive in some plots. A variety of other species may occur in the herb layer, including *Chimaphila maculata*, *Asplenium platyneuron*, *Lorinseria areolata*, *Chasmanthium laxum*, *Galium circaezans*, *Galium uniflorum*, *Hexastylis arifolia* var. *arifolia*, *Dichantherium commutatum*, and *Sanicula canadensis*.

**Range and Abundance:** Ranked G3. Examples occur irregularly throughout the Coastal Plain of the state; they are largely limited to narrow bands of dissected lands along stream systems, but a few examples also occur on “swamp islands” in the flat lands of the outer Coastal Plain in the northeastern part of the state. The equivalent association ranges from southern Virginia to South Carolina, but most of its range may be in North Carolina.

**Associations and Patterns:** This subtype occurs as small patches, though some may aggregate into larger occurrences in bluff systems. It usually grades downhill to a Coastal Plain floodplain community, but a few may be surrounded by or occur on edges of Nonriverine Wet Hardwood Forest or Nonriverine Swamp Forest. Examples on bluffs usually grade uphill to Dry-Mesic Oak–Hickory Forest or Dry Oak–Hickory Forest. Enough are now bordered by altered vegetation on flatter uplands that the range of transitions may not be known.

**Variation:** Three variants are distinguished, corresponding to different landscape settings, which are believed to have effects on hydrology and fire dynamics. Vegetation differences among them are not known but have not been sought. Further study may show them to warrant treatment as subtypes, but the boundaries between them may not be well marked and the floristic differences are not as strong as between the recognized subtypes.

1. Bluff/Slope Variant occurs on locally relatively steep or dissected lands near streams. Examples are well drained but may have seepage, grade to drier communities above, and probably were naturally subject to more frequent fire than the other subtypes.
2. Swamp Island Variant occurs on isolated ridges surrounded by wetter communities, generally nonriverine wetlands. Examples are usually small and remote from other examples. They must have limited gene flow for plants and sessile animals and may be depauperate (nevertheless, examples have the surprising presence of large-seeded species not shared with the surrounding

communities). Surrounding vegetation generally is not flammable, and this variant must rarely if ever burn naturally.

3. Upland Flat Variant occurs on very gentle rises on wet upland flats of the outer Coastal Plain or of relict high river terraces without flooding. Examples are often in a mosaic with marginal wetlands such as Nonriverine Wet Hardwood Forest, with which they can share some species, but they generally are not associated with drier communities. They may be more subject to high water tables than the other variants. Surrounding vegetation generally is not very flammable, but fire is more likely to occur occasionally than in the Swamp Island Variant.

**Dynamics:** Dynamics are generally similar to other Piedmont and Coastal Plain Mesic Forests. However, at least some examples of the Bluff/Slope Variant are at greater risk of fire because of their association with drier, more flammable upland vegetation. This subtype also is more subject to disturbance by hurricanes than the Piedmont Subtype, because it occurs closer to the coast and because soils are less dense.

**Comments:**

*Fagus grandifolia* - *Quercus alba* - *Quercus laurifolia* / *Galax urceolata* Forest (CEGL007863) has been described for Virginia and could possibly occur in NC. It is an unusual community, presumably strongly acidic. *Quercus laurifolia*, though common in floodplains in North Carolina, is rare in mesic forests. *Fagus grandifolia* - *Liquidambar styraciflua* - *Quercus (michauxii, nigra)* Forest (CEGL007866) is a Coastal Plain small stream bottom association of South Carolina and Georgia. Peet has assigned plots from the Roanoke River floodplain to it, which apparently would better fit in this subtype. *Fagus grandifolia* - *Quercus (alba, rubra)* - *Liriodendron tulipifera* / (*Ilex opaca* var. *opaca*) / *Polystichum acrostichoides* Forest (CEGL006075) is a Coastal Plain mesic forest of northern Virginia and northward but is not expected to occur in North Carolina.

**Rare species:**

**References:**

## **BASIC MESIC FOREST (PIEDMONT SUBTYPE)**

**Concept:** Basic Mesic Forests are forests of moist but not wet sites, with indicators of unusually high pH or base-rich soils. They are characterized by vegetation dominated or codominated by *Fagus grandifolia*, *Liriodendron tulipifera*, or *Quercus rubra* but lacking the more diverse montane flora of Montane Cove Forests. The Piedmont Subtype covers examples on Piedmont substrates, where *Quercus rubra* and other characteristic Piedmont species are present and characteristic Coastal Plain species are absent or scarce.

**Distinguishing Features:** Basic Mesic Forests are distinguished from Mesic Mixed Hardwood Forests by higher species richness and by the presence of multiple species that in the Piedmont and Coastal Plain are indicators of higher pH soils (e.g., *Actaea racemosa*, *Asarum canadense*, *Adiantum pedatum*, *Sanguinaria canadensis*, *Andersonglossum (Cynoglossum) virginianum*, *Cubelium (Hybanthus) concolor*, *Actaea pachypoda*, *Carpinus caroliniana*, *Fraxinus americana*, *Lindera benzoin*, and *Aesculus sylvatica*). Additional species are more widespread but tend to be more abundant in Basic Mesic Forest, such as *Cercis canadensis*, *Ostrya virginiana*, and *Acer floridanum*. Because many of the indicator species are herbs, it can be difficult to distinguish Basic Mesic Forests from Mesic Mixed Hardwood Forests in the winter. In addition, because many of them are present at low density, few may appear in plot data.

Rich Cove Forests contain most of the species that distinguish Basic Mesic Forests, but they contain a number of additional montane species that are lacking from Basic Mesic Forest. These include the trees *Aesculus flava*, *Tilia americana* var. *heterophylla*, *Halesia tetraptera*, and *Betula lenta*, and a number of additional herbs such as *Caulophyllum thalictroides*.

Basic Mesic Forests are distinguished from Piedmont Levee Forest (Beech Subtype), Piedmont Headwater Stream Forest, Piedmont Alluvial Forest, and other floodplain communities, which may contain similar tree species, by the absence of evidence of flooding and by the lack of characteristic floodplain plant species such as *Platanus occidentalis*, *Fraxinus pennsylvanica*, *Betula nigra*, and *Xanthorhiza simplicissima*. However, a number of species typical of floodplains are present on slopes in Basic Mesic Forest but not in Mesic Mixed Hardwood Forest (e.g., *Lindera benzoin*, *Elymus hystrix*, *Elymus virginicus*, and *Chasmanthium latifolium*).

The Piedmont Subtype is distinguished from the Coastal Plain Subtype by substrate and by a number of species that occur primarily in the Coastal Plain, at least in mesic uplands. Coastal Plain species include *Quercus nigra*, *Stewartia malacodendron*, *Aesculus pavia*, *Symplocos tinctoria*, *Gaylussacia frondosa*, *Ilex glabra*, and *Clethra alnifolia*. *Quercus rubra* is generally a good indicator of Piedmont flora. However, a number of species considered typical of the Piedmont occur as disjunct populations in the Coastal Plain in Mesic Mixed Hardwood Forests, including *Podophyllum peltatum*, *Epifagus virginiana*, and *Hamamelis virginiana*.

**Synonyms:** *Fagus grandifolia* - *Quercus rubra* / *Acer barbatum* - *Aesculus sylvatica* / *Actaea racemosa* - *Adiantum pedatum* Forest (CEGL008466).

Ecological Systems: Southern Piedmont Mesic Forest (CES202.342).

**Sites:** Most examples occur on steep slopes, bluffs, or ravines underlain by diabase, amphibolite, gabbro, or other mafic rocks, or by some metasedimentary formations, in dissected uplands along streams, where slope aspect or topographic sheltering create a cool microclimate and limit the spread of fire.

**Soils:** Soils in these communities are called “basic,” reflecting long usage of the term by North Carolina’s botanists. The species distinctly associated with them are widely recognized as indicating higher base status. However, the pH measured for CVS plots, as in most studies, is well below neutral, and the difference from Mesic Mixed Hardwood Forests is not as much as often implied (averaging 5.3 and 4.8 respectively in surface soils, 5.2 and 4.7 deeper). Average base saturation in surface soils similarly is 59% versus 43%. Calcium abundance, however, is much greater: 1327 ppm versus 455 ppm. Additional causes of this geologically-driven distinction may remain to be discovered.

Examples are mapped with a wide diversity of soils. Most frequent is Wilkes (Typic Hapludalf). Poindexter is also frequent, and there are several other Typic Hapludalfs mapped. A number of examples are mapped as Goldston (Typic Dystrudept) and some as other Alfisols. Those mapped as Pacolet (Typic Kanhapludult) presumably represent inclusions; those mapped as Chewacla (Fluvaquentic Dystrudept) may also represent inclusions or may indicate mesic river terraces.

**Hydrology:** Sites are well drained but moist due to topographic sheltering, cool slope aspects, and low slope position.

**Vegetation:** Forests generally are dominated by *Fagus grandifolia*, but sometimes by *Liriodendron tulipifera*, *Acer floridanum*, or *Quercus rubra*. Other canopy trees may include *Quercus alba*, *Fraxinus americana*, *Carya glabra*, *Carya ovata*, *Pinus taeda*, *Carya tomentosa*, and less often *Quercus velutina*, *Quercus shumardii*, *Juglans nigra*, and *Carya cordiformis*. The understory may be dominated by *Fagus grandifolia*, *Acer floridanum*, *Ostrya virginiana*, *Carpinus caroliniana*, *Asimina triloba*, *Magnolia tripetala*, or *Cornus florida*. Other understory species frequent in CVS plots include *Cercis canadensis*, *Prunus serotina*, *Morus rubra*, *Ulmus alata*, *Oxydendrum arboreum*, and *Nyssa sylvatica*. Shrubs generally are not dense. Frequent species are *Lindera benzoin*, *Euonymus americana*, and *Viburnum* spp. Other shrub and understory species indicative of Basic Mesic Forest include *Tilia americana* var. *caroliniana*, *Chionanthus virginiana*, *Celtis* sp., *Staphylea trifoliata*, *Hydrangea arborescens*, and *Styrax grandifolia*. The herb layer may be dense to sparse but includes a fairly diversity of species that include a number indicative of basic soil conditions. The most constant species include *Maianthemum racemosum*, *Galium circaezans*, *Botrypus virginianus*, *Arisaema triphyllum*, *Uvularia perfoliata*, *Polygonatum biflorum*, *Sanguinaria canadensis*, *Actaea racemosa*, and *Phryma leptostachya*. Additional species that sometimes are abundant include *Podophyllum peltatum*, *Phegopteris hexagonoptera*, *Amphicarpaea bracteata*, *Andersonglossum virginianum*, *Geranium maculatum*, *Elymus hystrix*, *Asarum canadense*, *Piptochaetium avenaceum*, and *Elymus virginicus*. Other species indicative of Basic Mesic Forest include *Cubelium concolor*, *Aquilegia canadensis*, *Agrimonia pubescens*, *Collinsonia canadensis*, *Iris cristata*, *Osmorhiza longistylis*, *Oxalis violacea*, *Thaspium barbinode*, and *Actaea pachypoda*. Other species fairly frequently occurring include *Tiarella cordifolia*, *Stellaria pubera*, *Eurybia divaricata*, *Nabalus altissima*, and *Epifagus virginiana*.

**Range and Abundance:** Ranked G3G4, but probably more appropriately G4. This community has numerous examples widely distributed throughout the Piedmont, though most are small patches confined to the intersection of mesic topographic settings with unusual rock types. The equivalent association ranges from Georgia to Virginia, with its northern range limit at the Nottoway River. A related association replaces it farther north.

**Associations and Patterns:** Basic Mesic Forests usually occur as small patch communities, occasionally as large patches. Many small examples are associated with diabase dikes, which produce narrow surface expressions of mafic rock. Basic Mesic Forests usually grade to Dry-Mesic Basic Oak—Hickory Forest or Dry Basic Oak—Hickory Forest above, and to floodplain communities below. Mesic Mixed Hardwood Forest may border them along slopes, often with fairly sharp boundaries marking geologic contacts.

**Variation:** Examples vary greatly in their dominant species and in their overall composition. Harry LeGrand, in several Natural Heritage Program reports, proposed recognition of subtypes with stronger and weaker basic character. Preliminary analysis of CVS plot data did not show consistent differences corresponding to proposed examples of the groups. Though not recognized here as subtypes, they are recognized as variants to allow use of the concepts and to encourage further investigation. The idea of a gradient in basic influence appears reasonable, but may be difficult to apply. The pool of indicator species, especially of the more basic variant, includes many species that have low constancy among sites. Many occur only sparsely within sites, and others are visible only early in the spring, making them unlikely to be detected in plots and often missed in whole-site species lists. Indeed, they appear in almost no CVS plots, even those sampled in places reported to have them.

1. Intermediate Variant is the common variant, containing only the more widespread and broadly tolerant circumneutral plant species such as *Adiantum pedatum*, *Sanguinaria canadensis*, *Cardamine concatenata*, and *Actaea racemosa*.
2. Basic Variant contains the more narrowly tolerant base-loving plant species such as *Cubelium (Hybanthus) concolor*, *Enemion biternatum*, *Trillium cuneatum*, *Dicentra cucullaria*, and *Aquilegia canadensis*. These sites presumably have soils with higher pH and base status, but no difference has been recognized in geologic substrates.

**Dynamics:** Dynamics are similar to the theme in general.

**Comments:** Peet and Christensen (1980) demonstrated the distinctness of Basic Mesic Forest vegetation in their analysis of Piedmont communities, calling them mesic eutrophic forests.

*Quercus rubra* / *Magnolia tripetala* - *Cercis canadensis* / *Actaea racemosa* - *Tiarella cordifolia* Forest (CEGL003949) is another basic mesic association that apparently overlaps this subtype.

**Rare species:** *Enemion biternatum*, *Euonymus atropurpureus*, others.

#### **References:**

Peet, R.K., and N.L. Christensen. 1980. Hardwood forest vegetation of the North Carolina Piedmont. Veroeff. Geobot. Inst. ETH, Stiftung Rubel, Zurich. 69. Heft: 14-39.

## **BASIC MESIC FOREST (COASTAL PLAIN SUBTYPE)**

**Concept:** Basic Mesic Forests are forests of moist but not wet sites, with indicators of unusually high pH or base-rich soils. They are characterized by vegetation dominated or codominated by *Fagus grandifolia*, usually along with *Liriodendron tulipifera*, and *Quercus alba*. The Coastal Plain Subtype is a community of bluffs or other fire-sheltered sites with Coastal Plain soils, generally containing characteristic Coastal Plain species as well as often having species more typical of inland areas.

**Distinguishing Features:** Basic Mesic Forests are distinguished from Mesic Mixed Hardwood Forests by higher species richness and by the presence of multiple species that in the Piedmont and Coastal Plain are indicators of higher pH soils (e.g. *Actaea racemosa*, *Adiantum pedatum*, *Sanguinaria canadensis*, *Carpinus caroliniana*, *Fraxinus americana*, *Ulmus rubra*, *Asimina triloba*, *Lindera benzoin*, and *Aesculus pavia*). Additional species are more widespread but tend to be more abundant in Basic Mesic Forest, such as *Ostrya virginiana* and *Acer floridanum*. A Basic Mesic Forest should have several members of this suite present in the site, and have them dispersed through the community. Because many of the indicator species are herbs, it can be difficult to distinguish Basic Mesic Forests in the winter. In addition, because many of them are present at low density, few may appear in plot data.

The Coastal Plain Subtype is distinguished from the Piedmont Subtype by occurring on Coastal Plain sediments and by floristic differences. Substrates may be rich alluvium on well-drained terrace slopes, soils influenced by limestone, or sandy soils with abundant shells. The interpretation of floristic differences is complex because these communities often harbor disjunct populations of plant species typical of the Piedmont. Plants frequently present in the Coastal Plain Subtype and scarce or lacking in the Piedmont Subtype include *Quercus shumardii*, *Quercus michauxii*, *Stewartia malacodendron*, and *Chasmanthium sessiliflorum*, along with the species listed above the distinguish the Coastal Plain Subtype of Mesic Mixed Hardwood Forest. Plants found in the Piedmont Subtype but scarcely or never in the Coastal Plain Subtype include *Cubelium (Hybanthus) concolor*, *Iris cristata*, *Hydrangea arborescens*, *Actaea pachypoda*, *Dicentra cucullaria*, *Collinsonia canadensis*, *Cardamine concatenata*, *Viburnum rafinesqueanum*, *Staphylea trifolia*, *Dirca palustris*, *Quercus muhlenbergii*, and *Carya carolinae-septentrionalis*, among others.

Basic Mesic Forests may share some species with Brownwater Levee Forest, but lack characteristic alluvial species such as *Platanus occidentalis*, *Acer negundo*, and generally *Celtis laevigata*.

Coastal Plain Marl Outcrop communities may be embedded in Basic Mesic Forest. They are distinguished by substantial cover of limestone ("marl"), with most vascular plants limited to rooting in crevices and soil pockets. Coastal Plain Marl Outcrops tend to be small, and often are shaded by trees of the adjacent Basic Mesic Forest.

**Synonyms:** *Fagus grandifolia* - *Quercus alba* - (*Acer barbatum*) / Mixed Herbs Forest (CEGL007206).

Ecological Systems: Southern Atlantic Coastal Plain Mesic Hardwood Forest (CES203.242).

**Sites:** Basic Mesic Forests occur on upland areas protected from fire. The Coastal Plain Subtype is primarily on north-facing river bluffs and ravine slopes with limestone close to the surface, occasionally on slopes of alluvial terraces that are now above flood levels.

**Soils:** As in the Piedmont Subtype, soils are higher in pH, base saturation, and content of calcium and other nutritive cations, but do not generally exceed neutral pH. Soil series mapped are quite variable. Recorded occurrences for which soils were noted included 11 series, of which none were in more than two sites. Most are Hapludults or Paleudults, a few are Endoaquults, and some are simply mapped as Dystrochrepts. Many of these examples may actually be on inclusions in the soil map unit.

**Hydrology:** Moisture levels are mesic overall, though local small areas with seepage are common in the Coastal Plain Subtype.

**Vegetation:** Forests are dominated by combinations of species that usually include *Fagus grandifolia* and often include *Quercus alba*, *Liriodendron tulipifera*, and *Carya tomentosa*, and sometimes include *Quercus shumardii*, *Quercus michauxii*, *Quercus nigra*, *Pinus taeda*, *Fraxinus americana*, *Acer floridanum*, and *Ulmus rubra*. Understory species typically frequent and abundant in CVS data are *Carpinus caroliniana*, *Acer floridanum*, *Cornus florida*, *Acer rubrum*, and *Ilex opaca*, less frequently *Asimina triloba*, *Stewartia malacodendron*, *Magnolia tripetala*, and *Oxydendrum arboreum*. Shrubs tend to be few, but may include *Hamamelis virginiana*, *Lindera benzoin*, *Symplocos tinctoria*, *Euonymus americana*, *Styrax grandifolia*, *Callicarpa americana*, and *Persea palustris*. Widespread vines of the Coastal Plain are frequent, including *Parthenocissus quinquefolia*, *Smilax rotundifolia*, *Muscadinia rotundifolia*, *Smilax glauca*, and *Toxicodendron radicans*. The herb layer is dense to moderate. *Polystichum acrostichoides* or *Mitchella repens* may form large patches. Other species that sometimes are abundant in plots include *Podophyllum peltatum*, *Adiantum pedatum*, *Amphicarpaea bracteata*, *Parthelypteris noveboracensis*, *Geranium maculatum*, and *Brachyelytrum erectum*. Other species are less frequent but are indicative of basic conditions, including *Sanguinaria canadensis*, *Solidago caesia*, *Endodeca serpentaria*, *Phryma leptostachya*, *Dichantheium boscii*, *Actaea racemosa*, *Melica mutica*, and *Aquilegia canadensis*.

**Range and Abundance:** The equivalent association is ranked G4, but should perhaps be G3. This community is rare in North Carolina, and almost all examples are small. The equivalent association ranges through South Carolina, and possibly into Georgia.

**Associations and Patterns:** This subtype occurs as small patches, associated with rare specialized site conditions. It may grade or abruptly transition to Mesic Mixed Hardwood Forest at the edge of the calcareous substrate. It may grade to Dry-Mesic Basic Oak—Hickory Forest on drier sites, and usually is bordered by a floodplain community below. Coastal Plain Marl Outcrop communities are embedded in a few examples.

**Variation:** There are two distinct variants of this subtype. These may warrant separate associations, but the floristic differences have not been adequately clarified.

1. Marl Outcrop Variant occurs on soils derived from or influenced by limestone.



2. Terrace Slope Variant occurs on slopes mantled with rich alluvial material on the edges of floodplain terraces.

**Dynamics:** Dynamics are generally similar to other Piedmont and Coastal Plain Mesic Forests. Some examples are more subject to fire than the Piedmont Subtype, because they are associated with flammable upland vegetation. This subtype is more subject to disturbance by hurricanes than in the Piedmont Subtype, because they are closer to the coast and because soils are less dense.

**Comments:** Few studies have been published that include the Coastal Plain Subtype. Sears (1966) addressed those along Island Creek.

**Rare species:** Vascular plants – *Camassia scilloides*, *Carex basiantha*, *Carex emmonsii*, *Carex jamesii*, *Enemion biterntum*, *Hackelia virginiana*, *Malaxis spicata*, *Ponthieva racemosa*, *Quercus austrina*, *Schisandra glabra*, *Scutellaria nervosa*, *Trillium sessile*, *Urtica chamaedryoides*, likely others.

**References:**

Sears, M.N. 1966. A floristic study of the limestone along Island Creek in Jones County, North Carolina. M.S. Thesis, UNC-Chapel Hill.

## PIEDMONT/COASTAL PLAIN HEATH BLUFF

**Concept:** Piedmont/Coastal Plain Heath Bluff is a community of cool microsites in the Piedmont and Coastal Plain, generally on north-facing bluffs, with a dense shrub layer dominated by *Kalmia latifolia*, *Rhododendron catawbiense*, or occasionally *Symplocos tinctoria*, generally under a mesic canopy.

**Distinguishing Features:** Piedmont/Coastal Plain Heath Bluffs are distinguished from Mesic Mixed Hardwood Forests by having a dense shrub layer dominated by *Kalmia latifolia*, *Rhododendron* sp., or *Symplocos tinctoria*. The first two shrub species generally occur as disjunct populations; however, individuals of them may be found at lower density in the adjacent mesic and dry-mesic forests.

Heath Bluffs grade conceptually into Acidic Cove Forests in the upper Piedmont, with *Rhododendron maximum* becoming a more prominent component and more montane flora being present. Substantial presence of *Tsuga canadensis*, *Betula lenta*, *Halesia tetraptera*, or *Liriodendron tulipifera*, predominating over *Quercus montana*, *Quercus alba*, or *Fagus grandifolia*, indicates Acidic Cove Forest.

The Heath Subtype of Piedmont Monadnock Forest also has a dense shrub layer of *Kalmia*, but may be distinguished by occurring on higher, more exposed rocky slopes, and by having a canopy dominated by *Quercus montana* and lacking more mesophytic trees.

**Synonyms:** *Fagus grandifolia* - *Quercus alba* / *Kalmia latifolia* - (*Symplocos tinctoria*, *Rhododendron catawbiense*) / *Galax urceolata* Forest (CEGL004539).  
Ecological Systems: Southern Piedmont Mesic Forest (CES202.342).

**Sites:** Heath Bluffs usually occur on steep north-facing slopes, often on stream bluffs, occasionally in sheltered ravines.

**Soils:** Soils may be any of those associated with Mesic Mixed Hardwood Forest, either Piedmont or Coastal Plain Subtype. Piedmont examples sometimes have small bedrock outcrops.

**Hydrology:** Sites are moist but well drained. They presumably stay moister than other mesic communities because of the cool slope aspect.

**Vegetation:** Vegetation usually has a forest structure but occasionally is a more open woodland. The canopy generally is dominated by *Fagus grandifolia*, alone or in combinations with *Quercus alba* or *Quercus montana*, less often with *Carya tomentosa*, *Carya glabra*, *Liriodendron tulipifera*, and a variety of other species. Predominant understory species are *Oxydendrum arboreum*, *Ilex opaca*, *Nyssa sylvatica*, *Acer rubrum*, and *Cornus florida*, with *Liquidambar styraciflua* often present. The shrub layer is dense. *Kalmia latifolia* strongly dominates in most examples, but a few examples are dominated or codominated by *Rhododendron catawbiense* or *Rhododendron maximum*. A few examples are dominated or codominated by *Symplocos tinctoria*. *Hamamelis virginiana* often is present. Various shrubs shared with adjacent communities are common, especially *Euonymus americana* and *Vaccinium pallidum*. Herbs are sparse beneath the dense

shrubs. *Galax urceolata* is most frequent, *Polystichum acrostichoides* and *Mitchella repens* are frequent, and *Epigaea repens*, *Hexastylis minor* and a variety of other species may occur.

**Range and Abundance:** The equivalent association is ranked G2G3, but G3 likely is appropriate. This community is uncommon in the Piedmont but is scattered throughout most of the region. It is rarer in the Coastal Plain but is scattered over a large area, including a few examples overlooking tidal creeks.

**Associations and Patterns:** Piedmont/Coastal Plain Heath Bluffs occur as small patch communities, associated with Mesic Mixed Hardwood Forest. They generally are bordered by a floodplain community below, and by Dry–Mesic Oak–Hickory Forest or Mesic Mixed Hardwood Forest above. Occasional examples are associated with basic communities or with cliff communities.

**Variation:** At least three variants can be recognized, based on the dominant shrub.

1. Mountain Laurel Variant is the most common variant, throughout the Piedmont and Coastal Plain. Its shrub layer is dominated by *Kalmia latifolia*.
2. Catawba Rhododendron Variant is dominated by *Rhododendron catawbiense*, with or without *Kalmia*. It apparently is limited to a cluster of sites in Orange and Durham counties. The disjunction is particularly notable because this species of *Rhododendron* is associated with higher elevations in the mountains.
3. Horse Sugar Variant is dominated by *Symplocos tinctoria*, usually with *Kalmia* but occasionally without it. It is confined to a few sites in the Coastal Plain.

**Dynamics:** Most aspects of dynamics are similar to other mesic forests. The distinctive characteristic of this community is the occurrence of disjunct populations of plants more typical of the Mountains, sometimes of animals as well. These populations are presumed to be relict since the Pleistocene, when they were more widespread in the Piedmont and Coastal Plain. They persist because of the cool microclimate of north-facing bluffs. However, it is notable that the disjunct species often are present beyond the cool bluff, in the adjacent forest. They presumably have spread there from the bluff, and this suggests that the confinement of these species to disjunct locations may be at least partly a result of factors other than the current climate. It is likely they were confined to the coolest bluffs at least partly by fire rather than by temperature alone. Not all cool bluffs support Heath Bluff communities, and it is likely that the warmer and drier Hypsithermal period eliminated their characteristic species from all but the most protected sites.

**Comments:** This community type barely ranges into Virginia. In much of the Virginia Piedmont, *Kalmia latifolia* is widespread in the oak-heath forests and is not confined to cool microsites. The Heath Bluff communities therefore grade into more widespread oak-heath forests, recognized in the NVC as *Quercus prinus* - (*Quercus coccinea*, *Quercus rubra*) / *Kalmia latifolia* / *Vaccinium pallidum* Forest (CEGL006299) and *Quercus alba* - *Quercus* (*coccinea*, *velutina*, *prinus*) / *Gaylussacia baccata* Forest (CEGL008521). A similar but less drastic blurring occurs in the Uwharrie Mountains, where *Kalmia* is more widespread in the landscape and occurs in other community types, but distinct occurrences of Piedmont/Coastal Plain Heath Bluff are still recognizable there. In the rest of the North Carolina Piedmont and Coastal Plain, *Kalmia latifolia* is scarce and is largely confined to this community type.

*Fagus grandifolia* - (*Liquidambar styraciflua*) / *Oxydendrum arboreum* / *Kalmia latifolia* Forest (CEGL004636) is a nonstandard entity in the NVC, based on results of the Roanoke River study by Rice, and Peet 1997) It is not clear that Roanoke River examples or most Coastal Plain examples are distinct from those in the Piedmont. However, some Coastal Plain examples contain a larger component of characteristic Coastal Plain species, usually including some wetland species that apparently are associated with seepage from the steep bluffs.

*Pinus echinata* - *Pinus virginiana* / *Rhododendron minus* - *Kalmia latifolia* Woodland (CEGL003563) was named as a slate slope community, based on a single site for which there is no community documentation. There is not enough evidence to support recognition of slate slopes as a distinctive type or subtype. This association, or the site on which it was based, may be best classified as a Piedmont/Coastal Plain Heath Bluff.

**Rare species:**

**References:**

Rice, S. K., and R. K. Peet. 1997. Vegetation of the Lower Roanoke River Floodplain. Unpublished report to The Nature Conservancy. 154 pp.

## CAPE FEAR VALLEY MIXED BLUFF FOREST

**Concept:** Cape Fear Valley Mixed Bluff Forests are rare shrubby forests or woodlands with a distinctive mixed composition of wetland and upland species and of Piedmont and Coastal Plain species, occurring on steep bluffs with a combination of seepage and good drainage, ameliorated microclimate, and natural sheltering from fire. These communities are associated with the unusual, deeply entrenched major tributaries on the west side of the Cape Fear River in the Sandhills Region: Little River, Rockfish Creek, and Willis Creek.

**Distinguishing Features:** Cape Fear Valley Mixed Bluff Forest is distinguished by its distinctive mixed dominance of upland and wetland trees, generally including *Quercus alba* or *Quercus nigra* along with *Chamaecyparis thyoides*, and comparably mixed dominance of shrubs, generally including *Kalmia latifolia*, mesophytic species such as *Hamamelis virginiana*, and wetland species such as *Cyrilla racemiflora*, *Lyonia lucida*, *Clethra alnifolia*, or *Arundinaria tecta*.

**Synonyms:** *Pinus taeda* - *Quercus alba* - *Chamaecyparis thyoides* / *Kalmia latifolia* - *Hamamelis virginiana* - *Lyonia lucida* Forest (CEGL004304).

Ecological Systems: Southern Atlantic Coastal Plain Mesic Hardwood Forest (CES203.242).

**Sites:** Cape Fear Valley Mixed Bluff Forests occur on steep slopes of clay and sand, along deeply entrenched valleys of small rivers. The geologic processes that have created their distinctive setting have not been well studied. The Cape Fear River in the vicinity of Fayetteville has cut deeply below its older floodplain terraces. This has induced several of the larger tributaries in the Sandhills region to cut deep gorge-like valleys into the underlying Cretaceous sediments, leaving relict floodplain terraces far above the stream.

**Soils:** Soils in this community are usually mapped as Gilead (Arenic Hapludult) and are a heterogeneous mix of sand and clay.

**Hydrology:** Moisture levels in this community are generally mesic but may be heterogeneous on a very fine scale. The vegetation is a mix of upland species with species largely confined to wetlands. The sandy cover at the top of the bluffs, and possibly interbedded sand layers within them, provide a source of seepage. The dense clay layers limit water penetration and may force seepage water to flow along the surface.

**Vegetation:** The canopy is usually dense but may be somewhat open. It is a diverse mix of trees, with *Chamaecyparis thyoides*, *Acer rubrum*, *Pinus taeda*, *Liquidambar styraciflua*, *Quercus alba*, and *Quercus nigra* usually present. Other species may include *Quercus falcata* in the upper parts and *Nyssa biflora* and *Fraxinus caroliniana* near the base. The understory usually includes *Magnolia virginiana*, *Ilex opaca*, and *Cornus florida*, and often also has *Oxydendrum arboreum*, *Persea palustris*, and sometimes *Hamamelis virginiana*, as well as canopy species. The shrub layer is dense. *Kalmia latifolia*, *Clethra alnifolia*, and *Lyonia lucida* are usually present. Also frequent and sometimes abundant are *Alnus serrulata*, *Vaccinium elliotii*, *Arundinaria tecta*, *Vaccinium arboreum*, *Ilex coriacea*, and *Symplocos tinctoria*. Other species sometimes present include *Leucothoe axillaris*, *Gaylussacia frondosa*, *Vaccinium tenellum*, *Rhododendron periclymenoides*, *Rhododendron viscosum*, *Rhododendron arborescens*, *Rhododendron*

*atlanticum*, *Nestronia umbellula*, *Itea virginica*, and, in one example, *Kalmia buxifolia*. Vines are not usually prominent, but *Bignonia capreolata*, *Smilax rotundifolia*, and *Smilax glauca* may be present. The herb layer is sparse. *Mitchella repens* is the most constant species, and *Viola primulifolia* and *Agrostis perennans* are frequent. Other herb species include *Erigeron vernus*, *Pteridium aquilinum*, *Hexastylis minor* (possibly *Hexastylis sorrei*), *Epigaea repens*, *Galax urceolata*, *Lygodium palmatum*, *Osmundastrum cinnamomeum*, *Steinchisma areolata*, and *Anchistea virginica*. Other species unusual to the region that have been reported in this community include *Trillium catesbaei*, *Maianthemum racemosum*, *Chionanthus virginicus*, *Gaultheria procumbens*, and *Amsonia tabernaemontana*.

**Range and Abundance:** Ranked G1G2, but likely G1. This community is endemic to small parts of four counties and to three small stream systems. The distinctive geologic setting that supports it is unlikely to be found elsewhere, at least in North Carolina.

**Associations and Patterns:** Cape Fear Valley Mixed Bluff Forests occur as narrow bands or series of small patches along stream bluff systems. Above the bluffs they give way to longleaf pine communities, usually Pine/Scrub Oak Sandhill. The bluffs may plunge directly into the stream, or they may be bordered by Cypress–Gum Swamp or other floodplain communities below. Coastal Plain Seepage Bank communities are sometimes associated.

**Variation:** Examples are heterogeneous and variable from one patch to another. No pattern of variation has been identified.

**Dynamics:** The dynamics of this community are particularly little known. As with Piedmont/Coastal Plain Heath Bluffs, the presence of *Kalmia latifolia* and some other disjunct species probably is relict from the Pleistocene. The heterogeneous distribution of seepage is presumably an important factor in the coexistence of so many species characteristic of different conditions. Though slumps are not readily apparent, it is possible that slumping or slope movement is a periodic natural disturbance.

The role of fire in the Mixed Bluff Forest is not known. They probably are excluded from present controlled burning, and examples do not show evidence of fire. Natural fires would burn the upper edges, and might occasionally penetrate the community, but as in other mesic forests, the steep slope and nonflammable vegetation below presumably limit fire intensity and frequency.

**Comments:** This is one of the most enigmatic of communities in North Carolina, and it appears not to have been reported before systematic natural heritage surveys of Fort Bragg in the 1990s. Its placement with mesic forests is marginal and somewhat problematic, but its odd mix of flora makes it a poor fit in any theme. It shares the most characteristics with Piedmont/Coastal Plain Heath Bluff, Coastal Plain Seepage Bank, Low Elevation Seep, and Sandhill Seep.

**Rare species:**

**References:**