GUIDE TO THE NATURAL COMMUNITIES OF NORTH CAROLINA
FOURTH APPROXIMATION

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INTRODUCTION

This document presents a revised framework for the classification of natural communities in North Carolina. Natural communities are central to the work of the Natural Heritage Program. Tracking occurrences of good examples of them comprises a major portion of the program's inventory and database work. Natural communities are important components of biodiversity. They also represent a crucial means of conserving species diversity, as they offer a means of capturing many of the poorly-known and un-tracked species that occur in them. The classification of natural communities has also proved useful for a variety of other purposes, including guiding research, organizing ecological information, characterizing sites, and defining habitat for particular species.

At this stage, the 4th Approximation is published in brief form, as a guide. The guide is a relatively brief document, intended to make the 4th Approximation concepts and units available to users as quickly as possible. Partially completed drafts have been in circulation for a number of years. This has provided the opportunity to test and to receive feedback on the majority of the units, and that feedback has been incorporated into this final, complete version. While the publication of the guides represents the official publication of the 4th Approximation by the Natural Heritage Program, a longer document, with more thorough descriptions and additional information, will follow.

DEFINITION OF NATURAL COMMUNITIES

A natural community is defined as:

> "a distinct and reoccurring assemblage of populations of plants, animals, bacteria, and fungi naturally associated with each other and their physical environment."

This definition remains the same as in previous versions of the North Carolina classification. It implies an attempt to account for a wide variety of ecological components, so that the units will represent differences in local-scale ecosystem function and structure, as well as differences in species composition. It implies that we seek to define units that are the result of the processes of nature, that differ in ways that are enduring and significant rather than trivial, and that would be found again in other places with similar environments.

Natural community classification considers a wide range of ecological characteristics, including vegetation composition and physiognomy, assemblages of animals or other organisms, topography, substrate, hydrology, soil characteristics, other enduring site characteristics, and prevailing natural disturbance regimes. It thus differs conceptually from classifications that are based solely on vegetation, such as the National Vegetation Classification. In practice, however, this large number of factors is tightly correlated, and the natural community units usually correspond well to units defined by the vegetation that exists in the most natural, least altered examples that can be found.

NEED FOR A NEW APPROXIMATION

The 3rd Approximation was published in 1990. Much new information, experience, and understanding have accumulated since that time. Indeed, the study of natural communities in North Carolina has expanded as never before. Natural Heritage Program inventories have found hundreds of new, good examples of natural communities. Numerous graduate studies and published scientific papers offer new

insights. The Carolina Vegetation Survey has been systematically amassing the largest set of vegetation plot data ever collected in the state. The National Vegetation Classification has developed, and offers different perspectives on the crucial vegetation component of natural communities in North Carolina and in other states. We now know of the importance of distinctions that were not recognized in 1990, we know of kinds of communities that we didn't know existed then, and we have better understanding of the nature of most of our communities.

Much remains to be learned about all of our natural communities and how they are related to each other. This edition of the classification, as previous ones, is called an approximation. This is meant to remind that user that, while it is the best synthesis of knowledge that can be offered at this time, and can be useful, our understanding will continue to evolve.

STRUCTURE OF THE 4TH APPROXIMATION CLASSIFICATION

The 4th Approximation is structured in the same way as the previous editions. The focal level is the type and subtype, which represent the scale at which biodiversity conservation should be addressed. The Natural Heritage Program tracks natural community occurrences for subtypes if they are defined, and for types where there are no subtypes. A finer, less formal level of division, called variants, is used to name units that are not well enough marked or well enough understood to be subtypes. Variants allow standardized recognition of such entities or groupings of occurrences, and offer a chance to "test out" ideas that may become subtypes in a later approximation. Some variants are noted in the guides, but a complete naming of the variants awaits the more thorough 4th Approximation document.

The community types are placed in biological themes. The 32 themes were defined in 1993 to provide a meaningful coarser ecological classification for purposes where that was needed. First published in the 1993 Natural Heritage Program Protection Plan, they have seen widespread use, including in the state parks system plans and the Wildlife Action Plan. Small changes have been made in them here to fit the 4th Approximation. This higher organization is a change from the informal ecological groups that were used in earlier approximations and in earlier drafts of the 4th Approximation. Using the ecological themes should increase the versatility of the 4th Approximation, offering meaningful classification entities at three levels over a great range in coarseness. As with the previous grouping, the themes are not a strict hierarchy. Some community types could as easily be placed in different theme.

While the 4th Approximation keeps most of the basic structure as the 3rd, there is a difference in balance. The 3rd Approximation had very few community types that were divided into subtypes. In the 4th Approximation, most community types have at least two subtypes, and many have several. Most of the new distinctions recognized in the 4th Approximation are at the subtype level, and most of the community types are unchanged or little changed from the 3rd Approximation.

CLASSIFICATION APPROACH

The 4th Approximation uses the same classification approach used in earlier editions. This approach is integrative, considering all the ecological characteristics that are known, and attempting to group them in ways that they are naturally correlated. The greatest emphasis is upon vegetation and upon readily observable aspects of the physical environment such as topography, elevation, and wetness. This is justified because plants are good indicators of the most important environmental influences, and integrate them over time. It is also necessary, because plants are most easily observable, and we have

much more information on them than on any other component. However, vegetation is interpreted in light of what it tells us about the environment and how that may be important for animals and other organisms. Differences in vegetation that indicate short-term fluctuations or human alteration are downplayed; those that indicate prevailing natural disturbance regimes, soil fertility, or moisture levels are emphasized. Conversely, aspects of the environment that can be seen to affect the flora are emphasized. Aspects of the environment considered likely to affect other biota without affecting vegetation may be used, but only if confidence in their importance is high.

Both quantitative and qualitative data were used, and both quantitative analysis and qualitative evaluation contributed to this classification. Much more quantitative data exist now than were available when the 3rd Approximation was done. The Carolina Vegetation Survey (CVS) data set was heavily used as a reference. New graduate studies that focus on the patterns of particular groups of communities or of the communities in particular sites, were used along with the older studies that informed the 3rd Approximation. Many of the National Vegetation Classification associations were based on similar quantitative studies. These analyses can reveal patterns that are not obvious in any other way. Some additional ad hoc analysis was done on subsets of the CVS database to answer specific classification questions for the 4th Approximation. At the same time, much need remained to use qualitative approaches as well. All existing quantitative analyses have a more limited focus than the 4th Approximation, either geographically or in the range of communities addressed. In addition, quantitative data and analysis can be misleading if data are not abundant enough for some kinds of communities. Work on the 4th Approximation therefore integrates the more extensive observations in Natural Heritage Program inventory reports, and the broader experience of myself and others, to extend understandings to a state-wide scale, to cover more fully the range of variation, and to address the many communities that do not have adequate quantitative representation.

Potential 4th Approximation types and subtypes were evaluated for suitability by a set of criteria:

- The unit represents a difference in enduring natural character, and is not just a short-lived part of a natural cycle. Communities that are parts of longer term, naturally shifting mosaics are recognized if they will persist for a number of years or if they will not likely return to the original state, while predictable and short-lived shifts are not recognized as different types. Thus, beaver ponds are recognized in the classification, while the differences in vegetation stature that follow fire in pocosins are considered part of natural temporal variation within the same type.
- The unit's distinctness is a result of natural environment and natural processes, and is not merely an artifact of a different history of human alteration. All existing community occurrences have at least some human alteration, and we seek to understand it. But we use the least altered existing examples and our knowledge of how things are altered to base classification on underlying natural characteristics.
- The differences between the unit and related units matter for biodiversity conservation. They are great enough that we would not consider the units interchangeable for conservation purposes, and would seek to protect examples of both.
- The occurrences of the unit are at the appropriate spatial scale to be conservation planning targets – ¼ acre to hundreds or potentially thousands of acres, depending on the physical structure and contrast with adjacent areas. Micro-ecosystems such as the mosses on fallen logs in forests or on individual boulders may have strong contrast but are too small to be practical conservation targets. (Being conservation planning targets does not mean that we seek to conserve them without their landscape context, just that we must think about them specifically to make sure they are conserved.)

- The unit is well enough understood that we would recommend conservation action on it. It is well enough understood that others can be told how to recognize it and to distinguish it from related units.

Two additional major considerations in developing the 4th Approximation were to minimize disruption to users of the 3rd Approximation, and to provide as much commonality with the National Vegetation Classification (NVC) as possible. Recognizing most of the new units at the subtype level, while keeping most community types unchanged, means that most users familiar with the 3rd Approximation should easily be able to transfer that knowledge. All NVC associations attributed to North Carolina were considered for creation of equivalent 4th Approximation types or subtypes. However, no such units were adopted without meeting the above tests. This led to substantial one-to-one correspondence with the NVC but not complete agreement.

Units in the classification are named with the intent of providing convenient, memorable titles by which to refer to the units, while minimizing confusion. No single form of names, such as all environmental names or all plant-based names, is used. Instead, the characteristics that are easiest or most concise to name are used. Some descriptors used in names must be interpreted in light of the common usage and range of variation in factors within North Carolina or within the range of similar community types. Thus, "xeric" refers to the driest conditions in North Carolina, even though desert regions elsewhere are drier. Similarly, “basic” is used as it is used by most North Carolina ecologists, as a convenient word for an intercorrelated set of characteristics that includes a higher soil pH (but not necessarily truly alkaline), higher content of “base” cations (compared to other upland sites but not to alluvial soils), and presence of a distinctive set of species that tend to occur on such soils and not elsewhere. It should be remembered, however, that names are merely “handles” and are not definitions. The user needs to learn the concepts of the units and not assume that the characteristics in the name are either necessary or sufficient to recognize the type. Thus, High Elevation Red Oak Forests will not naturally lack red oaks, but Dry Oak-Hickory Forests may occasionally have no hickories and Chestnut Oak Forest may occasionally be dominated by scarlet oak.

3rd Approximation names were changed only where there was a significant change in the concept of the type or where new understandings or past confusion made a compelling case for a different name. Most community type names remain the same, and for many changes, the connection to the old name should be apparent. A table of new names for which the 3rd Approximation equivalent name is not obvious is included at the end of this document.

4TH APPROXIMATION COMPONENTS AND TIMETABLE

The 4th Approximation guide is intended as a relatively brief document that will allow all users to begin to make use of the units and concepts. It is analogous to the many recent plant manuals that have keys to species and some comments but lack full descriptions. The guide is only the first of a series of products to be produced by the Natural Heritage Program for the 4th Approximation. The sequence of these is outlined below.

- 4th Approximation guides
- Conversion of Natural Heritage Program element occurrence database
- State element ranks (Sranks)
- 4th Approximation descriptive book
- Criteria for rating occurrences of different community types (EO rank specs)

- Beginning of work on the 5th Approximation.

A more thorough descriptive book for the 4th Approximation, comparable to the book for the 3rd Approximation, will be produced, but the guide has been produced first in order to get the new classification into use. The guide will be maintained as a briefer explanation of the classification than the descriptive book, one that may be preferred by some users. There will probably be an updated version of the guide when the descriptive book is published.

The primary information in the guide is a brief concept statement meant to highlight the essential distinctive features of each type and subtype, and a distinguishing features section that gives more specific information on how to tell each type and subtype from those most similar to it. There is also synonymy given for the NVC associations and to the NatureServe ecological systems. Synonyms for a few influential recent classification studies are also given, along with indications of major changes in names from the 3rd Approximation and from earlier drafts of the 4th Approximation guides. The NVC associations are almost always equally or more finely divided than subtypes. If possible, a single primary association has been chosen for the synonym, with the relationship to any others addressed in comments. The ecological systems are generally coarser, so each single ecological system will be synonymized to multiple types and subtypes. In addition, a subtype, as with NVC associations, may occur in more than one ecological system. A few references are cited, but more thorough citation of literature awaits the description book.

Nomenclature for plant species in the guide text follows Weakley (2011). Where well-known plant names have recently been changed, the older names are sometimes given in parentheses to help the reader. Name changes between Weakley and earlier published floras are so numerous that doing this systematically would unduly crowd the text and delay completion. Thus, parenthetical names are few, and they focus on the most recently changed names and on those most likely to be confusing. Note that the nomenclature in the NVC association names follows a different, older standard list. As these are the official names in the NVC, they have not been updated to follow Weakley. There thus are some differences in plant names between the synonyms and the rest of the text.

Spruce-Fir Forests

FRASER FIR FOREST (HERB SUBTYPE) G1

Synonyms: *Abies fraseri / Viburnum lantanoides / Dryopteris campyloptera - Oxalis montana / Hylocomium splendens* Forest (CEGL006049).
Ecological Systems: Central and Southern Appalachian Spruce-Fir Forest (CES202.028).

Concept: Type covers the highest mountain forests, in which *Abies fraseri* dominates. Subtype covers those examples without a substantial evergreen heath layer, which generally have deciduous shrubs and well-developed herb layers. Forests where *Abies fraseri* formerly dominated and has not regenerated may be regarded as degraded examples of this subtype or may be classified as successional communities. Forests where *Abies fraseri* canopies died and regenerated as very dense stands that have no shrub or herb layer are included in this subtype. A few natural forests dominated by *Sorbus americana* along with *Abies fraseri* are also included here.

Distinguishing Features: The Fraser Fir Forest type is theoretically distinguished from Red Spruce–Fraser Fir Forest and all other natural communities by having present or recent past natural dominance by *Abies fraseri*, making up 67 percent or more of the canopy cover. Because of widespread destruction of fir canopy by the balsam woolly adelgid, examples are now dominated by young fir trees or by successional vegetation of *Rubus allegheniensis* or other species. The presence of large numbers of dead conifer stems combined with absence or scarcity of other mature trees is generally sufficient to distinguish a damaged Fraser Fir Forest from other high elevation community types. Some Red Spruce–Fraser Fir Forests became dominated by *Abies fraseri* after logging in the early part of the century (Fraser fir more readily establishes in gaps than red spruce). These are particularly difficult to distinguish without historical data.

The Herb Subtype is distinguished from the Rhododendron Subtype by dominance of the lower strata by herbs or deciduous shrubs, rather than *Rhododendron* or other evergreen heaths.

Comments: A successional association, *Rubus canadensis* - (*Rubus idaeus ssp. strigosus*) / *Athyrium filix-femina - Solidago glomerata* Shrubland (CEGL003893), has been defined to cover examples of fir forests where canopy trees have died and not regenerated.

The dominance of fir without codominant spruce on the highest peaks has been noted in ecological literature for decades. Some spruce, and even birch, is generally present to the highest elevations, so the change in communities does not indicate a limit of physiological tolerance of the high elevation but only a shift in dominance. Given fir's greater ability to respond to canopy gaps, it may be driven by chronic exposure to severe disturbance. The distinction has been blurred by the widespread death of firs, and may become lost as the climate becomes warmer. However, it appears worth keeping for the present.

FRASER FIR FOREST (RHODODENDRON SUBTYPE) G1

Synonyms: *Abies fraseri / (Rhododendron catawbiense, Rhododendron carolinianum*) Forest (CEGL006308).
Ecological Systems: Central and Southern Appalachian Spruce-Fir Forest (CES202.028).

Concept: Subtype covers those examples with canopies dominated by *Abies fraseri* and with a substantial evergreen heath layer, usually *Rhododendron catawbiense*. These are generally associated with more exposed topography, such as sharp ridge tops.

Distinguishing Features: The Rhododendron Subtype is distinguished from the Herb Subtype by having a well-developed shrub layer dominated by *Rhododendron* or other evergreen heaths in places with exposed topography. Exposed high mountain sites with large numbers of dead trees and dominance by *Rhododendron* can be assumed to be degraded examples of this subtype.

Comments: This subtype appears to be quite rare, occurring only as small patches within a matrix of the Herb Subtype. It is not present in many ridge top locations, and may be additionally tied to shallow soils, particularly sharp topography, or edges of rock outcrops. It has usually not been distinguished in earlier reports, which makes it hard to tell how much may have once been present.

RED SPRUCE–FRASER FIR FOREST (HERB SUBTYPE) G2

Synonyms: *Picea rubens - (Abies fraseri) / Vaccinium erythrocarpum / Oxalis montana - Dryopteris campyloptera / Hylocomium splendens* Forest (CEGL007131).
Ecological Systems: Central and Southern Appalachian Spruce-Fir Forest (CES202.028).

Concept: Type covers high mountain forests in which *Picea rubens* (or occasionally *Sorbus americana*), with or without *Abies fraseri* or hardwoods, are naturally dominant. Subtype covers the most common examples with canopies of primarily *Picea rubens*, with or without *Abies fraseri*, only minor amounts of other trees, and lower strata consisting of deciduous shrubs, herbs, and mosses.

Distinguishing Features: The Red Spruce–Fraser Fir Forest type is distinguished from all other communities by a canopy dominated or codominated by *Picea rubens* or *Sorbus americana* occurring on high mountains. The Spruce Subtype of Swamp Forest–Bog Complex is distinguished by valley bottom location and saturated soils. The Fraser Fir Forest type has more the 67 percent canopy cover of *Abies fraseri*, either presently or before balsam woolly adelgid mortality.

The Herb Subtype is distinguished from the Rhododendron Subtype and Low Rhododendron Subtype by dominance of the lower strata by herbs or deciduous shrubs, rather than *Rhododendron* spp. It is distinguished from the Birch Transition Subtype by having less than 33 percent *Betula alleghaniensis* cover in the canopy, counting gaps recently occupied by now-dead *Abies fraseri*. The Herb Subtype is distinguished from the Boulderfield Subtype, which also has a deciduous shrub, herb, and moss undergrowth, by having boulder cover less than 90 percent, having a richer herb layer, and having *Ribes* spp., *Polypodium appalachianum*, and other boulderfield species present in no more than small numbers.

Comments: The communities of this subtype are the most widely regarded as typical spruce-fir forests and have received the most study. It appears to be the most abundant subtype. This subtype occurs primarily in North Carolina and Tennessee, but extends into Virginia. Communities that are regarded as the same association occur in West Virginia on the highest peaks.

RED SPRUCE–FRASER FIR FOREST (RHODODENDRON SUBTYPE) G1
Synonyms: *Picea rubens* - (*Abies fraseri*) / (*Rhododendron catawbiense, Rhododendron maximum*) Forest (CEGL007130).
Ecological Systems: Central and Southern Appalachian Spruce-Fir Forest (CES202.028).

Concept: Subtype covers those examples with a substantial evergreen heath layer, generally associated with more exposed topography.

Distinguishing Features: The Rhododendron Subtype is distinguished from the Low Rhododendron Subtype by occurrence at higher elevations, in topographically exposed sites, and having the evergreen shrub layer dominated by *Rhododendron catawbiense* or *Rhododendron carolinianum* rather than *Rhododendron maximum*. It is distinguished from the Herb Subtype and Boulderfield Subtype by having a well-developed shrub layer dominated by *Rhododendron*. It is distinguished from the Birch Transition Subtypes by having less than 33percent cover of these tree species in the canopy.

Comments: As with the Rhododendron Subtype of Fraser Fir Forest, the subtype appears to be very rare and is often absent even on exposed ridge tops. Some literature suggests it is part of a regularly occurring community pattern, but this may not be the case.

RED SPRUCE–FRASER FIR FOREST (BOULDERFIELD SUBTYPE) G1
Synonyms: *Picea rubens / Ribes glandulosum* Forest (CEGL007128).
Ecological Systems: Central and Southern Appalachian Spruce-Fir Forest (CES202.028).

Concept: Subtype covers *Picea*-dominated boulderfields. Well-developed boulderfields have near 100 percent ground cover of large rocks, with soil present only locally. Plants capable of rooting in moss mats or shallow soil make up most of the community. This subtype is transitional to the Boulderfield Forest type of lower elevations, but is more similar to other spruce-fir forests than lower elevation boulderfields are to Northern Hardwood Forests.

Distinguishing Features: The Boulderfield Subtype is distinguished from all other subtypes by having large rocks covering most of the ground (more than 90 percent) and lower strata composed largely of boulderfield plant species such as *Ribes glandulosum, Polypodium appalachianum,* and mosses. While many spruce-fir forests of all subtypes are rocky and have shallow soil, this subtype is reserved for the rare extreme setting of well-developed boulderfields.

Comments: This may be the rarest of Spruce–Fir forest subtypes. Well-developed examples are known only from Grandfather Mountain.

RED SPRUCE–FRASER FIR FOREST (BIRCH TRANSITION HERB SUBTYPE) G2
Synonyms: *Picea rubens - (Betula alleghaniensis, Aesculus flava) / Viburnum lantanoides / Oxalis montana - Solidago glomerata* Forest (CEGL006256).
Ecological Systems: Central and Southern Appalachian Spruce-Fir Forest (CES202.028).

Concept: Subtype covers forests in the broad transition zone on open slopes, where Red Spruce–Fraser Fir Forest grades to Northern Hardwood Forest with a fairly even mix of *Betula alleghaniensis* and

Picea rubens, and where a dense ericaceous shrub layer is absent. This is the lower elevation equivalent of the Herb Subtype.

Distinguishing Features: The Birch Transition Herb Subtype is distinguished from most other subtypes by canopy composition, which naturally includes more than 33percent cover of *Betula alleghaniensis* and more than 33 percent cover of *Picea rubens* in a well-developed, undisturbed canopy. It is distinguished from the Birch Transition Shrub Subtype by having lower strata of deciduous shrubs and herbs, instead of evergreen shrubs. It is distinguished from the Boulderfield Subtype by having less than 90 percent boulder cover and having only small amounts of characteristic boulderfield species.

RED SPRUCE–FRASER FIR FOREST (BIRCH TRANSITION SHRUB SUBTYPE) G1?
Synonyms: *Picea rubens - (Betula alleghaniensis, Aesculus flava) / Rhododendron (maximum, catawbiense)* Forest (CEGL004983).
Ecological Systems: Central and Southern Appalachian Spruce-Fir Forest (CES202.028).

Concept: Subtype covers forests in the broad transition zone on open slopes, where Red Spruce–Fraser Fir Forest grades to Northern Hardwood Forest with a fairly even mix of *Betula alleghaniensis* and *Picea rubens*, and where a dense ericaceous shrub layer is present. The shrub layer is usually *Rhododendron catawbiense* or *Rhododendron maximum*, but in the Smokies, *Leucothoe fontanesiana* may dominate.

Distinguishing Features: The Birch Transition Shrub Subtype is distinguished from most other subtypes by canopy composition, which includes more than 33 percent cover of *Betula alleghaniensis* and more than 33 percent cover of *Picea rubens* in a well-developed canopy. It is distinguished from the Birch Transition Herb Subtype by having a dense evergreen shrub layer rather than deciduous shrubs and herbs.

Comments: The association corresponding to this subtype was created for vegetation in the Great Smoky Mountains. It is unclear if it occurs in any other parts of North Carolina. It may only questionably be distinct from the Low Rhododendron Subtype.

RED SPRUCE–FRASER FIR FOREST (LOW RHODODENDRON SUBTYPE) G2?
Synonyms: *Picea rubens - (Tsuga canadensis) / Rhododendron maximum* Forest (CEGL006152).
Ecological Systems: Central and Southern Appalachian Spruce-Fir Forest (CES202.028).

Concept: Subtype covers spruce-dominated or -codominated forests of lower elevation, topographically sheltered sites. *Rhododendron maximum* generally dominates the undergrowth.

Distinguishing Features: The Low Rhododendron Subtype is distinguished from all other subtypes by having a well-developed shrub layer dominated by *Rhododendron maximum*, occurring in a lower elevation, sheltered setting. *Tsuga canadensis* occasionally is codominant in the canopy. *Rhododendron maximum* may sometimes be present on higher, more exposed topography in the Rhododendron Subtype, but will usually be mixed with *Rhododendron catawbiense*.

Comments: Early versions of the 4th approximation recognized a Hemlock Subtype at lower elevations. This has been lumped into this subtype. The NVC association corresponding to it, *Picea rubens - Tsuga canadensis / Rhododendron maximum* Forest (CEGL006272), has also been lumped. Most examples of this subtype occur as part of a mosaic of spruce–fir forests in the highest mountain ranges. However, unusual examples of this subtype occur without other spruce-fir forests in lower elevation sites at Alarka Laurel and Long Hope Valley.

This subtype occurs in West Virginia, as well as presumably in Tennessee and Virginia.

Grass and Heath Balds

GRASSY BALD (GRASS SUBTYPE) G1

Synonyms: *Danthonia compressa - (Sibbaldiopsis tridentata)* Herbaceous Vegetation (CEGL004242).
Ecological Systems: Southern Appalachian Grass and Shrub Bald (CES202.294).

Concept: Type covers naturally, or apparently naturally, non-forested high mountain complexes dominated by grasses and sedges, sometimes with *Alnus viridis* var. *crispa* forming a shrub layer above them. Subtype covers examples dominated by grasses, primarily *Danthonia compressa*. Forbs such as *Sibbaldiopsis tridentata* may be abundant or even locally dominant. Most Grassy Balds now also contain areas of invading *Rubus* spp., shrubs, or trees. Heavily pastured balds now dominated by exotic pasture species are classified as anthropogenic or successional types. Successional communities clearly resulting from forest clearing and pasturing may be dominated by *Danthonia compressa*, but should not included here.

Distinguishing Features: Grassy Balds are distinguished from other natural communities by the natural dominance of dense herbaceous vegetation in high elevation upland sites with deep soils. High Elevation Rocky Summit communities may contain small patches of herbaceous vegetation with some of the same species, but contain substantial bare rock. High Elevation Mafic Glades and Low Elevation Acidic or Basic Glades contain more grass but are clearly related to shallow soil. Many Grassy Bald communities have been invaded by *Rubus* spp. or shrubs and are no longer herb-dominated. They may be regarded as successional types or as degraded Grassy Balds. Areas with shrub dominance are treated as Grassy Balds unless the shrubs have become dense enough to eliminate the herbaceous layer.

The Grass Subtype is distinguished from the Sedge Subtype by dominance by grasses, usually *Danthonia compressa*, rather than *Carex* spp.

Comments: The previous distinction between a Northern Grass Subtype (*Danthonia compressa - Sibbaldiopsis tridentata* Herbaceous Vegetation (CEGL004258)) and Southern Grass Subtype has been dropped.

GRASSY BALD (SEDGE SUBTYPE) G1

Synonyms: *Carex pensylvanica* Herbaceous Vegetation (CEGL004094).
Ecological Systems: Southern Appalachian Grass and Shrub Bald (CES202.294).

Concept: Subtype covers portions of larger Grassy Balds that are dominated by sedges. Sedge-dominated areas resulting from recent forest clearing should not be included.

Distinguishing Features: The Sedge Subtype is distinguished from the Grass Subtype by the dominance of *Carex* spp.

Comments: This subtype may be only marginally distinct. The widespread alteration of Grassy Bald communities by grazing, woody plant invasion, and later management make the distinguishing of appropriate herbaceous dominance problematic.

GRASSY BALD (ALDER SUBTYPE) G1
Synonyms: *Alnus viridis ssp. crispa / Carex pensylvanica* Shrubland (CEGL003891).
Ecological Systems: Southern Appalachian Grass and Shrub Bald (CES202.294).

Concept: Subtype covers examples dominated by *Alnus viridis* var. *crispa*, often with *Danthonia compressa* and other herbaceous species beneath at low to moderate density. This subtype is confined to the Roan Mountain highlands.

Distinguishing Features: The Alder Subtype is distinguished from all other communities in North Carolina by the dominance of *Alnus viridis* var. *crispa*.

Comments: This community was treated under Heath Bald in the 3rd approximation. However, it occurs in close association with Grassy Bald, and contains many Grassy Bald herbs beneath the shrub canopy, which is often fairly open. All Heath Bald subtypes have dense shrub canopies with almost no herbaceous presence.

The dynamics of this subtype in relation to the other subtypes at Roan Mountain are somewhat unclear. Alder is believed to have spread into formerly open Grass Subtype and possibly Sedge Subtype, but this is not entirely clear. At the same time, the Alder Subtype has also been invaded by *Rubus* and by the same woody species that are encroaching on the other subtype, and is threatened by them.

HEATH BALD (CATAWBA RHODODENDRON SUBTYPE) G2
Synonyms: *Rhododendron catawbiense* Shrubland (CEGL003818).
Ecological Systems: Southern Appalachian Grass and Shrub Bald (CES202.294).

Concept: Type covers naturally, or apparently naturally, non-forested high mountain communities dominated by shrubs in the Ericaceae. Subtype covers examples dominated by *Rhododendron catawbiense*, with or without abundant *Kalmia latifolia* or *Vaccinium* spp., generally on high elevation narrow ridgetops, broad high elevation domes, or in smaller patches bordering rock outcrops.

Distinguishing Features: Heath Balds are distinguished from all other community types by the dominance of dense shrubs (other than *Alnus viridis* var. *crispa*), with natural absence or near absence of tree cover, in topographically exposed, high elevation, convex slope sites. Shrub-dominated communities created by the burning of spruce-fir forests should be treated as successional vegetation rather than as Heath Balds. They generally are less dense, have more irregular physiognomy that includes herb patches and young trees, and have a larger component of deciduous shrubs. Other natural shrub communities are either wetlands in valley bottoms or seeps, or are in streamside settings. Rock

outcrop communities often have patches of shrubs of the same species as Heath Balds, and the distinction can be difficult. Classification as Heath Bald should be reserved for shrub communities not associated with substantial rock outcrops, or to exceptionally large patches associated with rock outcrops (comparable to the open rock in extent).

The Catawba Rhododendron Subtype is distinguished from all other subtypes by the dominance of *Rhododendron catawbiense* with few other shrub species, particularly without those species that distinguish the other subtypes. This subtype may be confined to north of the Asheville Basin, where *Pieris floribunda* is absent.

HEATH BALD (CAROLINA RHODODENDRON SUBTYPE) G2
Synonyms: *Rhododendron carolinianum* Shrubland (CEGL003816).
Ecological Systems: Southern Appalachian Grass and Shrub Bald (CES202.294).

Concept: Subtype covers examples strongly dominated by *Rhododendron carolinianum*, occurring on quartzite or potentially on other rocks but not on slate.

Distinguishing Features: The Carolina Rhododendron Subtype is distinguished from most other subtypes by the strong dominance of *Rhododendron carolinianum*. It occurs at somewhat lower elevation, associated with pine communities rather than spruce-fir or northern hardwood forests. The Slate Subtype of the Great Smoky Mountains has *Rhododendron carolinianum* dominating in combination with other species, usually in more open stands.

Comments: The concept of this subtype has been narrowed by the creation of the Slate Subtype. *Rhododendron carolinianum* has a very patchy distribution, and is not even present in most Heath Balds. Communities where it dominates are rare. This subtype may exist only at Linville Gorge, but may be found in a few other places.

HEATH BALD (SOUTHERN MIXED SUBTYPE) G1
Synonyms: *Rhododendron catawbiense - Pieris floribunda* Shrubland (CEGL004516).
Ecological Systems: Southern Appalachian Grass and Shrub Bald (CES202.294).

Concept: Subtype covers high elevation examples containing *Pieris floribunda* as well as other shrubs, usually codominant with *Rhododendron catawbiense*. This subtype is confined to south of the Asheville Basin.

Distinguishing Features: The Southern Mixed Subtype is distinguished from all other subtypes by the substantial presence of *Pieris floribunda*, though it may not dominate. Other Heath Balds at high elevations south of Asheville and codominated by other evergreen shrub species (other than *Kalmia latifolia*) may also be classified here.

Comments: This subtype, originally intended to cover several southern variations, has been narrowed by the creation of the Slate Subtype. This subtype reportedly does not occur in the Great Smoky Mountains.

HEATH BALD (SLATE SUBTYPE) G1
Synonyms: *Rhododendron carolinianum - Rhododendron catawbiense - Leiophyllum buxifolium* Shrubland (CEGL007876).
Ecological Systems: Southern Appalachian Grass and Shrub Bald (CES202.294).

Concept: Subtype covers examples occurring on slate in the Great Smoky Mountains. The vegetation is somewhat more mixed and more open than most other subtypes.

Distinguishing Features: The Slate Subtype is distinguished by its occurrence on slate substrate and by vegetation.

Comments: This association was created by NatureServe to cover examples in the Great Smoky Mountains. It may be narrowly defined. It is somewhat unclear how distinct it is from the Carolina Rhododendron Subtype. Both quartzite and the sulfidic slate of the Great Smoky Mountains form extremely acidic soils. The slate is also prone to landslides and is less stable. Both characteristics may make for distinctive vegetation.

HEATH BALD (SAND MYRTLE SUBTYPE) G1
Synonyms: *Leiophyllum buxifolium* Dwarf-shrubland (CEGL003951).
Ecological Systems: Southern Appalachian Grass and Shrub Bald (CES202.294).

Concept: Subtype covers examples dominated by *Kalmia buxifolia (= Leiophyllum buxifolium).*

Distinguishing Features: The Sand Myrtle Subtype is distinguished by the strong dominance of *Kalmia buxifolia* over the whole community. It is distinguished from rock outcrop communities, which may contain moderatesized patches of *Kalmia buxifolia* by covering a larger area and having the area of the community dominated by shrub cover rather than rock or herbs.

HEATH BALD (LOW ELEVATION SUBTYPE) G2G3
Synonyms: *Kalmia latifolia - Rhododendron catawbiense - (Gaylussacia baccata, Pieris floribunda, Vaccinium corymbosum*) Shrubland (CEGL003814).
Ecological Systems: Southern Appalachian Grass and Shrub Bald (CES202.294).

Concept: Subtype covers lower elevation examples, dominated by *Kalmia latifolia*.

Distinguishing Features: The Low Elevation Subtype is distinguished from the Catawba Rhododendron Subtype by having a larger amount of *Kalmia latifolia,* making up more than 50 percent of cover, along with the presence of associated lower elevation species such as *Rhododendron maximum, Quercus rubra, Quercus prinus,* rather than high elevation species such as *Picea rubens, Abies fraseri,* and *Sorbus americana*. It lacks significant amounts of *Pieris floribunda* or *Kalmia buxifolia (= Leiophyllum buxifolium).*

Comments: These communities may be relatively short-lived communities related to fire, and it is uncertain how closely related they are to other Heath Bald subtypes. *Photinia melanocarpa - Gaylussacia baccata / Carex pensylvanica* Shrubland (CEGL008508) is a G1? association defined in

Virginia and stated to potentially occur in North Carolina. It is described as a mosaic of shrub, herbs, and bare rock, so it would not be considered a Heath Bald. *Menziesia pilosa - Vaccinium (erythrocarpum, simulatum, corymbosum) - Sorbus americana* Shrubland [Provisional] (CEGL004819) has been defined for Mount Rogers. Communities like it may occur in North Carolina, and may represent a distinctive subtype most closely related to this subtype.

Northern Hardwood Forests

NORTHERN HARDWOOD FOREST (TYPIC SUBTYPE) G3G4

Synonyms: *Betula alleghaniensis - Fagus grandifolia - Aesculus flava / Viburnum lantanoides / Eurybia chlorolepis - Dryopteris intermedia* Forest (CEGL007285).
Ecological Systems: Southern Appalachian Northern Hardwood Forest (CES202.029).

Concept: Type covers forests of exposed to sheltered sites at mid to high elevations, dominated by mesophytic hardwoods. Subtype covers the common examples that have a mixed canopy of moderate diversity but lack a rich cove-like herb layer and some of the other trees of richer soils.

Distinguishing Features: The Northern Hardwood Forest community type is distinguished from High Elevation Birch Boulderfield Forest by having less than 90 percent boulder cover and having most of the plants of lower strata rooted in soil rather than on rock. It is distinguished from most other types by having a canopy dominated by combinations of *Betula alleghaniensis, Fagus grandifolia, Aesculus flava,* and *Acer saccharum*. The distinction from Rich Cove Forest and Acidic Cove Forest can be difficult because these types share many species in all strata and the gradation is particularly gradual. Northern Hardwood Forests (especially the Typic Subtype) lack low elevation species characteristic of Rich Cove Forests, such as *Liriodendron tulipifera, Magnolia fraseri, Magnolia acuminata, Ostrya virginiana,* and *Cornus florida*. Northern Hardwood Forest species that are uncommon or absent in Rich Cove Forests are fewer, but include *Viburnum lantanoides, Rhododendron catawbiense,* and *Picea rubens*. The transition between the two types is generally around 4000 feet in North Carolina, but may shift substantially with slope aspect and latitude.

The Typic Subtype is distinguished from the Beech Gap Subtype by having a canopy not strongly dominated by *Fagus grandifolia*. It is distinguished from the Rich Subtype by having lower plant diversity, especially in the herb layer but often also in the canopy, and lacking the rich-site species. Trees characteristic of the Rich Subtype but seldom in the Typic Subtype include *Fraxinus americana, Tilia americana var. heterophylla,* and *Prunus serotina*.

Comments: The boundary between Rich Cove Forest and Northern Hardwood Forest is particularly gradual, and is one of the most difficult of common community boundaries to define. This has led some authors, including Whittaker (1956), to decline to use the traditional term Northern Hardwood Forest, calling them Upper Cove Forest instead. However, the central concept of Northern Hardwood Forest, on open, often convex slopes at high elevation, with a reduced and distinctly high elevation flora, is quite distinct from the typical Rich Cove Forest.

NORTHERN HARDWOOD FOREST (RICH SUBTYPE) G3

Synonyms: *Aesculus flava - Betula alleghaniensis - Acer saccharum / Acer spicatum / Caulophyllum thalictroides - Actaea podocarpa* Forest (CEGL004973).

Ecological Systems: Southern Appalachian Northern Hardwood Forest (CES202.029).

Concept: Subtype covers examples with rich, cove-like herb layers, generally occurring on mafic substrate or in sheltered high elevation coves.

Distinguishing Features: The Rich Subtype is distinguished from the other subtypes by having a dense, diverse herb layer sharing many species with Rich Cove Forests, and often also by having several additional canopy species shared with them. These include *Fraxinus americana, Tilia americana var. heterophylla,* and *Prunus serotina*.

Comments: The boundary between Rich Cove Forest and Northern Hardwood Forest is one of the most difficult of common community boundaries to define. This is particularly true of the Rich Subtype, which shares more species, and which may extend into high elevation concave slopes at the heads of coves. More work is needed to clarify the best indicators for this boundary. There is a somewhat repeatable forest of *Fraxinus americana, Prunus serotina,* and *Acer saccharum* that occurs in some high elevation coves, which may be distinctive enough to recognize as a subtype or variant, but this needs more study.

NORTHERN HARDWOOD FOREST (BEECH GAP SUBTYPE) G1
Synonyms: *Fagus grandifolia / Carex pensylvanica - Ageratina altissima var. roanensis* Forest (CEGL006130).
Ecological Systems: Southern Appalachian Northern Hardwood Forest (CES202.029).

Concept: Subtype covers examples with canopies strongly dominated by *Fagus grandifolia,* typically occurring at very high elevation, usually as small areas around ridge top gaps at very high elevations, but sometimes on open peaks.

Distinguishing Features: The Beech Gap subtype is distinguished from other Northern Hardwood Forests by having a canopy strongly dominated by *Fagus grandifolia,* with *Aesculus flava* being the only other common species. The trees are generally stunted, but not necessarily so. The herb layer may be either a lawn of *Carex pensylvanica* or dominated by forbs.

Comments: A separate forb-dominated Beech Gap community was recognized in earlier versions of the 4th approximation guide, as well as in the NVC. This distinction has been dropped, as most examples appear to be mixes of sedges and forbs. The former association, *Fagus grandifolia / Ageratina altissima var. roanensis* Forest (CEGL006246), has been lumped into this one.

HIGH ELEVATION BIRCH BOULDERFIELD FOREST G3 [should be G2]
Synonyms: Boulderfield Forest. *Betula alleghaniensis / Ribes glandulosum / Polypodium appalachianum* Forest (CEGL006124).
Ecological Systems: Southern Appalachian Northern Hardwood Forest (CES202.029).

Concept: Type covers vegetated boulderfields at high elevations (generally above 4000 feet), with canopies strongly dominated by *Betula alleghaniensis,* and some component of high elevation species. Well-developed boulderfields have near 100 percent ground cover of large rocks, with soil present only

locally. Plants capable of growing on rock, or rooting in moss mats or shallow soil, are the majority, and overall species richness is low.

Distinguishing Features: High Elevation Birch Boulderfield Forests are distinguished from the Boulderfield Subtype of Rich Cove Forest by higher elevation and lower species richness. Most High Elevation Birch Boulderfield Forests are strongly dominated by *Betula alleghaniensis* and some have no other canopy trees. Rich Cove Forest boulderfields have a mix of species of Rich Cove Forests, though *Betula alleghaniensis* is often abundant at lower elevations than it is otherwise common. *Tilia americana var. heterophylla* is usually particularly abundant, but *Fraxinus americana, Liriodendron tulipifera*, and other species are usually also present. High Elevation Birch Boulderfields are generally above 4000 feet, though some Rich Cove Forests may extend a bit higher in elevation. High Elevation Birch Boulderfields lack low elevation species such as *Aristolochia macrophylla* and *Ribes cynosbati*, and often have minor amounts of higher elevation species such as *Picea rubens, Sorbus americana, Sambucus racemosa (= Sambucus pubens),* and *Viburnum lantanoides*.

Mountain Cove Forests

RICH COVE FOREST (MONTANE INTERMEDIATE SUBTYPE) G4

Synonyms: *Liriodendron tulipifera - Fraxinus americana - (Tilia americana, Aesculus flava) / Actaea racemosa - Laportea canadensis* Forest (CEGL007710).
Ecological Systems: Southern and Central Appalachian Cove Forest (CES202.373).

Concept: Type covers mesic forests of low to middle elevations, containing a rich montane herbaceous flora. They generally occur on concave land surfaces, which may include north-facing and lower slopes as well as cove bottoms. Subtype covers examples of middle elevations, generally 2000 to 4500 feet, lacking a significant component of high pH, rich-site flora.

Distinguishing Features: The Rich Cove Forest type is distinguished by dominance of some mixture of mesophytic trees and a fairly rich to very rich herb layer. Trees common in Rich Cove Forest and scarce to absent in Acidic Cove Forest include *Aesculus flava, Fraxinus americana, Tilia americana var. heterophylla*, and *Magnolia acuminata*. Less common trees absent in Acidic Cove Forests include *Juglans nigra, Carya ovata*, and *Cladrastis kentukea (= Cladrastis lutea). Liriodendron tulipifera, Acer rubrum, Tsuga canadensis*, and *Betula* spp. are shared by Rich Cove Forest and Acidic Cove Forest. Herbs present in Rich Cove Forest and absent or scarce in Acidic Cove Forest include *Actaea racemosa (= Cimicifuga racemosa), Caulophyllum thalictroides, Prosartes lanuginosa, Aruncus dioicus, Adiantum pedatum, Collinsonia canadensis, Osmorhiza claytonii*, and *Laportea canadensis*. Acidic Cove Forests generally have a better developed shrub layer dominated by *Rhododendron maximum* or *Leucothoe fontanesiana*, which is often present but not abundant in Rich Cove Forests. Most of the small number of herbaceous species of Acidic Cove Forest (e.g., *Polystichum acrostichoides, Medeola virginiana*, and *Viola canadensis*) may also occur in Rich Cove Forest.

Rich Cove Forest is distinguished from Northern Hardwood Forest, with which it shares a similar vegetation structure and many species, by containing lower elevation species in addition to the common species. Tree species found in Rich Cove Forests but generally absent in Northern Hardwood Forests include *Liriodendron tulipifera, Magnolia acuminata, Juglans nigra*, and *Ulmus* spp. *Fraxinus americana* and *Tilia americana var. heterophylla* are also absent from most Northern Hardwood Forests. Rich Cove Forests are distinguished from the Mesic Mixed Hardwood Forests and Basic Mesic

Forests of the Piedmont by having a large component of montane flora; montane species may be present in Basic Mesic Forests, but generally only a few species at a given site and at low density. *Fagus grandifolia* is almost always a major component of the Piedmont communities, and *Tilia americana var. heterophylla, Aesculus flava, Magnolia acuminata, Betula alleghaniensis*, and *Betula lenta* are indicators of Rich Cove Forest.

The Montane Intermediate Subtype is distinguished from the Montane Rich Subtype by the absence or scarcity of the most calciphilic species, such as *Diplazium pycnocarpon, Asplenium rhizophyllum, Dryopteris goldiana, Aquilegia canadensis*, and *Acer nigrum*. It is distinguished from the Foothills Subtypes by higher elevation, generally above 2000 feet, and by floristic differences that include the lack of lower elevation species such as *Liquidambar styraciflua*. The Montane Intermediate Subtype generally has denser and more diverse herb layers than the Foothills Intermediate Subtype.

Comments: The Rich Cove Forests are one of the most complex groups of communities to classify in the Southern Blue Ridge, due to a combination of wide environmental range, high species richness, and high biogeographic variability. This division into four subtypes based on fertility and elevation, along with two additional subtypes for specialized rocky sites, appears to work well, but needs further clarification of how to define the boundaries precisely. The boundary with Northern Hardwood Forest is also extremely gradual and difficult to define.

RICH COVE FOREST (MONTANE RICH SUBTYPE) G3G4

Synonyms: *Aesculus flava - Acer saccharum - (Fraxinus americana, Tilia americana var. heterophylla) / Hydrophyllum canadense - Solidago flexicaulis* Forest (CEGL007695).
Ecological Systems: Southern and Central Appalachian Cove Forest (CES202.373).

Concept: Subtype covers examples of middle elevations, generally 2000-4500 feet, containing flora indicative of the most fertile, high pH conditions.

Distinguishing Features: The Montane Rich Subtype is distinguished from the Montane Typic Subtype by floristic differences that are believed to correlate with soil pH and fertility. These differences are primarily in the herb layer, and include the presence of calciphilic species such as *Asplenium rhizophyllum, Aquilegia canadensis, Dryopteris goldiana, Cystopteris protrusa,* and *Diplazium pycnocarpon*. Woody calciphilic species include *Philadelphus hirsutus* and *Acer nigrum*. Additional species, such as *Asarum canadense* and *Hydrophyllum canadense* tend to be more abundant in the Montane Rich Subtype. The Montane Rich Subtype is distinguished from the Foothills subtypes by higher elevation, generally above 2000 feet, and by corresponding floristic differences.

Comments: This subtype is intended to cover the uncommon richest examples. The boundary between this subtype and the Montane Intermediate Subtype in classifying plot data has become confused and needs further clarification. The corresponding NVC association has sometimes been interpreted more broadly in NatureServe projects. These projects of limited geographic scope included few of the most fertile sites.

RICH COVE FOREST (FOOTHILLS INTERMEDIATE SUBTYPE) G4?
Synonyms: *Liriodendron tulipifera - Tilia americana var. heterophylla - (Aesculus flava) / Actaea racemosa* Forest (CEGL007291).
Ecological Systems: Southern and Central Appalachian Cove Forest (CES202.373).

Concept: Subtype covers examples at low elevations, generally below 2000 feet, lacking a significant component of high pH, rich-site flora. The herbaceous layer of this subtype is fairly diverse, much more diverse than that of Acidic Cove Forest, but is often not as dense as it is in the other subtypes.

Distinguishing Features: The Foothills Intermediate Subtype is distinguished from the Foothills Rich Subtype by the absence of strongly calciphilic species, such as *Aquilegia canadensis, Trillium simile, Asplenium rhizophyllum*, and *Cystopteris protrusa*. Some species shared by the Montane Intermediate and Foothills Rich subtypes, such as *Laportea canadensis*, are also absent or scarce. The Foothills Intermediate Subtype is distinguished from the Montane subtypes by the presence of lower elevation species.

Comments: There are a few occurrences of communities that fall between this subtype and Acidic Cove Forest. They generally have canopies of primarily *Liriodendron*, with a few of the other Rich Cove Forest canopy species. They have few or no heaths, but have herb layers with only a few species not found in Acidic Cove Forests, generally *Brachyelytrum erectum, Phegopteris hexagonoptera, Amphicarpaea bracteata, Ageratina altissima var. altissima*, and *Dichanthelium boscii*. These will be treated as a Transitional Variant, but probably represent too fine a level of variation to recognizes as an additional subtype.

RICH COVE FOREST (FOOTHILLS RICH SUBTYPE) G2G3
Synonyms: *Tilia americana var. heterophylla - Fraxinus americana - (Ulmus rubra) / Sanguinaria canadensis - (Aquilegia canadensis, Asplenium rhizophyllum)* Forest (CEGL007711).
Ecological Systems: Southern and Central Appalachian Cove Forest (CES202.373).

Concept: Subtype covers examples at low elevations, generally below 2000 feet, containing a significant component of high pH, rich-site flora.

Distinguishing Features: The Foothills Rich Subtype is distinguished from the Foothills Intermediate Subtype by the presence of strongly calciphilic species such as *Asplenium rhizophyllum, Aquilegia canadensis, Cystopteris protrusa*, and *Trillium simile*. Some additional species common in both Montane subtypes are present in the Foothills Rich Subtype and absent or scarce in the Foothills Intermediate Subtype, including *Laportea canadensis, Asarum canadense*, and *Hydrophyllum canadense*.

RICH COVE FOREST (RED OAK SUBTYPE) G3
Synonyms: *Quercus rubra - Tilia americana var. heterophylla - (Halesia tetraptera var. monticola) / Collinsonia canadensis - Prosartes lanuginosa* Forest (CEGL007878).
Ecological Systems: Southern and Central Appalachian Cove Forest (CES202.373).

Concept: Subtype covers uncommon forests of intermediate-elevation, steep, rocky cove heads, where *Quercus rubra* dominates the canopy but the composition is otherwise similar to Rich Cove Forest. While the composition is intermediate between typical Rich Cove Forest and oak forests, these communities are tied to specialized rocky sites rather than being true ecotonal communities.

Distinguishing Features: The Red Oak Subtype is distinguished from the preceding subtypes by occurrence on rocky slopes at mid elevations and by dominance of *Quercus rubra*. It is distinguished from the Boulderfield Subtype by having less complete rock cover and having a richer herb layer which consists mostly of typical Rich Cove Forest species. It is distinguished from Montane Oak–Hickory Forest (Basic Subtype) by occurring in sheltered topographic settings, having a richer presence of Rich Cove Forest species, and generally lacking *Quercus alba*. While *Fraxinus americana* and some other mesophytic tree species occur in Montane Oak–Hickory Forest (Basic Subtype), most of the associated woody species are more characteristic of drier sites. While a number of herbs are shared with Rich Cove Forests, those in Montane Oak–Hickory Forest (Basic Subtype) are a subset of those found in all the Rich Cove Forest subtypes. The Red Oak Subtype is distinguished from High Elevation Red Oak Forest (Rich Subtype) by occurrence at mid elevations and in more sheltered topography, and by floristic differences similar to those distinguishing Montane Oak–Hickory Forest. *Tilia, Carya cordiformis, Astilbe biternata, Osmorhiza* spp., *Monarda didyma, Thalictrum clavatum,* and *Arnoglossum muehlenbergii* are some species characteristic of this subtype that are not typical of the rich oak forest communities.

Comments: This subtype was initially recognized in plot studies in the Great Smoky Mountains. It now appears to be more widespread in North Carolina, but is apparently rare or uncommon. Most patches are small, but a few of 10-20 acres and one of about 100 acres have been reported.

RICH COVE FOREST (BOULDERFIELD SUBTYPE) G3

Synonyms: *Betula alleghaniensis - Tilia americana var. heterophylla / Acer spicatum / Ribes cynosbati / Dryopteris marginalis* Forest (CEGL004982).
Ecological Systems: Southern and Central Appalachian Cove Forest (CES202.373).

Concept: Subtype covers forests of strongly boulder-covered sites, having Rich Cove Forest flora but with composition different because of high boulder cover. Plants are rooted between or on top of rocks, in small soil pockets. In general, the canopy and especially the understory are more open and canopy gaps larger because sites for tree rooting are limited. The herb layer is much less dense; vines and plants capable of rooting on rocks are more abundant while herbs needing deep soil are confined to limited microsites. They may occur on relict periglacial boulderfields on north-facing slopes, or may occur on stable talus slopes below cliffs.

Distinguishing Features: The Boulderfield Subtype is distinguished from all other subtypes of Rich Cove Forest by having boulder cover of 90 percent or more, with an herb layer having less than 50 percent cover under undisturbed natural conditions. This is generally accompanied by a greater abundance of woody vines. Herbs that can root in shallow soil or directly on rocks are increased in abundance, though most common Rich Cove Forest herbs are present in limited microsites. *Betula alleghaniensis* and *Tilia americana var. heterophylla* are often very abundant in the Boulderfield Subtype, more so than in other subtypes. This subtype should be used only for well-developed

boulderfields. Many Rich Cove Forests of all subtypes occur on colluvial soils with abundant boulders, but most do not have enough boulder cover to affect community composition.

The Boulderfield Subtype is distinguished from High Elevation Birch Boulderfield Forest by a much richer flora, which overall is very similar to other Rich Cove Forests. *Betula alleghaniensis* often is the most abundant tree in both, but in the Boulderfield Subtype of Rich Cove Forest several other mesophytic tree species and a number of Rich Cove Forest herbs are also present. High Elevation Birch Boulderfield Forests generally occur at higher elevations; however, the Boulderfield Subtype can occur at higher elevations than other Rich Cove Forests subtypes, and may be bordered by Northern Hardwood Forest on adjacent exposed slopes.

Comments: This subtype is not divided by elevation into montane and foothills groups, and indeed can extend up to elevations more typical of Northern Hardwood Forest. Division by elevation may prove warranted in the future, but it appears that the more extreme environment of boulderfields overrides elevational effects in this subtype. Other variations, such as an odd example in Madison County dominated by *Tsuga canadensis*, but otherwise rich, may warrant recognition as variants. These communities appear to be less distinct from typical Rich Cove Forests than the High Elevation Birch Boulderfield Forest type is from Northern Hardwood Forests; they are treated as a subtype, but may warrant recognition as a full type.

ACIDIC COVE FOREST (TYPIC SUBTYPE) G5

Synonyms: *Liriodendron tulipifera - Betula lenta - Tsuga canadensis / Rhododendron maximum* Forest (CEGL007543).

Ecological Systems: Southern and Central Appalachian Cove Forest (CES202.373). Also attributed to Appalachian (Hemlock)-Northern Hardwood Forest (CES202.593). This may not be appropriate.

Concept: Type covers mesic forests dominated by combinations of acid-tolerant mesophytic trees, primarily *Liriodendron tulipifera, Betula lenta, Tsuga canadensis, Acer rubrum,* or *Betula alleghaniensis* with acid-tolerant undergrowth generally dominated by *Rhododendron maximum* or *Leucothoe fontanesiana*. These communities occur at low to mid elevations in the mountain region and foothills, generally in coves, gorges, or sheltered slopes. Subtype covers the common examples in most of the Blue Ridge of North Carolina, where *Halesia tetraptera* is not a significant component.

Distinguishing Features: Acidic Cove Forests are distinguished from the closely related Canada Hemlock Forest type by having a mixed canopy in which *Tsuga canadensis* does not dominate. They are distinguished from Rich Cove Forests by the absence or near absence of plants that require richer or less acidic soils. Trees such as *Aesculus flava, Tilia americana var. heterophylla, Acer saccharum,* are present in only minor quantities if at all. Likewise rich cove herbs such as *Actaea racemosa (= Cimicifuga racemosa), Caulophyllum thalictroides, Actaea pachypoda,* and *Adiantum pedatum* are absent or nearly so. All species of Acidic Cove Forests also occur in Rich Forests, though not as abundantly. Acidic Cove Forests are distinguished from Northern Hardwood Forests by the presence of low elevation species such as *Betula lenta* and *Liriodendron tulipifera* and generally by a more depauperate herb layer.

The Typic Subtype is distinguished from the Silverbell Subtype by lacking *Halesia tetraptera* or having it only as a minor component. It is distinguished from the High Elevation Subtype by elevation and by

having a canopy with a mix of species that does not include *Betula alleghaniensis* as dominant or codominant.

Acer rubrum - Betula (alleghaniensis ,lenta) - Magnolia fraseri / (Rhododendron maximum, Kalmia latifolia) Forest (CEGL008558) is an association that appears to overlap the concept of both subtypes of Acidic Cove Forest. It may represent a disturbed or successional version.

ACIDIC COVE FOREST (HIGH ELEVATION SUBTYPE) G3G4Q
Synonyms: *Betula alleghaniensis - (Tsuga canadensis) / Rhododendron maximum / (Leucothoe fontanesiana)* Forest (CEGL007861).
Ecological Systems: Southern Appalachian Northern Hardwood Forest (CES202.029).

Concept: Subtype covers examples at higher elevations, where *Betula alleghaniensis* becomes prominent. This subtype extends up into the elevational range of Northern Hardwood Forests, and is somewhat intermediate between them and Acidic Cove Forest.

Distinguishing Features: The High Elevation Subtype is distinguished by the significant presence of *Betula alleghaniensis* in the canopy. It may extend up to 4400 feet or even higher, but may occur below 4000 feet as well.

Comments: Extensive areas of this community, with *Leucothoe fontanesiana* shrub layers, are present around Mount LeConte in the Great Smoky Mountains. It is unclear how abundant they are in North Carolina. Examples tend to be small in extent and usually have dense *Rhododendron maximum* shrub layers without any *Leucothoe*. The global rank may more appropriately be G3.

Acer rubrum - Betula (alleghaniensis, lenta) - Magnolia fraseri / (Rhododendron maximum, Kalmia latifolia) Forest (CEGL008558) is an association that appear to overlap the concept of both subtypes of Acidic Cove Forest. It may represent a disturbed or successional version.

ACIDIC COVE FOREST (SILVERBELL SUBTYPE) G2
Synonyms: *Tsuga canadensis - Halesia tetraptera - (Fagus grandifolia, Magnolia fraseri) / Rhododendron maximum / Dryopteris intermedia* Forest (CEGL007693).
Ecological Systems: Southern and Central Appalachian Cove Forest (CES202.373).

Concept: Subtype covers examples of the southwestern ranges of the Blue Ridge, in which *Halesia tetraptera* is a significant component. It is known from the Tennessee side of the Great Smoky Mountains and from Joyce Kilmer-Slickrock Wilderness, but may be found elsewhere in southwestern North Carolina.

Distinguishing Features: The Silverbell Subtype is distinguished from the other subtypes by having a significant component of *Halesia tetraptera* in the canopy. It may have a somewhat more diverse flora than other Acidic Cove Forest subtypes and be somewhat transitional to Rich Cove Forest.

CANADA HEMLOCK FOREST (TYPIC SUBTYPE) G3G4
Synonyms: *Tsuga canadensis / Rhododendron maximum - (Clethra acuminata, Leucothoe fontanesiana)* Forest (CEGL007136).
Ecological Systems: Southern and Central Appalachian Cove Forest (CES202.373).

Concept: Forests dominated by *Tsuga canadensis*, with acid-tolerant undergrowth and low species richness. These forests occur in coves, gorges, or on sheltered slopes and share many species with Acidic Cove Forests. Occasional groves of *Tsuga canadensis* in Rich Cove Forests or other community types are not included here.

Distinguishing Features: Canada Hemlock Forest is distinguished by having *Tsuga canadensis* constituting more than 50 percent of the canopy in a mesic but not wet environment. Acidic Cove Forests usually have significant *Tsuga canadensis* in the canopy and often have a *Tsuga* understory but have a predominance of hardwoods. *Tsuga canadensis* may also be abundant in Swamp Forest–Bog Complex, but may be distinguished by the wetland setting and associated wetland species. *Pinus rigida, Nyssa sylvatica*, and a variety of wetland herbs occur in Swamp Forest–Bog Complex but rarely in Canada Hemlock Forest. Rich Cove Forest, Montane Alluvial Forest, and the Silverbell Subtype of Northern Hardwood Forest sometimes have *Tsuga canadensis* codominant locally. The Typic Subtype is distinguished from the White Pine subtype by lacking natural occurrence of *Pinus strobus*.

Comments: With the widespread mortality of *Tsuga canadensis* from hemlock wooly adelgid, the future fate of these communities, and their future distinctiveness, is in doubt. The most likely short-term outcome is for understory hardwood species to assume canopy dominance, perhaps along with rhododendron. In time, if hemlock wooly adelgid remains established, these communities will likely become indistinguishable from Acidic Cove Forest. However, because none of this is certain, for the present, forests that were dominated by *Tsuga* that is now dead should be regarded as Canada Hemlock Forests.

CANADA HEMLOCK FOREST (WHITE PINE SUBTYPE) G4
Synonyms: *Pinus strobus - Tsuga canadensis / Rhododendron maximum - (Leucothoe fontanesiana)* Forest (CEGL007102).
Ecological Systems: Appalachian (Hemlock)-Northern Hardwood Forest (CES202.593).

Concept: Forests dominated by a mixture of *Tsuga canadensis* and *Pinus strobus*. These forests occur in coves, gorges, or on sheltered slopes.

Distinguishing Features: Canada Hemlock Forest (White Pine Subtype) is distinguished from all other communities by having *Tsuga canadensis* and *Pinus strobus* codominant in the canopy. Associated canopy species and undergrowth are generally the same as in Canada Hemlock Forest (Typic Subtype) but somewhat different from in White Pine Forest. This subtype should be applied only for mixtures that are apparently of natural origin. Forests in which white pine was planted, where it is not believed to previously have been a component, should be regarded as altered examples of the Typic Subtype.

Comments: The distinction between this subtype and the Typic Subtype is one of the more uncertain and marginal distinctions recognized in the 4th approximation. But it may now be becoming more relevant,

as the presence of white pine may lead to a different ecological trajectory after hemlock mortality caused by hemlock wooly adelgid.

Piedmont and Coastal Plain Mesic Forests

MESIC MIXED HARDWOOD FOREST (PIEDMONT SUBTYPE) G3G4

Synonyms: *Fagus grandifolia - Quercus rubra / Cornus florida / Polystichum acrostichoides - Hexastylis virginica* Forest (CEGL008465).
Ecological Systems: Southern Piedmont Mesic Forest (CES202.342).

Concept: Type covers mesic hardwood forests of acidic north slopes and other sheltered sites in the Piedmont and Coastal Plain, dominated by combinations of *Fagus grandifolia, Quercus nigra, Liriodendron tulipifera, Quercus rubra,* or species of similar moisture tolerance but lacking the more diverse components of Rich Cove Forest or Acidic Cove Forest. Species of drier or wetter sites, such as *Quercus alba* or *Quercus michauxii,* are often present and may be abundant.

Subtype covers Piedmont examples, where *Quercus rubra* and other characteristic Piedmont species are present and characteristic Coastal Plain species are absent or scarce.

Distinguishing Features: The Mesic Mixed Hardwood Forest type is distinguished by a canopy dominated by mesophytic hardwoods while lacking indicators of higher pH soils. They also lack evidence of flooding and do not have a significant component of montane flora. *Fagus grandifolia* is nearly always present and distinguishes it from all related Piedmont and Coastal Plain upland communities except Basic Mesic Forest.

Mesic Mixed Hardwood Forest is distinguished from Piedmont Levee Forest (Beech Subtype), Piedmont Headwater Stream Forest, and other floodplain communities by the absence of evidence of flooding and by the lack of characteristic floodplain plant species. It may be 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. Such indicators are primarily herbs, and include *Actaea racemosa (= Cimicifuga racemosa), Asarum canadense, Adiantum pedatum, Sanguinaria canadensis, Hybanthus concolor,* and *Actaea pachypoda*. *Ostrya virginiana, Carpinus caroliniana, Fraxinus americana,* 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*.

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.

Comments: A few Coastal Plain examples are known that might better fit this subtype. The NVC association synonymized to this subtype is recognized as extending into the Coastal Plain in northern Virginia.

It has been suggested that mesic forests on very steep slopes may be a distinctive subtype. While this doesn't appear to be distinctive enough to be a subtype, it is treated as a Bluff Variant for now. It has a similar canopy, with *Fagus* typically dominant, but has some different species associated with shallow soil and greater drainage. These include *Hydrangea arborescens, Cunila origanoides, Epigaea repens, Solidago arguta, Hexastylis minor,* and *Silene virginica*. The Typic Variant has plants of deeper soils, such as *Polystichum acrostichoides, Podophyllum peltatum, Tiarella cordifolia, Cardamine angustata, Geranium maculatum,* and *Erythronium umbilicatum*.

MESIC MIXED HARDWOOD FOREST (COASTAL PLAIN SUBTYPE) G3
Synonyms: *Fagus grandifolia - Quercus (alba, nigra) / Symplocos tinctoria* – (*Stewartia malacodendron*) Forest (CEGL007211).
Ecological Systems: Southern Atlantic Coastal Plain Mesic Hardwood Forest (CES203.242).

Concept: Type covers mesic hardwood forests of acidic bluffs and other fire-sheltered sites in the Piedmont and Coastal Plain, dominated by combinations of *Fagus grandifolia, Quercus nigra, Liriodendron tulipifera, Quercus rubra,* or species of similar moisture tolerance but lacking the more diverse, less acid-tolerant components of Basic Mesic Forest and Rich Cove Forest, as well as lacking the montane flora of Acidic Cove Forest. Some component of *Quercus alba, Quercus michauxii,* or other species of more dry or more wet sites may be intermixed.

Subtype covers Coastal Plain examples, 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. A few examples with more Piedmont-like flora may occur in the northern Coastal Plain.

Distinguishing Features: The Mesic Mixed Hardwood Forest type is distinguished by a canopy dominated by mesic hardwoods while lacking indicators of higher pH soils and of flooding and lacking significant montane flora. *Fagus grandifolia* is nearly always present and distinguishes this from all related Piedmont and Coastal Plain upland communities other than Basic Mesic Forest. Mesic Mixed Hardwood Forest may be distinguished from Piedmont Alluvial Forest by lacking any significant component of floodplain species or indicators of flooding. It may be 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. Such indicators are primarily herbs. The large suite of species typical of Basic Mesic Forest and not Mesic Mixed Hardwood Forest include *Actaea racemosa (= Cimicifuga racemosa), Asarum canadense, Adiantum pedatum, Sanguinaria canadensis, Hybanthus concolor,* and *Actaea pachypoda*. *Ostrya virginiana, Carpinus caroliniana, Fraxinus americana, Aesculus sylvatica,* 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, Woodwardia areolata,* and *Osmundastrum (Osmunda) cinnamomeum*.

Comments: Three variants are distinguished: Bluff/Slope, Swamp Island, and Upland Flat. 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.

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. *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. *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.

BASIC MESIC FOREST (PIEDMONT SUBTYPE) G3G4

Synonyms: *Fagus grandifolia - Quercus rubra / Acer barbatum - Aesculus sylvatica / Actaea racemosa - Adiantum pedatum* Forest (CEGL008466).
Ecological Systems: Southern Piedmont Mesic Forest (CES202.342).

Concept: Type covers mesic forests of base-rich soils in the Piedmont and Coastal Plain, occurring on north-facing slopes or in other sheltered sites, and dominated by combinations of *Quercus rubra, Liriodendron tulipifera, Fagus grandifolia,* and mesophytic oaks. Subtype covers examples in the Piedmont, occurring on mafic rock or occasional calcareous substrates and lacking characteristic Coastal Plain flora.

Distinguishing Features: The Basic Mesic Forest type is distinguished by the combination of a canopy of mesophytic hardwoods and the presence of indicators of higher pH soils, along with the absence of montane species that would indicate Rich Cove Forest. *Fagus grandifolia,* virtually always present in Mesic Mixed Hardwood Forest, often is absent in Basic Mesic Forest. The indicators of base-rich soils are a fairly large suite of plants which typically occur with low constancy among sites and at moderate to low density. These include *Actaea racemosa (= Cimicifuga racemosa), Asarum canadense, Adiantum pedatum, Sanguinaria canadensis, Hybanthus concolor, Actaea pachypoda, Dicentra cucullaria*, and number of others. A Basic Mesic Forest should have several members of this suite present in the site, and have them well dispersed through the community. Because these indicators occur at low density, and some are spring ephemerals, Basic Mesic Forests may be hard to distinguish from Mesic Mixed Hardwood Forests on the basis of single plots.

The Piedmont Subtype is distinguished by occurring on crystalline rock substrates and by floristic differences. Plants present in the Coastal Plain Subtype and lacking in the Piedmont Subtype include *Quercus nigra, Stewartia malacodendron, Symplocos tinctoria, Gaylussacia frondosa, Ilex glabra,* and *Clethra alnifolia*.

Comments: There are two recognized variants which differ in amount of apparent basic influence. The Intermediate Variant contains only the more widespread and broadly tolerant circumneutral plant species such as *Adiantum pedatum, Sanguinaria canadensis, Cardamine concatenata,* and *Actaea racemosa (= Cimicifuga racemosa).* The Basic Variant includes these, sometimes in greater abundance, but also includes more narrowly tolerant base-loving plant species such as *Hybanthus concolor, Enemion biternatum, Trillium cuneatum, Dicentra cucullaria,* and *Aquilegia canadensis*. The advisability of recognizing these as subtypes is under investigation. Preliminary analysis of plot data collected by the Carolina Vegetation Survey does not show a strong distinction in vegetation. However, additional data collected in 2011 may change the picture.

This association ranges into southern Virginia, with its range limit at the Nottoway River.
Quercus rubra / Magnolia tripetala - Cercis canadensis / Actaea racemosa - Tiarella cordifolia Forest (CEGL003949) is another basic mesic association that apparently overlaps this subtype.

BASIC MESIC FOREST (COASTAL PLAIN SUBTYPE) G4
Synonyms: *Fagus grandifolia - Quercus alba - (Acer barbatum)* / Mixed Herbs Forest (CEGL007206).
Ecological Systems: Southern Atlantic Coastal Plain Mesic Hardwood Forest (CES203.242).

Concept: Type covers mesic forests of circumneutral or higher pH soils in the Piedmont and Coastal Plain, occurring on bluffs or other fire-sheltered sites, and dominated by combinations of *Fagus grandifolia, Quercus nigra, Liriodendron tulipifera, Quercus rubra,* and species of similar moisture tolerance, and containing some of the suite of base-loving plant species. Subtype covers examples in the Coastal Plain, occurring on rich, well-drained alluvium or around limestone outcrops.

Distinguishing Features: The Basic Mesic Forest type is distinguished by the combination of a canopy of mesic hardwoods and the presence of indicators of base-rich soils, along with the absence of montane species that would indicate Rich Cove Forest. The large suite of species typical of Basic Mesic Forest and not of Mesic Mixed Hardwood Forest include *Actaea racemosa (= Cimicifuga racemosa), Asarum canadense, Adiantum pedatum, Sanguinaria canadensis, Hybanthus concolor,* and *Actaea pachypoda*. *Ostrya virginiana, Carpinus caroliniana, Fraxinus americana, Aesculus sylvatica,* and *Aesculus pavia* tend to be common in Basic Mesic Forest and scarce in Mesic Mixed Hardwood Forest. These indicator species often occur with low constancy among sites and with moderate to low abundance. A Basic Mesic Forest should have several members of this suite present in the site, and have them dispersed through the community. Basic Mesic Forests may be hard to distinguish from Mesic Mixed Hardwood Forests on the basis of single plots if they do not fully represent the community.

The Coastal Plain Subtype is distinguished 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 *Hybanthus concolor, Iris cristata, Hydrangea arborescens, Actaea pachypoda, Dicentra cucullaria, Collinsonia canadensis, Cardamine concatenata, Viburnum rafinesquianum,*

Staphylea trifolia, Dirca palustris, Quercus muhlenbergii, and *Carya carolinae-septentrionalis,* among others.

Comments: There are two distinct variants of this subtype, one on soils around limestone outcrops and the other on rich alluvial terrace slopes. These may warrant separate associations, but the floristic differences have not been adequately clarified.

This subtype ranges through NC, SC, and possibly GA.

PIEDMONT/COASTAL PLAIN HEATH BLUFF G2G3

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

Concept: Type covers communities of cool microsites in the Piedmont and Coastal Plain, generally north-facing bluffs, with dense shrub layers dominated by *Kalmia latifolia, Rhododendron catawbiense,* or occasionally *Symplocos tinctoria,* under a variable, usually open, canopy.

Distinguishing Features: Piedmont/Coastal Plain Heath Bluff is distinguished from Mesic Mixed Hardwood Forest by having a dense shrub layer dominated by *Kalmia latifolia, Rhododendron* sp., or *Symplocos tinctoria*. The species diversity is generally very low. These communities may 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. This type grades into the Heath Subtype of Piedmont Monadnock Forest on higher, more exposed rocky slopes, at least in the Uwharrie Mountains.

Comments: At least three variants can be recognized. A Catawba Rhododendron Variant, dominated by *Rhododendron catawbiense,* is confined to Orange and Durham counties. The Mountain Laurel Variant, dominated by *Kalmia latifolia* is the most widespread. The Horse Sugar Variant has *Symplocos tinctoria* dominant or codominant, with or without abundant *Kalmia latifolia,* and encompasses some of the Coastal Plain examples.

Fagus grandifolia - (Liquidambar styraciflua) / Oxydendrum arboreum / Kalmia latifolia Forest (CEGL004636) is a nonstandard entity in the NVC, based on Rice and Peet's (1997) Roanoke River study. 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 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 Heath Bluff.

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.

CAPE FEAR VALLEY MIXED BLUFF FOREST G1G2
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).

Concept: Type covers shrubby forests with unusual 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: The Cape Fear Valley Mixed Bluff Forest is distinguished by the mixed dominance of upland and wetland tree, 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*.

Mountain Dry Coniferous Woodlands

PINE–OAK / HEATH (TYPIC SUBTYPE) G3
Synonyms: *Pinus pungens - Pinus rigida - (Quercus prinus) / Kalmia latifolia - Vaccinium pallidum* Woodland (CEGL007097).
Ecological Systems: Central and Southern Appalachian Montane Pine Forest and Woodland (CES202.331).

Concept: Type covers open-canopy woodlands of sharp ridges and dry slopes, naturally dominated by yellow pines and generally having a dense shrub layer. Canopies typically have less than 60 percent cover but may sometimes be denser, particularly if fire has not occurred for a long time. Subtype covers the common examples at low to mid elevations and lacking high elevation species such as *Rhododendron catawbiense*.

Distinguishing Features: The Pine-Oak/Heath type is distinguished from the Low Mountain Pine Forest type by having an open canopy, a dense, generally tall, shrub layer, occurring at higher elevation, and lacking *Pinus echinata*. It usually occurs above 2000 feet elevation, and on sharper ridges than Low Mountain Pine Forest. It is distinguished from Chestnut Oak Forest by having the canopy dominated by yellow pines when in natural condition. Most examples are altered by lack of fire, which has allowed

hardwoods to increase in them, blurring the boundary. Widespread pine mortality caused by southern pine beetles has further confused identification in many places. Communities with substantial numbers of dead pines should be regarded as altered examples of this type. Communities with open canopies dominated by hardwoods typical of the understory of fire-suppressed Pine–Oak/Heath – *Quercus coccinea, Nyssa sylvatica, Oxydendrum arboreum,* and *Acer rubrum,* often are altered examples of this type (but could represent logged examples of Chestnut Oak Forest. Closed canopy forests of sharp ridge tops that are dominated by *Quercus montana* but have a small number of pines should generally be treated as Chestnut Oak Forest. Classification is particularly difficult in this situation, because *Quercus montana* can increase with fire suppression but pines can increase with past logging.

The Typic Subtype is distinguished from the High Elevation Subtype by the absence of high elevation species such as *Rhododendron catawbiense*.

Comments: Some literature has suggested subdivisions of this type, particularly along a gradient from dominance by *Pinus virginiana* at lower elevations to *Pinus rigida* at intermediate elevations to *Pinus pungens* at the highest elevations. This gradient does not appear to be universal enough to recognize variants. While *Pinus virginiana* is absent at the higher elevations, its occurrence at lower elevations is irregular and probably tied to community dynamics and disturbance history. Some of the low elevation examples may be other community types, such as Low Mountain Pine Forest. Both of the other characteristic pines may occur at any elevation, from the lowest to the highest. Most examples of Pine–Oak/Heath are a mixture of at least two pine species.

PINE–OAK / HEATH (HIGH ELEVATION SUBTYPE) G2
Synonyms: *Pinus rigida - (Pinus pungens) / Rhododendron catawbiense - Kalmia latifolia / Galax urceolata* Woodland (CEGL004985).
Ecological Systems: Central and Southern Appalachian Montane Pine Forest and Woodland (CES202.331).

Concept: Subtype covers high elevation examples containing characteristic high elevation species such as *Rhododendron catawbiense*.

Distinguishing Features: The High Elevation Subtype is distinguished from the Typic Subtype by the presence of characteristic high elevation species, particularly *Rhododendron catawbiense*. The canopy may be either *Pinus rigida* or *Pinus pungens*.

Comments: This subtype is much rarer than the Typic Subtype.

CAROLINA HEMLOCK FOREST (TYPIC SUBTYPE) G2
Synonyms: Carolina Hemlock Bluffs (Third Approximation). *Tsuga caroliniana / Kalmia latifolia - Rhododendron catawbiense* Forest (CEGL007139).
Ecological Systems: Central and Southern Appalachian Montane Pine Forest and Woodland (CES202.331).

Concept: Type covers all communities dominated or codominated by *Tsuga caroliniana*. Subtype covers examples on ridges or exposed slopes with *Tsuga caroliniana* dominating and lacking appreciable pines. Small groves of *Tsuga caroliniana* embedded in oak forests are not included here.

Distinguishing Features: The Carolina Hemlock Forest type is distinguished from all other communities by the dominance or codominance of *Tsuga caroliniana* in the canopy. The Typic Subtype is distinguished from the Pine Subtype by the dominance of *Tsuga caroliniana* and the absence of an appreciable pine component. Some oaks or other hardwoods may be present and may occasionally be codominant. It is distinguished from the Mesic Subtype by occurrence in dry, topographically exposed environments, and by a shrub layer dominated by *Kalmia latifolia, Rhododendron catawbiense,* or *Rhododendron minus* rather than by *Rhododendron maximum*.

CAROLINA HEMLOCK FOREST (PINE SUBTYPE) G2

Synonyms: Carolina Hemlock Bluff (Third Approximation). *Tsuga caroliniana - Pinus (rigida, pungens, virginiana*) Forest (CEGL006178).
Ecological Systems: Central and Southern Appalachian Montane Pine Forest and Woodland (CES202.331).

Concept: Subtype covers examples with yellow pines abundant or codominant.

Distinguishing Features: The Pine Subtype is distinguished from the other subtypes by an appreciable component of yellow pines, which may be codominant. Some oaks and other hardwoods may be present.

Comments: This subtype is one of the less distinctive communities in the 4th approximation. It is included because the different dynamics of pine and Carolina hemlock communities suggest communities codominated by them may represent a distinct situation. The mixture may be becoming more relevant, as widespread of hemlocks occurs. Communities with a substantial pine component may follow a different ecological trajectory.

CAROLINA HEMLOCK FOREST (MESIC SUBTYPE) G1G2

Synonyms: *Tsuga caroliniana - (Tsuga canadensis) / Rhododendron maximum* Forest (CEGL007138).
Carolina Hemlock Bluff (Third Approximation).
Ecological Systems: Appalachian (Hemlock)-Northern Hardwood Forest (CES202.593).

Concept: Type covers all communities dominated or codominated by *Tsuga caroliniana*. Subtype covers examples in more sheltered sites than the other two, with more mesic composition transitional to Canada Hemlock Forest.

Distinguishing Features: The Mesic Subtype is distinguished by occurrence in topographically sheltered or valley bottom environments (but not wetlands), by having a shrub layer dominated by *Rhododendron maximum* rather than less mesic species, and often by having *Tsuga canadensis* codominant.

Comments: This subtype is somewhat intermediate between Carolina Hemlock Forest and Canada Hemlock Forest. Its appears to be only slightly more closely tied to the former than to the latter. This type is apparently rarer than the other two.

WHITE PINE FOREST G2G3
Synonyms: *Pinus strobus / Kalmia latifolia - (Vaccinium stamineum, Gaylussacia ursina)* Forest (CEGL007100).
Ecological Systems: Southern Appalachian Low-Elevation Pine Forest (CES202.332).

Concept: Type covers natural forests dominated by *Pinus strobus*. Plantations and stands that have invaded old fields or clearcuts on sites that would not otherwise support white pine are excluded.

Distinguishing Features: White Pine Forest is distinguished from the White Pine Subtype of Chestnut Oak Forest, the White Pine Subtype of Montane Oak–Hickory Forest, and all other forests which may contain a mixture of *Pinus strobus* by having *Pinus strobus* naturally making up more than 66 percent of the canopy over an area more than 1 acre. Distinguishing natural from unnatural successional white pine forests can be difficult. In general, natural White Pine Forests are on slopes of gorges or on ridges, while successional white pine forests are on valley flats or gentle lower slopes. However, clearcutting may allow white pine to become dominant in Montane Oak–Hickory Forests or Chestnut Oak Forests in some parts of the state.

LOW MOUNTAIN PINE FOREST (SHORTLEAF PINE SUBTYPE) G4?
Synonyms: *Pinus echinata / Vaccinium (pallidum, stamineum) - Kalmia latifolia* Forest (CEGL007078).
Ecological Systems: Southern Appalachian Low-Elevation Pine Forest (CES202.332).

Concept: Type covers closed canopy yellow pine-dominated forests containing montane flora, occurring at low to moderate elevations in the Blue Ridge and foothills. Subtype covers lower elevation examples dominated by *Pinus echinata*.

Distinguishing Features: The Low Mountain Pine Forest type is distinguished from Pine--Oak/Heath by occurring at lower elevations, by having a denser canopy, a less dense shrub layer, and generally occurring on open slopes or broad ridges rather than narrow, sharp ridges. The Shortleaf Pine Subtype is distinguished by the dominance of *Pinus echinata* in the canopy.

Comments: *Pinus echinata / Schizachyrium scoparium* Appalachian Woodland (CEGL003560) is an association defined for South Carolina and Georgia, which appears to be a more frequently burned version of this.

LOW MOUNTAIN PINE FOREST (MONTANE PINE SUBTYPE) G3G4
Synonyms: *Pinus virginiana - Pinus (rigida, echinata) - (Quercus prinus) / Vaccinium pallidum* Forest (CEGL007119). *Pinus virginiana - (Pinus rigida, Pinus pungens) / Schizachyrium scoparium* Forest (CEGL008500).
Ecological Systems: Southern Appalachian Low-Elevation Pine Forest (CES202.332).

Concept: Subtype covers low to mid-elevation examples with a canopy dominated by pines of higher elevations than *Pinus echinata*, generally *Pinus virginiana* or *Pinus rigida*, but possibly *Pinus pungens*.

Distinguishing Features: The Montane Pine Subtype is distinguished from the Shortleaf Pine Subtype by having a canopy dominated by one of the above pines with *Pinus echinata* either absent or a smaller

component. It generally occurs at higher elevations than the Shortleaf Pine Subtype but lower elevations than Pine–Oak/Heath.

Comments: There are two NVC associations that seem to relate to this. The distinction between them is unclear. Both are wide-ranging community types, the first occurring in the Cumberland Plateau and into the Interior Low Plateau. Its distribution and ecology in North Carolina are very poorly known. It is also unclear how it is related to Southern Mountain Xeric Pine-Oak Woodland and Southern Mountain Pine-Oak Forest.

SOUTHERN MOUNTAIN PINE–OAK FOREST G3G4

Synonyms: *Pinus echinata - Quercus (prinus, falcata) / Oxydendrum arboreum / Vaccinium pallidum* Forest (CEGL007493).
Ecological Systems: Southern Appalachian Low-Elevation Pine Forest (CES202.332).

Concept: Forests of low elevation slopes and broad ridges on the fringes of the Blue Ridge Region, where *Pinus echinata* and dry-site oaks characteristic of lower elevations codominate.

Distinguishing Features: These communities are distinguished by canopies codominated by *Pinus echinata* and combinations of dry-site oaks that may include *Quercus falcata, Quercus coccinea, Quercus stellata, Quercus velutina,* and *Quercus alba*, along with the presence of Blue Ridge flora such as *Rhododendron calendulaceum, Kalmia latifolia*, and *Gaylussacia ursina*.

Comments: These communities are not well known. In North Carolina they are apparently largely confined to Cherokee County. They are probably more fire-dependent than most of our oak forests.

Pinus echinata - Quercus alba / Vaccinium pallidum / Hexastylis arifolia - Chimaphila maculata Forest (CEGL008427) is a widespread association that has been attributed by NatureServe to the Carl Sandberg Home. It may fall within the concept of this subtype.

SOUTHERN MOUNTAIN XERIC PINE–OAK WOODLAND G4?

Synonyms: *Pinus echinata - Quercus stellata - Quercus marilandica / Vaccinium pallidum* Woodland (CEGL003765).
Ecological Systems: Southern Appalachian Low-Elevation Pine Forest (CES202.332).

Concept: Open-canopy woodlands of *Pinus echinata* and xerophytic oaks, occurring on the driest ridges in foothills areas. This type is apparently extensive in the Georgia foothills. It is reported to occur in North Carolina but documentation is not known.

Distinguishing Features: Southern Mountain Xeric Pine–Oak Woodland is distinguished from Southern Mountain Pine-Oak Forest by a more open canopy, more xerophytic composition, and occurrence in the driest sites. It is distinguished from Low Mountain Pine Forest by the codominance of oaks.

Comments: This type is not well documented in North Carolina. It is unclear how abundant it is and what ecological factors separate it from other low elevation dry communities. It is possible that it represents merely a disturbed version of some other community type.

Mountain Oak Forests

HIGH ELEVATION RED OAK FOREST (TYPIC HERB SUBTYPE) G4

Synonyms: *Quercus rubra / (Vaccinium simulatum, Rhododendron calendulaceum) / (Dennstaedtia punctilobula, Thelypteris noveboracensis*) Forest (CEGL007300).
Ecological Systems: Central and Southern Appalachian Montane Oak Forest (CES202.596).

Concept: Type covers mid to high mountain forests dominated by *Quercus rubra* (more than 50 percent of canopy cover in natural condition, but see comment below). Subtype covers typical forests with limited cover of predominantly deciduous shrubs, and with the herb layer not dominated by a dense lawn of *Carex* spp. or high elevation forbs.

Distinguishing Features: The High Elevation Red Oak Forest type is distinguished from Northern Hardwood Forests and Red Spruce–Fraser Fir Forests by having *Quercus rubra var. ambigua (= Quercus rubra var. borealis)* making up more than 50 percent of the canopy cover under natural conditions. It is distinguished from high elevation occurrences of Montane Oak–Hickory Forest by having less than 10 percent *Quercus alba* canopy cover.

The Herb Subtype is distinguished by having a primarily deciduous shrub layer (greater than 50 percent of shrub cover) and lacking a dense lawn of *Carex* spp. It is distinguished from the Stunted Heath Subtype by having a full stature canopy, more than 8 meters tall unless very young. It is distinguished from the Rich Subtype by lacking any substantial presence of the species indicative of less acid soils, in any stratum. *Fraxinus americana, Tilia americana var. heterophylla, Actaea racemosa, Caulophyllum thalictroides, Prosartes lanuginosa, Collinsonia canadensis,* and *Sanguinaria canadensis* are absent or nearly so. Ericaceous shrubs and other acid-tolerant species are generally abundant.

Comments: This subtype is widely regarded as the most typical of the type, and is also the most widespread and abundant. High Elevation Red Oak Forest is extensive below the spruce-fir forests in the highest mountain ranges and at the tops of lower and more southerly ranges. In the zone where it s abundant, it often occurs in a mosaic, occupying the warmer slope aspects while Northern Hardwood Forest occupies the cooler.

Many, perhaps most, examples of High Elevation Red Oak Forest, particularly of this subtype, have a dense understory of mesophytic trees characteristic of Northern Hardwood Forest canopies (*Betula alleghaniensis, Aesculus flava, Acer saccharum,* and others). *Quercus rubra* is often scarce or absent from the understory, and the forests appear to be succeeding to Northern Hardwood Forest. Patches where canopy oaks have died may already be dominated by these species but can generally be recognized as belonging to a surrounding stand still dominated by *Quercus rubra*. The dynamics related to this change are not fully understood but, as with oak regeneration failure at lower elevations, is thought by many to be related to lack of fire.

HIGH ELEVATION RED OAK FOREST (RICH SUBTYPE) G2

Synonyms: *Quercus rubra - Fraxinus americana - Acer saccharum / Actaea racemosa - Caulophyllum thalictroides - Collinsonia canadensis* Forest (CEGL004256).
Ecological Systems: Central and Southern Appalachian Montane Oak Forest (CES202.596).

Concept: Subtype includes examples on mafic rock substrates, with a base-loving flora.

Distinguishing Features: The Rich Subtype is distinguished from all other subtypes by having a substantial presence of base-loving plants. *Fraxinus americana* and *Acer saccharum* are generally important in the canopy, and *Prunus serotina, Aesculus flava*, and *Tilia americana var. heterophylla* may also be present. Herbs more typical of Rich Cove Forest, such as *Actaea racemosa, Caulophyllum thalictroides, Prosartes lanuginosa, Collinsonia canadensis, Sanguinaria canadensis*, and *Impatiens pallida*, are abundant. Ericaceous shrubs are not dominant but may be present in small numbers.

Montane Oak–Hickory Forest (Basic Subtype) has a similar suite of base-loving plants, but has *Quercus alba* as the dominant or most abundant tree species. High Elevation Red Oak Forest is generally higher in elevation and more northerly than Montane Oak–Hickory Forest, but intermediate examples of these closely related subtypes occur. Rich Cove Forest (Red Oak Subtype) has a canopy similarly dominated by *Quercus rubra* and a suite of base-loving plants, but occurs at mid elevations rather than high, and in sheltered topography. Its flora is more mesophytic, with virtually all of the plants associated with the oak canopy being characteristic of Rich Cove Forest.

Comments: This subtype is known only from the Amphibolite Mountains, Craggy Mountains, and Balsam Mountains.

Quercus rubra - Carya (ovata, ovalis) - Fraxinus americana / Actaea racemosa - Hydrophyllum virginianum Forest (CEGL008518) is an analogous association defined from the Central Appalachians in Virginia.

HIGH ELEVATION RED OAK FOREST (HEATH SUBTYPE) G4

Synonyms: *Quercus rubra / (Kalmia latifolia, Rhododendron catawbiense, Rhododendron maximum) / Galax urceolata* Forest (CEGL007299).
Ecological Systems: Central and Southern Appalachian Montane Oak Forest (CES202.596).

Concept: Subtype includes examples with well-developed shrub layers of predominantly evergreen heaths, typically occurring on narrow ridges, rocky areas, or strongly convex slopes.

Distinguishing Features: The Heath Subtype is distinguished from the Herb Subtype and Orchard Forest Subtype by naturally having greater than 20 percent shrub cover, consisting of more than 50 percent evergreen heath species. It is distinguished from the Stunted Woodland Subtype by having a full stature canopy, not stunted by wind (more than 8 meters tall unless young). The Stunted Woodland Subtype generally has more mixed canopy composition, less strongly dominated by *Quercus rubra*.

Comments: The rank of G4 is probably high. This subtype appears much less common than the Herb Subtype. It appears to occur only on unusually sharp, narrow ridge tops, and where soil is shallow near rock outcrops. Broader ridge tops generally lack it.

HIGH ELEVATION RED OAK FOREST (ORCHARD FOREST SUBTYPE) G2
Synonyms: *Quercus rubra / Carex pensylvanica - Ageratina altissima var. roanensis* Forest (CEGL007298).
Ecological Systems: Central and Southern Appalachian Montane Oak Forest (CES202.596).

Concept: Subtype covers examples with low shrub cover and a dense herb layer dominated by *Carex* spp. and high elevation forbs, typically occurring on gentle slopes and broad ridges at the highest elevations reached by the type.

Distinguishing Features: The Orchard Forest Subtype is distinguished from all other subtypes by having a dense herb layer dominated by *Carex pensylvanica*, other *Carex* spp., *Ageratina altissima, Claytonia caroliniana, Angelica triquinata,* and other species typical of the high elevations. *Rhododendron catawbiense* and other evergreen heaths may be present but are sparse.

Comments: This subtype is often associated with ridgetop gaps. Recognition of this as a natural subtype is somewhat uncertain. It has been suggested it may be an artifact of past grazing. However, grazing has been widespread in most parts of the high mountains, and has not produced communities recognizable as this subtype in most places. Older descriptions emphasize the lawn-like aspect, with *Carex pensylvanica* strongly dominant. Many examples now have extensive portions of the herb layer dominated by forbs. It is unclear if this represents a successional change, a change caused by an increase in canopy gaps with storms in recent years, or only a change in emphasis in the descriptions.

HIGH ELEVATION RED OAK FOREST (STUNTED WOODLAND SUBTYPE) G2
Synonyms: *Quercus rubra / Rhododendron catawbiense - Rhododendron arborescens* Woodland (CEGL004503).
Ecological Systems: Central and Southern Appalachian Montane Oak Forest (CES202.596).

Concept: Subtype covers naturally stunted or wind-battered woodlands (canopy less than 8 meters tall, even when mature) with dense shrub layers, on peaks or narrow ridges. Many examples have mixed canopies of *Quercus rubra, Quercus alba, Amelanchier arborea,* and other species, and it is unclear if this subtype truly belongs in this type.

Distinguishing Features: The Stunted Heath Subtype is distinguished from the herb and heath subtypes by the stunted canopy, which is less than 8 meters tall even when mature. It is distinguished from the Orchard Forest Subtype, which may have a stunted canopy, by having a well-developed, generally very dense, shrub layer.

Comments: The dynamics and ecological relationships of this subtype are particularly poorly known. It appears to be quite rare, and many apparently-suitable sites do not have it. The corresponding NVC association is described as being particularly tied to granitic domes. Many examples of this subtype are associated with dome-shaped exfoliation outcrops, but not all.

HIGH ELEVATION WHITE OAK FOREST G2Q
Synonyms: *Quercus alba / Kalmia latifolia* Forest (CEGL007295).
Ecological Systems: Central and Southern Appalachian Montane Oak Forest (CES202.596).

Concept: Type covers high mountain forests strongly dominated by *Quercus alba*.

Distinguishing Features: The High Elevation White Oak Forest type is distinguished from all other high elevation forest types by having greater than 75 percent *Quercus alba* canopy cover when relatively undisturbed.

Comments: This remains a problematic community type, with few known well-developed examples and uncertainty how distinct it is from other types. It was initially based Whittaker's Great Smoky Mountains vegetation study, where *Quercus alba*-dominated forests were found at low and high elevations and not at intermediate elevations. This study was on the Tennessee side of the Smokies, and a similar pattern does not appear to occur in North Carolina. *Quercus alba* is common in forests in a continuous and broad range of elevations, especially south of Asheville, and most are mixed-canopy forests readily treated as Montane Oak–Hickory Forest. However, a few high elevation pure stands of *Quercus alba* occur, and appear to warrant recognition of this type in North Carolina.

CHESTNUT OAK FOREST (DRY HEATH SUBTYPE) G5
Synonyms: *Quercus (prinus, coccinea) / Kalmia latifolia / (Galax urceolata, Gaultheria procumbens)* Forest (CEGL006271).
Ecological Systems: Southern Appalachian Oak Forest (CES202.886).

Concept: Type includes dry slope and ridge forests of low to moderate elevation dominated by *Quercus montana*, sometimes in combination with *Quercus coccinea* or *Quercus rubra*. *Quercus alba* is not a significant component. Subtype covers the common examples of the Blue Ridge and foothills with well-developed shrub layers dominated by deciduous or evergreen heaths other than *Rhododendron* spp., generally occurring on dry open slopes or ridges.

Distinguishing Features: Chestnut Oak Forest is distinguished from all other community types by the dominance of *Quercus montana* or the codominance of *Quercus montana* with *Quercus coccinea, Quercus rubra*, or *Acer rubrum*. *Quercus alba* is a minor component only. The Dry Heath Subtype is distinguished from the Herb Subtype and the Mesic Subtype by having a well-developed shrub layer dominated by *Kalmia latifolia, Gaylussacia* spp., or *Vaccinium* spp. It is distinguished from the White Pine Subtype by lacking *Pinus strobus*. It is distinguished from Piedmont Monadnock Forest by the presence of plants generally absent in the Piedmont, such as *Castanea dentata, Rhododendron calendulaceum, Pyrularia pubera, Gaylussacia baccata, Gaylussacia ursina, Kalmia latifolia*, and *Carex pensylvanica*.

Comments: *Quercus prinus - Quercus velutina / Oxydendrum arboreum - Cornus florida* Forest (CEGL008522) is a dry chestnut oak forest without heath, described in western Virginia. It might occur in North Carolina. Its relationship with this subtype would need to be clarified. The shrub layer is usually dominated by tree regeneration, with only patchy *Vaccinium pallidum*. The herb layer and understory sound similar.

Vegetation analysis done for the Appalachian Trail corridor found examples with *Gaylussacia ursina* dominating the shrub layer to be distinct from other examples in this subtype. These should be

recognized as a variant, and may warrant a distinct subtype. This variant is confined to areas south of the Asheville Basin.

Quercus coccinea is sometimes abundant, even codominant, in these communities. This species increases with logging and is not fire tolerant, so its abundance probably is related to past human alterations.

CHESTNUT OAK FOREST (HERB SUBTYPE) G4G5

Synonyms: *Quercus prinus - (Quercus rubra) - Carya* spp. / *Oxydendrum arboreum - Cornus florida* Forest (CEGL007267).
Ecological Systems: Southern Appalachian Oak Forest (CES202.886).

Concept: Subtype covers the common examples of the Blue Ridge and foothills that have well-developed herb layers and sparse to moderate shrub layers.

Distinguishing Features: The Herb Subtype is distinguished from the Dry Heath Subtype and the Mesic Subtype by the presence of a well-developed herb layer and absence of a dense shrub layer. Much confusion remains over the best way to classify our low elevation *Quercus prinus-Quercus rubra* forests. Multiple associations that are similar to this are used in adjacent states and ecoregions. Until there is further analysis, all *Quercus prinus-Quercus rubra* forests that do not fit the Mesic Subtype should be classified as this subtype.

Comments: *Quercus prinus - Quercus velutina / Oxydendrum arboreum - Cornus florida* Forest (CEGL008522) is a drier acidic but non-heath chestnut oak community known from western Virginia. *Quercus prinus - Quercus rubra / Hamamelis virginiana* Forest (CEGL006057) is another related association defined in Virginia. *Quercus prinus / Rhododendron catawbiense - Kalmia latifolia* Forest (CEGL008524) is a wide-ranging association of the Ridge and Valley, with some plots located in the Blue Ridge of Virginia near the state line. All could potentially be recognized as this subtype if they were found in North Carolina. Distinctions among them hold up in analysis of large plot datasets, but their field interpretation and ecological significance remain unclear.

CHESTNUT OAK FOREST (WHITE PINE SUBTYPE) G3

Synonyms: *Pinus strobus - Quercus (coccinea, prinus) / (Gaylussacia ursina, Vaccinium stamineum)* Forest (CEGL007519).
Ecological Systems: Southern Appalachian Oak Forest (CES202.886).

Concept: Subtype covers examples with a significant component of *Pinus strobus*, which may range from a substantial minority to codominant. Most examples resemble the Dry Heath Subtype except for the pine component.

Distinguishing Features: This subtype is distinguished from all other subtypes by having *Pinus strobus* present as a significant natural component along with *Quercus montana*. Undergrowth usually resembles that of the Dry Heath Subtype. The White Pine Subtype subtype should only be used where white pine is believed to be naturally present, not for forests where it has been planted or where it likely spread from nearby plantings. Forests with a more mesophytic composition, such as the forests of *Quercus rubra* and

Pinus strobus with *Rhododendron maximum* that occur around Linville Falls, are treated as the Mesic Subtype.

Comments: This subtype is somewhat uncertain. Some literature suggests white pine increases as a result of fire exclusion, while other sources suggest that fire and logging promote it. However, there is also a geographic component. *Pinus strobus* is completely absent from many Chestnut Oak Forests in the northern Blue Ridge escarpment and in the higher parts of the mountains, regardless of stand history of logging or fire suppression. It is common in the northern foothills and in the southern escarpment, as well as in some large mountain gorges. It thus appears that the presence of *Pinus strobus* in Chestnut Oak Forests may represent natural ecological variation, while the abundance of it may be related to forest history and degree of alteration.

CHESTNUT OAK FOREST (MESIC SUBTYPE) G4

Synonyms: *Quercus prinus - Quercus rubra / Rhododendron maximum / Galax urceolata* Forest (CEGL006286). Chestnut Oak Forest (Rhododendron Subtype).
Ecological Systems: Southern Appalachian Oak Forest (CES202.886).

Concept: Subtype covers examples with a shrub layer dominated by evergreen *Rhododendron* spp., generally *Rhododendron maximum*, occurring on more mesic sites of the Blue Ridge and foothills. It is usually on steep north-facing slopes or sides of gorges or ravines. The canopy may have as much *Quercus rubra, Liriodendron tulipifera, Oxydendrum arboreum*, or *Nyssa sylvatica* as it does *Quercus montana*, and may be somewhat open. Forests of *Quercus rubra* and *Pinus strobus* with no other tree species are provisionally included here as well.

Distinguishing Features: The Mesic Subtype is distinguished from all other subtypes by the dominance of *Rhododendron maximum* or similarly mesophytic species in the lower strata. This is often accompanied by more mesophytic species in the canopy (*Quercus rubra, Tsuga canadensis*), and by absence of more xerophytic species. Occasional forests dominated by *Quercus rubra* without *Quercus montana*, at elevations too low to be High Elevation Red Oak Forest, should be classified here.

Comments: Despite the low species richness and dominance by widespread species, these communities are usually quite distinctive. They occur between Acidic Cove Forests and drier oak forests, which are often Montane Oak–Hickory Forest rather than other subtypes of Chestnut Oak Forest. They are uncommon, however, being detectable in only a small minority of places where Acidic Cove Forests and drier oak forests adjoin. It is unclear how closely they are related to other Chestnut Oak Forests. They often occur in regions where other subtypes of Chestnut Oak Forest are scarce or absent. They are the primary habitat for *Fothergilla major*.

Comments: This subtype was called the Rhododendron Subtype in earlier drafts of this guide. The name was changed to be clearer about the concept. *Rhododendron maximum* occurs at moderate frequency in the Dry Heath Subtype, but its presence is probably an artifact of fire suppression. The Mesic Subtype is always associated with more mesic topographic settings and has few of the more xerophytic species.

The forests dominated by *Quercus rubra* and *Pinus strobus* that occur near the crest of the Blue Ridge escarpment around Linville Falls are distinctive enough to be recognized as a Red Oak–White Pine

Variant, and may warrant recognition as a different type with further study. Otherwise, this subtype is rather variable but distinct variants have not been clarified.

MONTANE OAK–HICKORY FOREST (ACIDIC SUBTYPE) G5
Synonyms: *Quercus alba - Quercus (rubra, prinus) / Rhododendron calendulaceum - Kalmia latifolia - (Gaylussacia ursina)* Forest (CEGL007230).
Ecological Systems: Southern Appalachian Oak Forest (CES202.886).

Concept: Type covers mountain upland forests dominated by mixtures of oaks with *Quercus alba* as a significant component. Subtype covers the common examples with typical acid-loving herbs and heath shrubs. This subtype lacks indicators of circumneutral soils and also lacks low elevation dry-site species.

Distinguishing Features: The Montane Oak–Hickory Forest type is distinguished from other mountain oak forest types by having a canopy containing significant *Quercus alba* mixed with other oaks, hickories, or pines. Both Chestnut Oak Forest and High Elevation Red Oak Forest have very little *Quercus alba*. High Elevation White Oak Forest has a canopy strongly dominated by *Quercus alba* and a dense heath layer occurring at elevations above 4000 feet. Montane Oak–Hickory Forests are distinguished from Oak–Hickory Forests of the Piedmont by having a significant component of montane flora, such as *Castanea dentata, Rhododendron calendulaceum, Kalmia latifolia, Magnolia fraseri*, and *Gaylussacia ursina*.

The Acidic Subtype is distinguished from the Basic Subtype by the absence or scarcity of plants that prefer circumneutral or higher soil pH and species typical of Rich Cove Forests. It is distinguished from the Low Dry Subtype by the absence of more typically Piedmont xerophytic species such as *Pinus echinata, Quercus falcata, Quercus stellata*, and *Quercus marilandica*. It is distinguished from the closely related White Pine Subtype by the absence or scarcity of *Pinus strobus* in the canopy.

MONTANE OAK–HICKORY FOREST (BASIC SUBTYPE) G3
Synonyms: *Quercus alba - Quercus rubra - Quercus prinus / Collinsonia canadensis - Podophyllum peltatum - Amphicarpaea bracteata* Forest (CEGL007692).
Ecological Systems: Southern Appalachian Oak Forest (CES202.886).

Concept: Subtype covers examples with flora that prefer circumneutral conditions or flora that occur in such dry sites only under circumneutral conditions. Heaths are generally present but in smaller numbers than in the other subtypes, and many species characteristic of Rich Cove Forests may be present.

Distinguishing Features: The Basic Subtype is distinguished from the Acidic Subtype and the Low Dry Subtype by the combination of limited heath shrub abundance and abundance of mesic herbs. Characteristic species such as *Pycnanthemum montanum, Tradescantia subaspera, Solidago curtisii, Podophyllum peltatum, Dichanthelium boscii*, and *Brachyelytrum erectum* are often abundant, but Rich Cove Forest and base-loving species such as *Collinsonia canadensis, Arisaema triphyllum, Actaea racemosa (= Cimicifuga racemosa), Caulophyllum thalictroides, Sanguinaria canadensis, Adiantum pedatum, Euphorbia purpurea*, and *Philadelphus inodorus* are also usually present. Additional canopy species associated with more mesophytic or more base-rich communities are also often present, with *Fraxinus americana* and *Magnolia acuminata* especially characteristic. This subtype is potentially

confused with Rich Cove Forest (Red Oak Subtype), but is distinguished by occurring in more topographically exposed settings and having a less mesophytic flora, as well as by having *Quercus alba* as a major component. While a number of herbaceous and woody species are shared with Rich Cove Forests, they represent a distinct subset of rich mesophytic species. Many of the associated species in this community are of drier sites.

MONTANE OAK–HICKORY FOREST (LOW DRY SUBTYPE) G2G3
Synonyms: *Quercus alba - Quercus coccinea - Quercus falcata / Kalmia latifolia - Vaccinium pallidum* Forest (CEGL007691).
Ecological Systems: Southern Appalachian Oak Forest (CES202.886).

Concept: Subtype covers the distinctive examples with drier flora and combinations of plants more common in the Piedmont, along with those characteristic of the Blue Ridge. These communities are known only from low to moderate elevation areas, mainly those with granitic substrate. The substrate may be important for their occurrence. Fire is probably particularly important for these communities.

Distinguishing Features: The Low Dry Subtype is distinguished from the other subtypes by the occurrence of characteristic lower elevation species such as *Quercus falcata* and *Quercus stellata* in the canopy and suite of low elevation, fire-tolerant herbs. These include *Baptisia tinctoria, Silphium compositum, Solidago odora, Iris verna, Pityopsis graminifolia*, and *Tephrosia virginiana*. It lacks any of the richer flora characteristic of the Basic Subtype, but shares many heath shrub species with the Acidic Subtype. The Low Dry Subtype is distinguished from the Southern Mountain Pine–Oak Forest by having less pine (though pines are often present in small numbers. *Quercus falcata* and *Quercus stellata* tend to be present in small numbers only in the Low Dry Subtype.

Comments: This is a very distinctive subtype that may be more closely related to Southern Mountain Pine-Oak Forest or to Low Mountain Pine Forest. While fire is now believed to be important in all mountain oak forests, it likely is particularly important in this subtype.

MONTANE OAK–HICKORY FOREST (WHITE PINE SUBTYPE) G2G3
Synonyms: *Pinus strobus - Quercus alba - (Carya alba) / Gaylussacia ursina* Forest (CEGL007517).
Ecological Systems: Southern Appalachian Oak Forest (CES202.886).

Concept: Subtype covers examples with a significant component of *Pinus strobus*. Most resemble the Acidic Subtype except for the pine, or have dense shrub layers of *Kalmia latifolia* or *Rhododendron maximum*.

Distinguishing Features: The White Pine Subtype is distinguished from the other subtypes by having *Pinus strobus* as a significant natural component, generally providing 25 percent to 75 percent of the canopy cover. Some *Pinus strobus* may be present in the Low Dry Subtype in particular. It is distinguished from White Pine Forest by having no more than 75 percent of the canopy cover being *Pinus strobus*. It is distinguished from the White Pine Subtype of Chestnut Oak Forest by having *Quercus alba* as a significant canopy component. The comments about the uncertainties in recognizing a White Pine Subtype of Chestnut Oak Forests also apply to this subtype.

LOW MONTANE RED OAK FOREST G4?

Synonyms: *Quercus rubra - Acer rubrum / Calycanthus floridus - Pyrularia pubera / Thelypteris noveboracensis* Forest (CEGL006192).
Ecological Systems: Southern Appalachian Oak Forest (CES202.886).

Concept: Low to mid elevation mountain forests dominated by *Quercus rubra*, without appreciable *Quercus alba*, without the distinctive features of Chestnut Oak Forest (Mesic Subtype) or Rich Cove Forest (Red Oak Subtype). This type has a floristic composition suggestive of intermediate soil fertility, lacking the well-developed heath shrub layer of Montane Oak–Hickory Forest (Acidic Subtype) but also lacking the rich herb layer of Montane Oak–Hickory Forest (Basic Subtype).

Distinguishing Features: This type is distinguished from most other oak forests by dominance by *Quercus rubra* without appreciable *Quercus alba* or other oaks, at low elevations. Chestnut Oak Forest (Mesic Subtype) can sometimes be dominated by *Quercus rubra* with few of the associated species, but has a composition indicative of very acid soils, with a prominent heath shrub layer.

Comments: This type is included somewhat tentatively, based on its recognition in neighboring states and on the presence of some low elevation red oak forests that have no other classification. However, its concept and circumscription remain confused.. The NVC name and Natural Heritage Program observations indicate an intermediate-fertility community, but parts of the NVC description suggest it can be much more acidic, with *Rhododendron maximum* or *Gaylussacia ursina* abundant. As this more acidic concept would seem to overlap with Chestnut Oak Forest (Mesic Subtype), it is excluded here. A marginally basic or circumneutral forest with *Quercus rubra*-dominated canopy, no ericaceous shrubs, and a moderate herb layer of species such as *Brachyelytrum erectum* and *Dichanthelium commutatum* occurs in North Carolina. It is accommodated here for now, but may warrant a new subtype or variant as more information becomes available. More depauperate *Quercus rubra / Rhododendron maximum* forests along the northern Blue Ridge crest might be interpreted to fit into this concept as well, but are treated here as part of Chestnut Oak Forest (Mesic Subtype).

CALCAREOUS OAK–WALNUT FOREST G1Q

Synonyms: *Quercus rubra - Quercus muehlenbergii / Hamamelis virginiana / Polymnia canadensis* Forest (CEGL007215); Basic Mesic Forest (Montane Calcareous Subtype) (3rd Approximation).
Ecological Systems: Southern Appalachian Oak Forest (CES202.886).

Concept: Low elevation dry-mesic mountain slope forests on dolomite or other calcareous rocks, dominated or codominated by *Quercus muehlenbergii* and/or *Juglans nigra*.

Distinguishing Features: Calcareous Oak–Walnut Forests are distinguished from all other community types by canopy composition.

Comments: This type was formerly treated as a subtype of Basic Mesic Forest, a predominantly Piedmont community type. It does not appear to be truly mesic in composition however, and is distinct enough from the other subtypes of Basic Mesic Forest to warrant a separate community type.

MONTANE GRAPE OPENING G2G3
Synonyms: *Vitis aestivalis* Vine-Shrubland (CEGL003890).
Ecological Systems: Southern Appalachian Oak Forest (CES202.886).

Concept: Type covers openings in forest canopy dominated by *Vitis aestivalis* or other *Vitis* species.

Distinguishing Features: Montane Grape Openings are distinguished by the lack of well-developed tree canopy over a significant area and strong dominance by *Vitis* spp.

Comments: This type was not known at the time of the Third Approximation. While vine-dominated openings may develop in response to logging at times, this type should be restricted to those of natural origin or others indistinguishable from them. These communities are known from old-growth forests on the Tennessee side of the Great Smoky Mountains and at least small examples are present in North Carolina. Their natural dynamics are poorly known, though the presence of dead snags within them shows that they developed from forest in fairly recent times. It appears that once established they may expand. These communities do not fit well into any theme, but are included in Mountain Oak Forests because that is where they most often occur. However, they may also occur in Mountain Cove Forests.

Piedmont and Coastal Plain Oak Forests

DRY-MESIC OAK–HICKORY FOREST (PIEDMONT SUBTYPE) G4G5
Synonyms: *Quercus alba - Quercus rubra - Carya alba / Cornus florida / Vaccinium stamineum / Desmodium nudiflorum* Piedmont Forest (CEGL008475).
Ecological Systems: Southern Piedmont Dry Oak-(Pine) Forest (CES202.339).

Concept: Type covers dry-mesic forests of acidic upland slopes and somewhat sheltered ridges in the Piedmont and Coastal Plain, dominated by combinations of *Quercus alba, Quercus rubra, Quercus velutina, Carya tomentosa, Carya glabra,* along with varying amounts of pine, maple, and poplar. Basic soil plants are absent or scarce, and acid tolerant species such as *Oxydendrum arboreum* and *Vaccinium* spp. are common. These forests cover the moisture range between that where *Fagus* becomes a significant component and that where *Quercus falcata, Quercus stellata, Quercus marilandica,* or *Quercus montana* become significant components. Subtype covers Piedmont examples, which lack characteristic Coastal Plain species.

Distinguishing Features: Dry-Mesic Oak–Hickory Forest is distinguished from Dry Oak–Hickory Forest by a flora of more mesic composition, most clearly in the canopy. *Quercus stellata, Quercus falcata, Quercus marilandica,* and *Quercus montana* are scarce or absent. It is distinguished from Mesic Mixed Hardwood Forest by the absence of more mesic species, particularly *Fagus grandifolia*. It is distinguished from Montane Oak–Hickory Forest by the absence of characteristically montane flora, such as *Castanea dentata, Magnolia fraseri, Acer pensylvanicum, Rhododendron calendulaceum,* and *Rhododendron maximum*. Additionally, some species are widespread in Montane Oak–Hickory Forests but are restricted to more mesic communities than this in the Piedmont and Coastal Plain. These include *Kalmia latifolia, Hamamelis virginiana,* and *Polygonatum biflorum.*

The Dry-Mesic Oak–Hickory Forest type is distinguished from Dry-Mesic Basic Oak–Hickory Forest by the absence or scarcity of a suite of basic indicators, such as *Symphoricarpos orbiculatus, Frangula caroliniana, Celtis* spp., *Fraxinus americana, Cercis canadensis, Brachyelytrum erectum,* and

Dichanthelium boscii. Basic indicators also include a set of species that are characteristic of more mesic or floodplain communities but that occur in dry sites that are less acidic. These include *Acer floridanum, Carya ovata, Elymus hystrix, Elymus virginicus, Phryma leptostachya*, and *Phegopteris hexagonoptera*. Characteristic species of acidic soils, such as *Oxydendrum arboreum, Vaccinium stamineum, Vaccinium pallidum, Vaccinium tenellum, Gaylussacia frondosa,* and *Chimaphila maculata* may be present in basic communities, but don't predominate as they do in Dry Mesic Oak–Hickory Forest.

The Piedmont Subtype is distinguished from the Coastal Plain Subtype by floristic differences. *Quercus rubra* is largely restricted to the Piedmont Subtype. *Quercus nigra, Gaylussacia frondosa, Morella cerifera*, and *Arundinaria tecta* are largely restricted to the Coastal Plain Subtype. The Coastal Plain Subtype also tends to have at some least some plants more typical of wetter habitats, such as *Ilex glabra, Osmunda cinnamomea,* and *Woodwardia areolata*, presumably associated with very small seepage patches.

Comments: This association is perhaps the most common one in the Piedmont. It is also common in Virginia, where *Quercus coccinea* becomes more common than *Quercus rubra* as a component. It extends across the Coastal Plain in northern Virginia.

DRY-MESIC OAK-HICKORY FOREST (COASTAL PLAIN SUBTYPE) G3G4

Synonyms: *Quercus alba - Carya alba / Oxydendrum arboreum - Ilex opaca / Gaylussacia frondosa - Symplocos tinctoria - Vaccinium stamineum* Coastal Plain Forest (CEGL004321).
Ecological Systems: Atlantic Coastal Plain Dry and Dry-Mesic Oak Forest (CES203.241).

Concept: Type covers dry-mesic forests of acidic upland slopes and somewhat sheltered ridges in the Piedmont and Coastal Plain, dominated by various combinations of *Quercus alba*, *Quercus rubra, Quercus velutina, Carya tomentosa*, *Carya glabra*, along with varying amounts of pine, maple, and tulip poplar. These forests cover the moisture range between that where *Fagus* becomes a significant component and where *Quercus falcata, Quercus stellata, Quercus marilandica*, or *Quercus montana* become significant components. Subtype covers examples of the Coastal Plain, where characteristic Coastal Plain species are generally present in lower strata and *Quercus rubra* is generally absent.

Distinguishing Features: The Dry-Mesic Oak–Hickory Forest type is distinguished by natural dominance of a mix of oaks, with or without hickories, in which *Quercus alba* is prominent and more drought tolerant oaks (*Quercus montana, Quercus marilandica, Quercus stellata,* and *Quercus falcata*) are scarce or are outweighed by trees more mesophytic than *Quercus alba*. The flora in all strata is limited to species tolerant of acidic soils, with species such as *Oxydendrum arboreum, Nyssa sylvatica, Cornus florida, Vaccinium* spp., *Chimaphila maculata, Goodyera pubescens,* and *Hexastylis arifolia* common, and species such as *Cercis canadensis, Fraxinus americana, Ostrya virginiana*, and most mesophytic herbs absent or scarce.

The Coastal Plain Subtype is distinguished from the Piedmont Subtype by floristic differences, most prominent in the lower strata. No species of very high constancy distinguish the subtypes, but a suite of species that are present in one but lacking in the other is generally represented. These species include *Gaylussacia frondosa, Symplocos tinctoria*, and various wetland species such as *Persea palustris, Magnolia virginiana, Clethra alnifolia, Ilex glabra, Vaccinium elliottii, Arundinaria tecta, Woodwardia areolata, Osmundastrum cinnamomeum,* and *Chasmanthium laxum*. Other species sometimes present in

the Coastal Plain Subtype but seldom in the Piedmont Subtype include *Morella cerifera* and *Callicarpa americana*. Species frequently found in the Piedmont Subtype but rarely or never in the Coastal Plain Subtype include *Vaccinium pallidum, Viburnum rafinesquianum, Viburnum prunifolium, Viburnum acerifolium, Corylus cornuta, Prunus serotina, Quercus coccinea, Quercus montana, Carya carolinae-septentrionalis,* and *Chionanthus virginicus.* Herbs are scarce in both subtypes. *Chasmanthium laxum* and *Mitchella repens* are among the most frequent herb layer species in the Coastal Plain Subtype but scarce in the Piedmont, while *Hieracium venosum* is frequent in the Piedmont Subtype but largely absent in the Coastal Plain. The Coastal Plain Subtype often has a greater mixture of plants of different moisture tolerance than the Piedmont Subtype. *Quercus falcata* and *Vaccinium arboreum* are frequent components, as are *Hamamelis virginiana* and *Styrax grandifolius,* and various wetland species.

Comments: *Pinus taeda* is more often a component of the Coastal Plain Subtype, even in situations that do not appear to be recently disturbed. It may be a more important natural component because of more frequent fire or because of more severe canopy disturbance by hurricanes. The transition from the Coastal Plain subtype to Mesic Mixed Hardwood Forest or Dry Oak–Hickory Forest appears to be more gradual than the comparable transition in the Piedmont. This may be a result of greater disruption of natural fire regimes, or may be a result of the nature of Coastal Plain soils. The presence of wetland species even in these dry upland communities is presumably related to small areas of seepage.

The NVC contains 3 associations comparable to this subtype. *Quercus alba - Carya glabra* / Mixed Herbs Coastal Plain Forest (CEGL007226), formerly attributed to North Carolina, has been clarified as an association of the Gulf Coast. *Quercus alba - Quercus nigra - Quercus falcata / Ilex opaca / Clethra alnifolia - Arundinaria gigantea ssp. tecta* Forest (CEGL007862), and *Quercus alba - Carya alba / Vaccinium elliottii* Forest [Provisional] (CEGL007224) are related associations that may overlap this subtype.

DRY OAK–HICKORY FOREST (PIEDMONT SUBTYPE) G4G5

Synonyms: *Quercus falcata - Quercus alba - Carya alba / Oxydendrum arboreum / Vaccinium stamineum* Forest (CEGL007244).
Ecological Systems: Southern Piedmont Dry Oak-(Pine) Forest (CES202.339).

Concept: Type covers upland hardwood forests of acidic soils in the driest typical topographic positions, on south slopes and ridge tops; where *Quercus alba, Q. stellata,* and *Q. falcata* predominate in the canopy. They are less xeric in composition than the *Quercus stellata - Q. marilandica* forests that occur in specialized edaphic conditions such clay hardpans, shallow rock, or very sandy soils. They contain acid-tolerant flora such as *Oxydendrum arboreum, Nyssa sylvatica, Vaccinium stamineum, Vaccinium pallidum,* and *Vaccinium arboreum,* and lack more base-loving plants. Subtype covers typical examples of the Piedmont, which lack significant Coastal Plain flora.

Distinguishing Features: Dry Oak–Hickory Forests are distinguished from Dry-Mesic Oak–Hickory Forests by canopy composition, which has *Quercus stellata, Q. falcata,* and other trees more drought-tolerant than *Quercus alba* predominating over *Quercus rubra* and other trees less drought-tolerant than *Quercus alba*. They are distinguished from Xeric Hardpan Forests by a canopy which contains significant Quercus alba and other trees that are less xerophytic than *Quercus stellata*.

Dry Oak–Hickory Forests are distinguished from Dry Basic Oak–Hickory Forests by having acid-tolerant plants predominating and by lacking more base-loving plants. This is most apparent in the lower strata, but the number of distinguishing species is less than in more mesic communities because of the limited number of species present. *Oxydendrum arboreum, Vaccinium pallidum, Vaccinium tenellum,* and *Chimaphila maculata* are generally abundant in Dry Oak–Hickory Forest but absent or scarce in Dry Basic Oak–Hickory Forest. *Cercis canadensis, Fraxinus americana, Acer leucoderme,* and *Viburnum* spp. are generally abundant in Dry Basic Oak–Hickory Forest and scarce in Dry Oak–Hickory Forest, and stronger basic indicators such as *Frangula caroliniana, Symphoricarpos orbiculatus,* or *Rhus aromatica* are often present. As in Dry-Mesic Basic Oak–Hickory Forest, species otherwise typical of floodplains or of more mesic communities may be present, though less commonly.

The Piedmont Subtype is distinguished from the Coastal Plain Subtype by floristic differences. The Coastal Plain Subtype generally has a number of species that are absent in the Piedmont, though they may not be the dominant species in the community. Species shared with drier communities, such as *Quercus margarettiae, Quercus incana, Cnidoscolus stimulosus*, or *Gaylussacia dumosa* are often present in the Coastal Plain Subtype, as are species of wetter communities, such as *Quercus nigra, Gaylussacia frondosa, Morella cerifera,* and *Arundinaria tecta*.

Comments: As currently defined in the NVC, this association is very broad and not precisely defined, extending to Mississippi and Kentucky. It apparently excludes the Atlantic Coastal Plain. It apparently does not occur in Virginia, where drier sites are occupied by an oak/heath forest of more northerly affinities. This concept is almost certainly inappropriately broad.

Pinus echinata - Quercus alba / Vaccinium pallidum / Hexastylis arifolia - Chimaphila maculata Forest (CEGL008427) and *Pinus taeda - Quercus (alba, falcata, stellata)* Successional Coastal Plain Forest (CEGL004766) are widespread associations that appear to overlap this. While pines of several species may be present in natural examples in North Carolina, codominant or dominant pines suggests a successional version of this community type. *Pinus taeda - Quercus falcata / Vaccinium pallidum / Hexastylis arifolia* Forest (CEGL006033) has been defined in Virginia and not attributed to North Carolina. It is unclear how it relates to this.

A Slate Slope Variant of Dry Oak–Hickory Forest may be recognized for steep slopes on slate or other rocks that break into small fragments. The accumulation of rock fragments makes these slopes better drained and somewhat unstable, and it has been suggested the vegetation is distinctive. They tend to have more *Pinus virginiana* or *Pinus echinata* in them, perhaps reflecting more frequent natural disturbance. They may have some unusual species, such as *Rhus aromatica,* along with more typical acid-tolerant species. These do not appear to be distinct enough to recognize as a subtype.

DRY OAK–HICKORY FOREST (COASTAL PLAIN SUBTYPE) G4?
Synonyms: *Quercus falcata - Quercus stellata - Carya alba / Vaccinium* spp. Coastal Plain Forest (CEGL007246).
Ecological Systems: Atlantic Coastal Plain Dry and Dry-Mesic Oak Forest (CES203.241).

Concept: Type covers upland hardwood forests of acidic soils in the driest typical topographic positions, on south slopes and ridge tops; where *Quercus alba,, Q. stellata,* and *Q. falcata* predominate in the canopy. They are less xeric in composition than the *Quercus stellata - Q. marilandica* forests that occur

in specialized edaphic conditions such clay hardpans, shallow rock, or very sandy soils. They contain acid-tolerant flora such as *Oxydendrum arboreum, Nyssa sylvatica, Vaccinium stamineum, Vaccinium pallidum*, and *Vaccinium tenellum,* and lack more base-loving plants. Subtype covers Coastal Plain examples, which have a distinct component of Coastal Plain flora.

Distinguishing Features: Dry Oak–Hickory Forests are distinguished from Basic Oak–Hickory Forests by having acid-tolerant plants predominating and lacking more base-loving plants. This is most apparent in the lower strata, but the number of distinguishing species is less than in more mesic communities because of the limited number of species present. *Oxydendrum arboreum, Vaccinium pallidum, Vaccinium tenellum*, and *Chimaphila maculata* are generally absent in Basic Oak–Hickory Forest. *Cercis canadensis, Fraxinus americana,* and *Viburnum* spp. are generally abundant in Basic Oak–Hickory Forest and less common in Dry Oak–Hickory Forest. Dry Oak–Hickory Forests are distinguished from Dry-Mesic Oak–Hickory Forests by canopy composition, which has *Quercus stellata, Q. falcata*, and other trees more drought-tolerant than *Quercus alba* predominating over *Quercus rubra* and other trees less drought-tolerant than *Quercus alba*. (*Quercus alba* tends to be dominant or most abundant in both). It is distinguished from Xeric Hardpan Forest by a canopy which contains significant *Quercus alba* and other trees that are less xerophytic than *Quercus stellata* and *Q. marilandica*.

The Coastal Plain Subtype is distinguished from the Piedmont Subtype by geography and substrate, and also by the presence of characteristic Coastal Plain species. *Quercus falcata* is very common, and more xerophytic trees such as *Quercus laevis* and *Quercus margarettiae* are often present. A variety of shrubs and herbs more characteristic of wetter communities are often present, including *Gaylussacia frondosa*, *Arundinaria tecta, Ilex glabra, Persea palustris, Woodwardia areolata,* and *Osmundastrum (Osmunda) cinnamomeum*.

Comments: *Quercus alba - Quercus falcata - (Carya pallida) / Gaylussacia frondosa* Forest (CEGL006269) is a more northerly Coastal Plain dry oak-hickory forest association that ranges from NJ to VA. It has been questionably attributed to NC but no distinctive northern version of Dry Oak--Hickory Forest that would warrant recognition has been found.

DRY-MESIC BASIC OAK–HICKORY FOREST (PIEDMONT SUBTYPE) G3G4

Synonyms: *Quercus alba - Quercus rubra - Carya (ovata, carolinae-septentrionalis) / Cercis canadensis* Forest (CEGL007232).
Ecological Systems: Southern Piedmont Dry Oak-(Pine) Forest (CES202.339).

Concept: Type covers dry-mesic Piedmont and Coastal Plain forests with less acidic and more fertile soils than typical, associated with mafic or intermediate crystalline rocks or occasionally calcareous sedimentary rocks. They are equivalent in moisture regime to Dry-Mesic Oak–Hickory Forest, and fall between Basic Mesic Forest and Dry Basic Oak–Hickory Forest on appropriate substrates.

Subtype covers examples in the Piedmont, believed to be floristically distinct from those in the Coastal Plain.

Distinguishing Features: The Dry-Mesic Basic Oak–Hickory Forest type is distinguished from Basic Mesic Forest by a drier flora and from Dry Basic Oak–Hickory Forest by a more mesic flora. The

canopy is dominated by *Quercus alba*, along with other oaks and hickories. There is essentially no *Fagus grandifolia* in the canopy, and *Liriodendron* is scarce. Drier site oaks such as *Quercus stellata, Quercus marilandica,* or *Quercus falcata* are scarce or absent.

This type is distinguished from Dry-Mesic Oak–Hickory Forest by occurrence of more base-loving flora that includes species such as *Symphoricarpos orbiculatus, Frangula caroliniana, Celtis* spp., *Fraxinus americana, Cercis canadensis, Brachyelytrum erectum*, and *Dichanthelium boscii*. Basic indicators also include a set of species that are characteristic of more mesic or floodplain communities but that occur in dry sites that are less acidic. These include *Acer floridanum, Carya ovata, Elymus hystrix, Elymus virginicus, Phryma leptostachya*, and *Phegopteris hexagonoptera*. Characteristic species of acidic soils, such as *Oxydendrum arboreum, Vaccinium stamineum, Vaccinium pallidum, Vaccinium tenellum, Gaylussacia frondosa*, and *Chimaphila maculata* may be present, but don't predominate as they do in Dry Mesic Oak–Hickory Forest.

Comments: Although this type is called basic, soil data from Virginia show that many examples do not have basic or even circumneutral pH. But soils have higher pH, higher base saturation, and higher levels of "base" cations than the more acidic Dry-Mesic Oak–Hickory Forest.

The distinction between a Basic and an Intermediate subtype, included in earlier versions of the 4th Approximation guide, has been dropped.

Quercus alba - Quercus rubra - Quercus prinus - Tilia americana var. caroliniana / Ostrya virginiana Forest (CEGL004542) is an association defined by analysis of Uwharrie Mountains CVS data, where it is represented by 5 plots (2-151, 2-165, 3-167, 3-168, and 6-151). The plots share a common feature of abundant *Tilia americana var. caroliniana*, but vary drastically in canopy dominants and even setting, with one apparently occurring on an alluvial terrace. For the upland sites, it is unclear how they would be distinguished from other Dry-Mesic Basic Oak–Hickory Forests, other than by the abundance of *Tilia*, one of a suite of basic indicators but a stronger basic indicator than most. The distinctness of this association needs to be assessed against a broader data set of basic communities, and field relations need to be determined.

DRY-MESIC BASIC OAK–HICKORY FOREST (COASTAL PLAIN SUBTYPE) G4?
Synonyms: *Quercus alba - Carya glabra - Carya alba / Aesculus pavia* Forest (CEGL007225).
Ecological Systems: Atlantic Coastal Plain Dry and Dry-Mesic Oak Forest (CES203.241).

Concept: Type covers dry-mesic Piedmont and Coastal Plain forests with less acidic and more fertile soils than typical, associated with mafic or intermediate crystalline rocks or occasionally calcareous sedimentary rocks or Coastal Plain sediments. They are equivalent in moisture regime to Dry-Mesic Oak–Hickory Forest, and fall between Basic Mesic Forest and Dry Basic Oak–Hickory Forest on appropriate substrates. Subtype covers the rare Coastal Plain examples, containing flora characteristic of the Coastal Plain in addition to widespread flora of the type.

Distinguishing Features: The Dry-Mesic Basic Oak–Hickory Forest type is distinguished by natural dominance of a mix of oaks and hickories in which *Quercus alba* is prominent and where more drought tolerant oaks (*Quercus montanas, Quercus marilandica, Quercus stellata*, and *Quercus falcata*) are scarce or are outweighed by trees more mesophytic than *Quercus alba*. Also, at least some of the lower

strata contain substantial amounts of species that depend on basic or circumneutral soils. This type is distinguished from Dry-Mesic Oak–Hickory Forest by occurrence of more base-loving flora in association with less acidic substrate. Heaths, at least the more acid-loving ones such as *Oxydendrum arboreum, Vaccinium pallidum*, and *Vaccinium tenellum*, are absent or scarce. *Fraxinus americana, Acer floridanum, Ostrya virginiana, Cercis canadensis*, and *Viburnum* spp. may be abundant. A few examples have distinctive base-loving herbs, but most are distinguished more by the woody strata.

The Coastal Plain Subtype often has a greater mixture of plants of different moisture tolerance than the Piedmont Subtype. *Quercus falcata* is a common component, even as characteristic wetland species are often present in small numbers.

Comments: This NVC association is unclearly defined, and it may not fit our examples well.

DRY BASIC OAK–HICKORY FOREST G2G3

Synonyms: *Quercus alba - Quercus stellata - Carya carolinae-septentrionalis / Acer leucoderme - Cercis canadensis* Forest (CEGL007773).
Ecological Systems: Southern Piedmont Dry Oak-(Pine) Forest (CES202.339).

Concept: Type covers dry Piedmont forests with less acidic and more fertile soils than typical, associated with mafic or intermediate crystalline rocks or occasionally calcareous sedimentary rocks. They are equivalent in moisture regime to Dry Oak–Hickory Forest. They are associated with dry topographic positions but not with more the extreme dry situations created by edaphic conditions such as clay hardpans, shallow rock, or excessive drainage. No examples are known in the Coastal Plain, but if any are found, they would be covered by this type.

Distinguishing Features: The Dry Basic Oak–Hickory Forest type is distinguished from Dry-Mesic Basic Oak–Hickory Forest by having a drier flora, with a canopy containing substantial amounts of *Quercus stellata* or *Quercus falcata*, along with abundant *Quercus alba*, and lacking substantial *Quercus rubra*. It is distinguished from Xeric Hardpan Forest by occurring on less extreme soils and having a less xerophytic canopy that generally has abundant *Quercus alba*.

Dry Basic Oak–Hickory Forests are distinguished from Dry Oak–Hickory Forests by a suite of basic indicator plants. *Cercis canadensis, Fraxinus americana, Acer leucoderme*, and *Viburnum* spp. are generally abundant in Dry Basic Oak–Hickory Forest and scarce in Dry Oak–Hickory Forest, and stronger basic indicators such as *Frangula caroliniana, Symphoricarpos orbiculatus*, or *Rhus aromatica* are often present. *Carya* spp. and *Juniperus virginiana* are more abundant than in Dry-Mesic Basic Oak–Hickory Forest, though less confined to it. As in the dry-mesic forests, species more typical of floodplains or mesic sites may occur in the basic type, but these are less common. More acid-tolerant species such as *Oxydendrum arboreum, Vaccinium pallidum, Vaccinium tenellum,* and *Chimaphila maculata* are generally abundant in Dry Oak–Hickory Forest but absent or scarce in Dry Basic Oak–Hickory Forest.

Comments: Earlier drafts of the 4th Approximation contained a provisions Uwharrie Boulderfield Subtype, represented by the association *Quercus alba - Carya glabra - Fraxinus americana / Acer leucoderme / Vitis rotundifolia* Forest (CEGL004541). Several CVS plots exist for it. It is not clear that it is distinctive enough to warrant recognition as a subtype, so it reduced to a variant in the final version.

It is distinguished by a high cover of large boulders, which leads to a high cover by woody vines and reduced cover by herbs. However, a variety of Piedmont oak forests are sometimes rocky and others have a high cover of vines even when they are not rocky.

PIEDMONT MONADNOCK FOREST (TYPIC SUBTYPE) G3G4

Synonyms: *Quercus prinus - Quercus alba / Oxydendrum arboreum / Vitis rotundifolia* Forest (CEGL006281).
Ecological Systems: Southern Piedmont Dry Oak-(Pine) Forest (CES202.339).

Concept: Type covers forests of rocky, acidic, central and eastern Piedmont sites dominated by *Quercus montana*, occasionally codominated by *Quercus coccinea*, but lacking characteristic montane species typical of Chestnut Oak Forests. These typically occur on isolated erosional remnant hills (monadnocks or inselbergs), but occasionally occur on bluffs.

Subtype covers most examples, those not having the distinctive characteristics of the other subtypes.

Distinguishing Features: Piedmont Monadnock Forests may be distinguished from Chestnut Oak Forests by a more limited flora that lacks many characteristic montane species, such as *Castanea dentata, Rhododendron calendulaceum, Pyrularia pubera, Gaylussacia ursina, Magnolia fraseri, Carex pensylvanica,* and *Maianthemum racemosum*. Piedmont species such as *Quercus falcata* and *Quercus stellata* are often present. It is distinguished from all other community types by the dominance of *Quercus montana*. Some Dry Oak–Hickory Forests that are transitional to this type may have abundant *Quercus montana*.

The Typic Subtype is distinguished by the absence of a significant admixture of pines, more xerophytic oaks, or *Kalmia latifolia*.

Comments: This community was tentatively treated as a subtype of Chestnut Oak Forest in earlier versions of the 4th Approximation guide. The recognition of several subtypes within it suggests it would be better treated as a distinct type. While floristically depauperate, it appears to be as distinct from montane Chestnut Oak Forest as Montane Oak–Hickory Forest is from Piedmont oak-hickory forests. Some examples have well-developed shrub layers of *Vaccinium pallidum*, or on Occoneechee Mountain, *Gaylussacia baccata*, but some have *Vitis rotundifolia* dominating the ground cover with little shrub or herb component. With a more natural fire regime, they might be more grassy.

Not all isolated hills support this community type. The abundance of rock may be an important factor in determining its occurrence, as may soil chemistry. Extreme soil acidity, accompanied by aluminum toxicity, has been suggested as important. Most examples are on hard rhyolite flows or quartzite. In the Uwharrie Mountains, the Piedmont Monadnock Forest type occurs on higher knobs of felsic volcanic rocks, grades to Dry or Dry-Mesic Oak–Hickory Forest downslope, but is abruptly replaced by Basic Oak–Hickory Forest on mafic volcanic rocks. In the largest monadnock expanses in the Uwharrie Mountains, there is a distinct landscape pattern of the Typic Subtype occurring on knobs and ridge tops, the Pine Subtype on east and west side slopes, the Xeric Subtype on south slopes, and the Heath Subtype on north slopes. On most smaller monadnocks elsewhere in the Piedmont, only the Typic Subtype is present. A few examples elsewhere occur on mafic or intermediate igneous rocks. These may represent a distinct variant.

PIEDMONT MONADNOCK FOREST (PINE SUBTYPE) G2
Synonyms: *Quercus prinus - Pinus echinata / Vaccinium pallidum* Piedmont Monadnock Forest (CEGL004148).
Ecological Systems: Southern Piedmont Dry Oak-(Pine) Forest (CES202.339).

Concept: Subtype covers examples with *Pinus echinata* as a significant component that is not merely successional after severe human disturbance, generally occurring on west and east slopes in the Uwharrie Mountains, and occasionally elsewhere. This subtype is not meant to cover the *Pinus echinata* groves that are sometimes a component within Dry Oak–Hickory Forest.

Distinguishing Features: The Pine Subtype is distinguished from the Typic Subtype by having a persistent significant component of *Pinus echinata* (greater than 10 percent).

Comments: While a substantial component of pine is generally interpreted as successional, indicating past cultivation or clearcutting in most Piedmont oak forests, in at least some monadnock situations it seems to be a natural longer-term component. In the extensive monadnock forests of the Badin area of the Uwharrie Mountains, there is a repeating pattern of this subtype occurring on east and west side slopes. A couple of examples have a few *Pinus palustris* trees.

PIEDMONT MONADNOCK FOREST (HEATH SUBTYPE) G3
Synonyms: *Quercus prinus - Quercus alba / Oxydendrum arboreum / Kalmia latifolia* Forest (CEGL004415)
Ecological Systems: Southern Piedmont Dry Oak-(Pine) Forest (CES202.339).

Concept: Subtype covers examples with a dense shrub layer of *Kalmia latifolia*, generally occurring on north-facing side slopes.

Distinguishing Features: The combination of *Quercus montana*-dominated canopy and dense *Kalmia latifolia* shrub layer, occurring in the eastern or central Piedmont, distinguishes this subtype from all other communities. Communities with only sparse *Kalmia latifolia* should not be classified as this subtype. In the western Piedmont and Blue Ridge, Chestnut Oak Forest (Dry Heath Subtype) may be locally dominated by the same combination of species but typically is more diverse and contains other characteristic montane species such as *Gaylussacia baccata, Gaylussacia ursina, Rhododendron calendulaceum,* or *Castanea dentata*. This subtype sometimes grades into Piedmont/Coastal Plain Heath Bluff on lower slopes, where more mesic canopy appears over the dense *Kalmia* shrub layer. However, in most places the two subtypes occur alone.

Comments: This subtype may be largely confined to the Uwharrie Mountains. It is compositionally related to the oak-heath forests of the Virginia Piedmont, which cover large expanses of the landscape, as well as to the Chestnut Oak Forests of the mountains. *Symplocos tinctoria* can be an important shrub component.

MIXED MOISTURE HARDPAN FOREST G2?

Synonyms: *Quercus phellos - Quercus (alba, stellata) - Carya carolinae-septentrionalis* Hardpan Forest (CEGL004037).
Ecological Systems: Piedmont Hardpan Woodland and Forest (CES202.268).

Concept: Type covers forests of clay hardpan soils with restricted internal drainage, where shallow water ponds in the winter but which are dry for most of the growing season, and whose vegetation is a mix of wetland and upland species. Typically, *Quercus phellos* is mixed with *Quercus alba, Quercus stellata,* or *Carya carolinae-septentrionalis* as the predominant canopy.

Distinguishing Features: This type is distinguished by co-occurrence by wetland and upland species, generally some of the above, without segregation into distinct Xeric Hardpan Forest and Upland Depression Swamp communities. They show evidence of shallow ponding of water but not of water flow. The mix of typically widely segregated tree species is distinctive for this type.

Comments: The distinctness of this community has been debated. Its composition would appear to be ecotonal, but it can cover areas of several acres, often without the presence of either of the end point communities. This type is more narrowly defined than most community types, but does not have clear enough affinities to make it a subtype of any single other type.

SWAMP ISLAND EVERGREEN FOREST G2G3

Synonyms: *Quercus hemisphaerica - Pinus taeda - (Quercus nigra) / Osmanthus americanus var. americanus / Ilex glabra* Forest (CEGL007022). Coastal Fringe Evergreen Forest (3rd Approximation).
Ecological Systems: Atlantic Coastal Plain Dry and Dry-Mesic Oak Forest (CES203.241).

Concept: Type covers forests of sandy upland islands surrounded by swamps, dominated by *Quercus hemisphaerica* and *Pinus taeda,* sometimes *Quercus nigra,* and containing several species otherwise found in North Carolina only in maritime and coastal zone communities. Natural isolation from fire is thought to be an important determinant of these communities.

Distinguishing Features: Swamp Island Evergreen Forest is distinguished from the various oak-hickory forest types by the abundant presence of hardwoods more typical in North Carolina in the coastal zone, most commonly *Quercus hemisphaerica* and *Osmanthus americanus,* but sometimes including *Quercus virginiana, Quercus geminata,* and other species. It is distinguished from Coastal Fringe Evergreen Forest and Maritime Evergreen Forest by its inland location, but also by the lack of certain characteristic species, such as *Ilex vomitoria*. Swamp Island Evergreen Forest sometimes grades into Pine/Scrub Oak Sandhill, from which it is distinguished by a denser canopy, lack of evidence of present or past abundance of *Pinus palustris*, and scarcity of shade-intolerant species. This distinction may become blurred with logging and long lack of fire.

Comments: Communities of this type were treated as Coastal Fringe Evergreen Forest in the 3rd Approximation. Both types are low in floristic diversity and share an abundance of evergreen woody species otherwise common in North Carolina only in maritime forests. They appear distinct enough to recognize as separate types. However, further investigation is needed of their behavior in states to the south, where they may be less distinct.

Pinus taeda - Quercus hemisphaerica / *Osmanthus americanus* / *Ilex glabra* Woodland (CEGL003619) is a swamp island woodland association attributed to North Carolina and states southward to Florida. It appears to overlap this subtype in concept. Its description includes "open to closed canopy."

Quercus virginiana - Pinus taeda / Ilex vomitoria / Chasmanthium sessiliflorum Forest [Provisional] (CEGL004095), *Quercus virginiana / Vaccinium arboreum - Ilex vomitoria* Forest (CEGL007028), and *Quercus hemisphaerica - Quercus geminata* / *Persea borbonia - Osmanthus americanus* Forest (CEGL004787) are other inland island communities with similar "maritime" composition recognized in SC, GA, and FL. The perception of maritime character of these communities is probably specific to North Carolina. Many of the indictor species are more widespread inland farther south, and *Quercus hemisphaerica* occurs in a wide variety of communities.

High Elevation Rock Outcrops

HIGH ELEVATION ROCKY SUMMIT (TYPIC SUBTYPE) G2

Synonyms: *Saxifraga michauxii - Carex misera - Danthonia spicata - Krigia montana* Herbaceous Vegetation (CEGL004279).
Ecological Systems: Southern Appalachian Rocky Summit (CES202.327).

Concept: Type covers communities of flat to vertical outcrops of fractured rock on ridge tops, upper to mid slopes, or other topographically exposed settings, at high elevations, generally above 4000 feet. Vegetation of Rocky Summits is sparse to moderate in density and is generally characterized by a mix of growth forms or by predominantly forbs and sparse woody vegetation.
Subtype covers most examples, with substrates ranging from felsic to mafic but not having a strong component of flora associated with basic soils or with the highest elevations.

Distinguishing Features: High Elevation Rocky Summits are distinguished from forests, shrublands, and grasslands by a structure of sparse vegetation or herbaceous vegetation of moderate cover with extensive fractured, bare rock. Patches of shrub cover are generally present on edges or in pockets of deep soil, but sizeable areas of shrub dominance should be considered Heath Balds. High Elevation Rocky Summits are distinguished from High Elevation Granitic Domes by having abundant fractured rock, in contrast to the largely smooth bedrock of the domes. They are distinguished from cliff communities by their occurrence in more topographically exposed situations, at mid slope or higher. The cliff types occur on lower slopes and in gorges, almost always at lower elevations. Their vegetation is often sparser, but what trees are able to grow are often of large stature. High Elevation Rocky Summits are distinguished from Low Elevation Rocky Summits by the general absence of low elevation plants such as *Diodia teres, Talinum teretifolium, Selaginella rupestris,* and *Quercus montana*. High elevation plants that are generally absent in Low Elevation Rocky Summits include *Sibbaldiopsis tridentata, Trichophorum caespitosum, Carex brunnescens, Geum radiatum, Liatris helleri, Solidago spithamaea, Houstonia montana, Menziesia pilosa, Abies fraseri, Picea rubens,* and *Sorbus americana*.

The Typic Subtype is distinguished from the High Peak Subtype by the presence of plants not present at the highest elevations. These include *Kalmia latifolia, Amelanchier arborea, Vaccinium pallidum, Danthonia spicata, Krigia montana, Carex umbellata*, and *Dichanthelium acuminatum*. The Typic Subtype is distinguished from the Little Bluestem Basic Subtype by the absence or minor role of warmer site plants characteristic of that subtype, such as *Schizachyrium scoparium* and *Coreopsis major* and the presence of more typical cool site plants such as *Sibbaldiopsis tridentata, Angelica triquinata*, and

Sorbus americana. It is distinguished from the Ninebark Basic Subtype by the absence or scarcity of *Phlox subulata ssp. subulata, Packera plattensis (= Senecio plattensis),* and *Physocarpus opulifolius*.

Comments: This subtype covers most High Elevation Rocky Summits, both felsic and mafic. It includes several groups distinguished by Wiser (1993), including two that she emphasized as being on mafic rocks. There may be sufficient difference to recognize a basic and acidic subtype from the communities included here; however, the flora of these groups is not strongly calciphilic and the floristic basis for distinction is not clear enough at this time.

This subtype has two variants. The Typic Variant has the characteristics of the type. The Ice/Rock Fall Variant is a distinctive open community that rarely forms at the base of vertical Rocky Summit or Granitic Dome cliffs where substantial amounts of ice form in the winter and fall to the base of the cliff. This variant is analogous in ecological process to the ice pond community of South Carolina (Hill 1999), but is much higher in elevation and consequently is rather different floristically. Its environment is a relatively level terrace of fallen boulders and soil at the base of the cliff, with small areas of water impounded by the accumulation of the terrace. Its flora includes boulderfield and wetland species as well as typical Rocky Summit species, some of which apparently established after falling from the rock above. It may warrant recognition as a distinct subtype, with further study.

This subtype apparently occurs only in North Carolina and adjacent Tennessee.

Photinia melanocarpa - Gaylussacia baccata / Carex pensylvanica Shrubland (CEGL008508) is a G1? rock outcrop association defined in Virginia and stated to potentially be in North Carolina. It is described as a mosaic of shrub patches, herb patches, and bare rock. If something like it occurs, it might fit as a subtype of High Elevation Rocky Summit or might be a kind of glade.

HIGH ELEVATION ROCKY SUMMIT (HIGH PEAK SUBTYPE) G1
Synonyms: *Saxifraga michauxii - Carex misera - Oclemena acuminata - Solidago glomerata* Herbaceous Vegetation (CEGL004277).
Ecological Systems: Southern Appalachian Rocky Summit (CES202.327).

Concept: Subtype covers examples in topographically exposed settings at the highest elevations, where even mid-elevation species are largely absent.

Distinguishing Features: The High Peak Subtype is distinguished from other subtypes by a high elevation location combined with absence or scarcity of plants from other subtypes. Species typically lacking in this subtype include *Kalmia latifolia, Amelanchier arborea, Vaccinium pallidum, Danthonia spicata, Krigia montana, Carex umbellata,* and *Dichanthelium acuminatum*.

Comments: This subtype was distinguished by quantitative analysis in Wiser (1993).

HIGH ELEVATION ROCKY SUMMIT (LITTLE BLUESTEM BASIC SUBTYPE) G1
Synonyms: *Schizachyrium scoparium - Saxifraga michauxii - Coreopsis major* Herbaceous Vegetation (CEGL004074).
Ecological Systems: Southern Appalachian Rocky Summit (CES202.327).

Concept: Subtype covers examples on southern or western exposures, on amphibolite or other basic substrates or felsic rocks subject to base-rich seepage. While not strongly calciphilic, the flora contains species not otherwise common in High Elevation Rocky Summits. The warm exposure allows some lower elevation plants to mix with high elevation species.

Distinguishing Features: The Little Bluestem Basic Subtype is distinguished from other subtypes of High Elevation Rocky Summit by the occurrence of abundant *Schizachyrium scoparium, Coreopsis major*, and other typically more low elevation species. It is distinguished from Low Elevation Rocky Summits and Low Elevation Glades by the presence of typically high elevation species such as *Sibbaldiopsis tridentata, Angelica triquinata*, and *Sorbus americana*. It is distinguished from High Elevation Mafic Glade by lower vegetation cover and more extensive bare rock. While the flora suggests basic soil conditions and research has shown soils to be high in base cations, not all examples are on mafic rocks. Some occur on normally acidic rocks which have some seepage, presumably because the seepage brings higher concentrations base cations.

Comments: This subtype was distinguished in analysis by Wiser (1993). This community is only marginally distinct from Low Elevation Mafic Glade, but the lower plant cover and greater importance of bare rock tie it to High Elevation Rocky Summit.

HIGH ELEVATION ROCKY SUMMIT (NINEBARK BASIC SUBTYPE) G1?
Synonyms: *Physocarpus opulifolius / Campanula divaricata - Tradescantia subaspera* - (*Packera plattensis)* Sparse Vegetation (CEGL004759). Montane Mafic Cliff (in part).
Ecological Systems: Southern Appalachian Montane Cliff and Talus (CES202.330).

Concept: Subtype covers vertical amphibolite cliffs with sparse vegetation dominated by *Physocarpus opulifolius, Phlox subulata,* and *Packera plattensis (= Senecio plattensis).* These communities lack many of the typical Rocky Summit plants and are transitional to Montane Cliff communities.

Distinguishing Features: The Ninebark Basic Subtype is distinguished by sparse vegetation that includes *Physocarpus opulifolius, Packera plattensis (= Senecio plattensis),* and *Phlox subulata ssp. subulata.*

Comments: This community type is not well understood, and the basis for its distinctness is not entirely clear. However, it was distinguished in analysis by Wiser (1993).

HIGH ELEVATION ROCKY SUMMIT (HIGH PEAK LICHEN SUBTYPE) G2?
Synonyms: *Lasallia papulosa - Umbilicaria caroliniana* Nonvascular Vegetation (CEGL004386). High Elevation Granitic Dome (High Peak Lichen Subtype) (earlier 4th Approximation drafts).
Ecological Systems: Southern Appalachian Granitic Dome (CES202.297).

Concept: Subtype covers rare examples of steep to gently sloping, dry, smooth outcrops at high elevations, where shallow soils mats are nearly absent and vegetation consists almost entirely of the umbilicate lichens *Lasallia papulosa* or *Umbilicaria caroliniana*, along with crustose lichens. The environment of this subtype has characteristics of both High Elevation Rocky Summit and High Elevation Granitic Dome.

Distinguishing Features: The High Peak Lichen Subtype is distinguished by the dominance of *Lasallia papulosa* or *Umbilicaria caroliniana* and the absence or near absence of both crevices and shallow soil herb mats.

Comments: This subtype was treated as a subtype of High Elevation Granitic Dome in early drafts, and is placed by NatureServe in the Granitic Dome ecological system. It remains one of the more poorly understood of the communities in the 4th Approximation. The limited number of people who can distinguish and who report on the different species of umbilicate lichens makes collecting information difficult. It was initially defined based on CVS plot on Grandfather Mountain, and indicated to likely occur in the Roan Mountain area. Neither mountain has well-developed granitic domes, though smooth surfaces that resemble exfoliation faces are locally present. Additional vertical, smooth rock faces covered with umbilicate lichens in the Black Mountains may also be this community. While the large High Elevation Granitic Domes farther south in the mountains sometimes have extensive faces dominated by umbilicate lichens, these apparently are not this community, which is confined to a few peaks north of Asheville and is limited to higher elevations. More study is needed to fully understand these communities. The move from High Elevation Granitic Dome remains somewhat uncertain, but their association with rocky summits and higher elevation appear to make it a better fit.

HIGH ELEVATION GRANITIC DOME G2G3

Synonyms: *Selaginella tortipila - Krigia montana - Houstonia longifolia* Herbaceous Vegetation (CEGL004283).
Ecological Systems: Southern Appalachian Granitic Dome (CES202.297).

Concept: Type covers communities of large, smooth, exfoliation surfaces with few cracks, at high elevations, generally over 3000 feet. Vegetation on granitic domes consists primarily of lichens on bare rock or of shallow mats generally dominated by *Selaginella tortipila*.

Distinguishing Features: Granitic Domes are distinguished from other rock outcrop communities by a near absence of crevices and deep soil pockets, so that the vegetation is strongly dominated by shallow mats. In contrast, glades have extensive areas of deeper soil where herb or shrub cove is high. Rocky summits may have local areas of shallow soil mats, but also support substantial plant cover rooted in crevices or deeper pockets. Cliffs are located in more topographically sheltered situations, generally on lower slopes or gorge walls, and generally also are more fractured. Smooth, exfoliated rock faces which extend onto lower slopes or gorge walls should be treated as High Elevation Granitic Domes if the rock is largely free of fractures and the vegetation is similar to that described above.

Comments: The Typic Subtype has two variants. The Typic Variant fits the above description of the subtype. The Ice/Rock Fall Variant is a distinctive open community that forms rarely at the base of vertical Granitic Dome faces where substantial amounts of ice form in the winter and fall to the base of the cliff. This variant is analogous in ecological process to the ice pond community of South Carolina (Hill 1999), but is at somewhat higher elevation. Its environment is a relatively level terrace of fallen boulders and soil at the base of the cliff, with small areas of water impounded by the accumulation of the terrace, and with a cold and wet microclimate created by accumulation of fallen ice. Its flora includes boulderfield and wetland species as well as typical Rocky Summit species, some of which apparently

established after falling from the rock above. This variant may prove distinctive enough to warrant a subtype or even a full type. However, occurrences are apparently all small and very heterogeneous.

The smooth rock surfaces of granitic domes give them different dynamics from other rock outcrop communities. Soil mats accumulate slowly, gradually becoming deep enough to support patches of shrubs and even trees. But those on steeper slopes eventually slough off, renewing the bare rock face. With roots confined to the soil mat, the fall of a tree in a storm or after its death in a drought, often pulls up the soil mat and destroys it. Granitic domes appear to exist as a mosaic of patches in a cyclic primary succession.

The High Peak Lichen Subtype, included in earlier drafts of the 4th Approximation, has been changed to a subtype of High Elevation Rocky Summit. This move remains somewhat uncertain.

Low Elevation Cliffs and Rock Outcrops

LOW ELEVATION ROCKY SUMMIT (ACIDIC SUBTYPE) G3?

Synonyms: *Saxifraga michauxii* Herbaceous Vegetation (CEGL004524).
Ecological Systems: Southern Appalachian Rocky Summit (CES202.327).

Concept: Type covers communities of flat to vertical outcrops of fractured rock on ridge tops, upper to mid slopes, or other topographically exposed settings at low to mid elevations, general below 4000 feet. Vegetation of Rocky Summits is sparse to moderate in density and is generally characterized by a mix of growth forms or by predominantly forbs and sparse woody vegetation. Subtype covers examples on felsic rocks, quartzite, or other acidic rocks, lacking plants that indicate higher pH conditions.

Distinguishing Features: Rocky Summits are distinguished from Montane Cliffs by occurring in topographically exposed situations. Cliffs are confined to lower slopes, gorges, or other sheltered environments. Rocky Summits are distinguished from glades and granitic domes by different rock and vegetation structure. They consist of rock with abundant crevices, in contrast to the smoother rock of granitic domes and glades. They thus offer scattered deeper rooting sites for plants as well as space for plants of bare rock and soil pockets. Domes offer mainly shallow soil mats, while glades offer more extensive soil that is a little deeper. Vegetation on rocky summits is generally characterized by a mix of growth forms, including lichens, mosses, forbs, graminoids, shrubs, and trees, or by predominantly forbs or shrubs. Rocky summits are distinguished from Heath Balds and various forest communities by low cover of woody plants, less than 50 percent cover.

The Acidic Subtype is distinguished from the Basic Subtype by the lack or near lack of plants preferring higher pH conditions, such as *Cheilanthes lanosa, Hylotelephium telephioides (= Sedum telephioides), Aquilegia canadensis,* and *Pycnanthemum incanum*. Given the often sparse vegetation of Rocky Summits, these species may be limited in abundance even in the Basic Subtype.

Comments: This community type occurs in Georgia, South Carolina, Tennessee, and probably Virginia, and occurs in the Piedmont as well as the Mountain Region.

LOW ELEVATION ROCKY SUMMIT (BASIC SUBTYPE) G1
Synonyms: *Saxifraga michauxii - Cheilanthes lanosa - Hylotelephium telephioides* Herbaceous Vegetation (CEGL004989).
Ecological Systems: Southern Appalachian Rocky Summit (CES202.327).

Concept: Subtype covers examples on mafic or basic igneous, metamorphic, or sedimentary rocks, or acidic rocks influenced by base-rich seepage, containing plants that prefer higher pH conditions.

Distinguishing Features: The Basic Subtype is distinguished from the Acidic Subtype by the presence of plants preferring higher pH conditions, such as *Cheilanthes lanosa, Hylotelephium telephioides (= Sedum telephioides), Aquilegia canadensis,* and *Pycnanthemum incanum*. Most species of the Acidic Herb Subtype, such as *Hydatica petiolaris (= Saxifraga michauxii*), *Danthonia spicata, Heuchera villosa,* and *Campanula divaricata* are also present. Rocky summits are extremely heterogeneous environments, with moisture and nutrient levels varying greatly among small microsites. Indicator plants of acidic or basic conditions may be sparse.

LOW ELEVATION ROCKY SUMMIT (QUARTZITE LEDGE SUBTYPE) G1
Synonyms: *Leiophyllum buxifolium - (Hudsonia montana) / Selaginella tortipila - Carex umbellata* Quartzite Outcrop Dwarf-shrubland (CEGL007010).
Ecological Systems: Southern Appalachian Rocky Summit (CES202.327).

Concept: Subtype covers the distinctive communities of flat-lying quartzite ledges at moderate elevation, with vegetation generally having abundant *Kalmia buxifolia (= Leiophyllum buxifolium), Hudsonia montana,* or *Rhododendron carolinianum,* and herbaceous mats dominated by *Selaginella tortipila*. The extensive smooth horizontal surfaces, coupled with the weathering resistance and extreme acidity of quartzite, make these sites a distinct environment with vegetation not resembling other rocky summits. These communities are best developed and most extensive on the rim of Linville Gorge. They may occur elsewhere, but not all quartzite rocky summits support this subtype.

Distinguishing Features: The Quartzite Ledge Subtype is distinguished from the other subtypes of both Low Elevation Rocky Summit and High Elevation Rocky Summit by the combination of distinctive environmental features, as well as by its vegetation. *Selaginella tortipila* is not prominent in other subtypes, and *Kalmia buxifolia* is much less frequent. *Hudsonia montana* is present only on the southeast rim of Linville Gorge, but this type may be recognized outside of its range where flat-lying quartzite ledges support an otherwise-similar community. While the Quartzite Ledge Subtype resembles High Elevation Granitic Dome in having *Selaginella tortipila* as a near-constant patch dominant, and in sharing a number of species, including *Carex umbellata, Danthonia sericea,* and a number of the shrubs, there are substantial floristic as well as environmental differences. In roughly 15 plots in the Carolina Vegetation Survey database for the Quartzite Ledge Subtype and 40 for Granitic Domes, plant species frequent in the Quartzite Ledge Subtype and seldom or never in Granitic Domes include *Hypericum densiflorum, Xerophyllum asphodeloides, Coreopsis major,* and *Tsuga caroliniana*. Species of High Elevation Granitic Domes and scarce or absent in this subtype include *Hypericum gentianoides, Houstonia longifolia, Hypericum buckleyi, Krigia montana,* and *Diervilla sessilifolia*.

Comments: This subtype is equivalent to the 3rd Approximation Quartzite Variant of High Elevation Rocky Summit. Its elevational range is near the 4000 elevation that is the general division between High

Elevation and Low Elevation Rocky Summit. However, most examples fall below 4000 feet, and the xeric nature of the vegetation, importance of fire, and absence of most of the characteristic high elevation plant species tie it more closely to other Low Elevation Rocky Summits.

LOW ELEVATION GRANITIC DOME G2

Synonyms: *Selaginella rupestris - Schizachyrium scoparium - Hypericum gentianoides - Bulbostylis capillaris* Herbaceous Vegetation (CEGL007690).
Ecological Systems: Southern Appalachian Granitic Dome (CES202.297).

Concept: Covers communities of lower elevation, large, smooth, exfoliation surfaces with few cracks, where vegetation consists primarily of lichens on bare rock or of shallow mats generally dominated by *Selaginella rupestris*. They generally occur below 3000 feet elevation.

Distinguishing Features: Granitic Domes are distinguished from other rock outcrop communities by a near absence of crevices and deep soil pockets, so that the vegetation is strongly dominated by shallow mats. In contrast, glades have undulating rock with more extensive areas of better-developed shallow soil where graminoids and low shrubs may predominate. Rocky summits may have local areas of shallow soil mats, but also support substantial plant cover rooted in crevices or deeper pockets. Cliffs are located in more topographically sheltered situations, generally on lower slopes or gorge walls, and generally also are more fractured. Smooth, exfoliated rock faces which extend onto lower slopes or gorge walls should be treated as High Elevation Granitic Domes if the rock is largely free of fractures and the vegetation is similar to that described above.

Comments: The communities formerly known as the Basic Variant of Low Elevation Granitic Dome have been removed to the newly defined Low Elevation Basic Glade type. This association occurs in North Carolina, Georgia, and possibly South Carolina.

Low Elevation Granitic Domes appear to undergo a cyclic primary succession in small patches, similar to that in High Elevation Granitic Domes.

MONTANE CLIFF (ACIDIC HERB SUBTYPE) G3G4

Synonyms: *Asplenium montanum - Heuchera villosa* Felsic Cliff Sparse Vegetation (CEGL004980).
Ecological Systems: Southern Appalachian Montane Cliff and Talus (CES202.330).

Concept: Type covers steep to vertical rock outcrops on river bluffs, lower slopes, and other topographically sheltered locations. It is more narrowly defined than the features that are commonly called cliffs; vertical outcrops on ridge tops and upper slopes are classified as Rocky Summit communities. Some of the communities called cliffs in the Third Approximation have been removed to the new glade types. Subtype covers the more common examples where bare rock, crustose lichens, mosses, or sparse herbs and woody vegetation predominate.

Distinguishing Features: Montane Cliffs are distinguished from forest and shrubland communities by having contiguous rock outcroppings large enough to form a canopy break. In general, the minimum size is about 10 meters in height. Smaller rock outcrops that are completely shaded by the adjacent forest should not be treated as notable occurrences. Montane Cliffs are distinguished from Rocky Summit

communities by occurring in more topographically sheltered locations, generally below mid slope. The plant species that are incidentally present are more likely to include mesophytic species such as *Tsuga canadensis, Quercus rubra, Betula* spp., or *Rhododendron maximum*, and to lack plants of more exposed sites. However, cliffs are heterogeneous environments, and xerophytic, mesophytic, and even hydrophytic species are often present in different microsites in close proximity. In addition, cliffs can vary with slope aspect and degree of topographic sheltering.

Montane Cliffs are distinguished from Low Elevation Acidic Glades and Low Elevation Basic Glades by having vertical rock more prominent and by having only limited area of soil mats with herbaceous vegetation. The herbaceous and woody vegetation that is present on Montane Cliffs is primarily rooted on bare rock or in crevices rather than in soil mats.

The Acidic Herb Subtype is distinguished from the Carolina Rocktripe Subtype by having vegetation dominated by bare rock, crustose lichens, or plants other than umbilicate lichens, though umbilicate lichens may be a component. The Acidic Herb Subtype is distinguished from the Mafic and Calcareous Subtypes by the absence of plant species indicative of higher pH conditions. These indicator plants are sometimes present only in small numbers, as all plants are usually sparse on cliffs.

Comments: The acidic, mafic, and calcareous cliff communities, treated as full types in the Third Approximation, have been reduced to subtypes here. In general, the variation in these communities due to chemical influences, while real, appears to be more limited than previously believed.

Much descriptive literature differentiates cliffs by slope aspect. These differences can be striking when extreme, but variable occurrence of seepage and extremely variable microsites usually make the distinction nearly meaningless. The most sheltered cliffs can be very dry, and even south-facing cliffs can have moist crevices or wet seeps. Slope aspect is potentially more important in the more exposed vertical portions of some Rocky Summit communities.

Comments: This subtype as defined is more diverse than most other subtypes. Additional subtypes may be able to be distinguished with more study. Variants that can be recognized include examples on quartzite, examples on felsic gneisses and schists, and very moist, moss-covered examples transitional to Spray Cliff. Montane Cliff Sparse Vegetation (CEGL004993) was formerly defined in NVC for North Carolina, but has been dropped.

MONTANE CLIFF (ACIDIC LICHEN SUBTYPE) G2?
Synonyms: *Lasallia papulosa - Lasallia pensylvanica* Nonvascular Vegetation (CEGL004385).
Ecological Systems: Southern Piedmont Cliffs (CES202.386).

Concept: Subtype covers the rare examples that are dominated by umbilicate lichens. These outcrops are known only from the upper Piedmont, but they are associated with communities more typical of the Blue Ridge and their floristic affinities are most closely tied to Montane Cliff

Distinguishing Features: Subtype is distinguished from all other communities by the dominance of *Lasallia papulosa* and *Lasallia pensylvanica* with virtually no vascular plants.

Comments: This is a very narrowly defined, very rare, community. At present, it is known only from Hanging Rock State Park; however, it has not been widely sought and may be found elsewhere.

MONTANE CLIFF (CAROLINA ROCKTRIPE SUBTYPE) G4?
Synonyms: *Umbilicaria mammulata* Nonvascular Vegetation (CEGL004387).
Ecological Systems: Southern Appalachian Montane Cliff and Talus (CES202.330).

Concept: Moist, shaded, generally vertical outcrops, where *Umbilicaria mammulata* strongly dominates over a large area and vascular plants are sparse or absent.

Distinguishing Features: The Carolina Rocktripe Subtype is distinguished from all other subtypes by the dominance of *Umbilicaria mammulata* over an area of at least 0.1 hectare. It has not been widely recognized, but is not believed as rare as the Acidic Lichen Subtype.

MONTANE CLIFF (MAFIC SUBTYPE) G3
Synonyms: (*Hydrangea arborescens, Toxicodendron radicans) / Heuchera americana - (Dichanthelium depauperatum, Woodsia obtusa)* Shrubland (CEGL004395).
Ecological Systems: Southern Appalachian Montane Cliff and Talus (CES202.330).

Concept: Subtype covers all examples occurring on mafic substrates or mixed substrates containing plant species characteristic of mafic substrates.

Distinguishing Features: The Mafic Subtype is distinguished by occurrence on mafic rock substrate or by the presence of plants that indicate basic soil conditions but without those indicative of stronger calcareous conditions. *Cystopteris protrusa, Micranthes (Saxifraga) careyana, Micranthes (Saxifraga) caroliniana, Asplenium trichomanes, Asplenium rhizophyllum, Aquilegia canadensis, Hydrangea arborescens, Philadelphus inodorus, Ulmus rubra*, or species of Rich Cove Forests may indicate basic chemistry. Indicator plants are often low in abundance, with more widespread species of rock outcrops or of surrounding forests more common. *Toxicodendron radicans* is sometimes abundant. These communities generally occur on mafic rocks, but may occur on felsic rocks that are influenced by the chemistry of nearby mafic rocks through seepage.

Comments: The acidic, mafic, and calcareous cliff communities, treated as full types in the Third Approximation, have been reduced to subtypes here. In general, the variation in these communities due to chemical influences appears to be more limited than previously believed. The distinction between the Mafic Subtype and Calcareous Subtype needs further study.

MONTANE CLIFF (CALCAREOUS SUBTYPE) G3G4
Synonyms: *Asplenium ruta-muraria - Pellaea atropurpurea* Sparse Vegetation (CEGL004476).
Ecological Systems: Southern Interior Calcareous Cliff (CES202.356).

Concept: Subtype covers examples on dry to moist calcareous rock, characterized by *Pellaea atropurpurea, Asplenium ruta-muraria, Asplenium resiliens, Aquilegia canadensis, Cystopteris bulbifera*, and a variety of mosses.

Distinguishing Features: The Calcareous Subtype is distinguished from other subtypes by the presence of strong calciphilic plants such as *Pellaea atropurpurea, Cystopteris bulbifera, Asplenium ruta-muraria, Asplenium resiliens*, as well as more generally base-loving species such as *Aquilegia canadensis* and *Asplenium rhizophyllum*.

Comments: *Cystopteris bulbifera - (Asplenium rhizophyllum)* Sparse Vegetation (CEGL004394) is another calcareous cliff association of sinkhole walls, occurring in adjacent states. It is unlikely to occur in North Carolina.

TALUS VINELAND G2G3Q
Synonyms: *Parthenocissus quinquefolia / (Dicentra eximia)* Sparse Vegetation (CEGL004454).
Ecological Systems: Southern Appalachian Montane Cliff and Talus (CES202.330).

Concept: Type covers treeless or nearly treeless rocky areas of gorge walls below rock outcrops, dominated by vines.

Distinguishing Features: Talus Vinelands are distinguished from all forest communities, including those of boulderfields, by lacking a well-developed tree canopy. They are distinguished from rock outcrop communities by having cover strongly dominated by woody vines.

Comments: This type was not known at the time of the Third Approximation. They are apparently extremely rare in North Carolina, but their distribution and natural character are very poorly known.

PIEDMONT CLIFF (ACIDIC SUBTYPE) G2?
Synonyms: Piedmont Acidic Cliff Sparse Vegetation (CEGL003979).
Ecological Systems: Southern Piedmont Cliff (CES202.386).

Concept: Type covers the herbaceous-dominated to sparsely vegetated communities of acidic cliffs - outcrops of felsic igneous or metamorphic rocks or acidic sediments, in topographically sheltered locations such as river bluffs, and steep to vertical slopes. The vegetation often includes some woody plants rooted in deeper soil pockets or crevices, but the overall woody cover is low. Subtype covers typical examples lacking basic flora, excepting the rare quartzite outcrops that are dominated by foliose lichens.

Distinguishing Features: Cliff communities in general are distinguished from Rocky Summit communities by occurring in topographically low and therefore sheltered positions such as bluffs or lower slopes. They are distinguished from Rocky Bar and Shore communities, which also occur in topographically low sites by the lack of flooding, with its associated transport of seeds and scouring of soil. Cliff communities are distinguished from glade communities in general by having lower vegetation cover, with much bare rock present, herbaceous cover persistently less than 25 percent, and woody plants restricted to rare specialized microsites. Cliffs generally have substantial vertical or very steep surface, but more gently sloping rock outcrops should be placed in this category if they don't meet the criteria for other kinds of rock outcrops. Flat ledges on cliff faces and related vegetation on flatter tops of outcrops are included in the cliff occurrence. Piedmont/Coastal Plain Cliffs are distinguished from

Montane Cliffs by having flora that lacks characteristic mountain species such as *Hydatica petiolaris (= Saxifraga michauxii)* and *Asplenium montanum*, and having a generally more southern floristic composition. Cliffs with montane flora in the upper Piedmont are classified as Montane Cliffs.

The Acidic Subtype is distinguished from the other subtypes by lacking base-loving flora.

Comments: As with other Mountain communities, Montane Cliffs may occur on upper Piedmont monadnocks. The lichen-covered cliffs at Hanging Rock in the Sauratown Mountains, called Piedmont Cliff (Acidic Lichen Subtype) are one of these disjunct communities, and are now classified as Montane Cliff (Acidic Lichen Subtype).

PIEDMONT CLIFF (BASIC SUBTYPE) G2?
Synonyms: Piedmont Mafic Cliff Sparse Vegetation (CEGL003982).
Ecological Systems: Southern Piedmont Cliff (CES202.386).

Concept: See above for concept of cliffs. The Basic Subtype covers examples with basic substrates and substantial base-loving flora present.

Distinguishing Features: The Basic Subtype is distinguished from other subtypes by the presence of base-loving flora in more than token numbers. Acid-loving flora typical of the Acidic Subtype is usually present as well. In the absence of full floristic information, substrate chemistry may provisionally be used to distinguish this subtype; however, some mafic rock outcrops have vegetation indistinguishable from felsic rock outcrops. Cliffs of meta-mudstone and andesitic igneous and metamorphic rocks, which have intermediate chemistry, should be classified as the Basic Subtype only if base-loving flora is present.

Comments: The Montane Cliff type has separate subtypes for mafic and calcareous substrates. The 3rd Approximation also recognized separate Piedmont Mafic and Piedmont Calcareous Cliff types. However, no well-developed examples of Calcareous Cliffs were found outside of mountain-like upper Piedmont areas.

COASTAL PLAIN CLIFF G2?
Synonyms: Coastal Plain Acidic Cliff Sparse Vegetation (CEGL004388). Piedmont/Coastal Plain Acidic Cliff (3rd approximation).
Ecological Systems:

Concept: Type covers sparsely vegetated, largely dry communities of steep to vertical exposures of bare substrate.

Distinguishing Features: Coastal Plain Cliffs are distinguished from most communities of the Coastal Plain by sparse vegetation on steep to vertical exposures. Piedmont/Coastal Plain Heath Bluff and Cape Fear Valley Mixed Bluff Forest occur on steep bluffs but have dense vegetation. Coastal Plain Cliffs are distinguished from Coastal Plain Seepage Bank communities by having only local saturated seepage zones and having a flora consisting primarily of upland plants. They are distinguished from Piedmont Cliffs by occurring on unconsolidated Coastal Plain sediments rather than acidic crystalline rock, and by

the more dynamic environment this creates. There are substantial floristic differences between Piedmont and Coastal Plain cliff communities. Many of the most characteristic species, such as *Morella cerifera* and *Pinus taeda,* are scarce and infrequent on Piedmont cliffs. Characteristic Piedmont cliff species that don't typically occur on Coastal Plain cliffs include *Pinus virginiana, Chionanthus virginicus, Rhododendron* spp., *Vaccinium pallidum, Danthonia spicata, Cheilanthes lanosa, Solidago caesia, Pleopeltis polypodioides,* and *Hieracium venosum*. Distinctive species of Coastal Plain Cliff are less well known, but *Morella cerifera, Vaccinium arboreum,* and *Pinus taeda* are often common. *Mikania scandens, Andropogon tenuispatheus*, and a variety of weedy species may be present.

Coastal Plain Marl Outcrop

COASTAL PLAIN MARL OUTCROP (BLUFF SUBTYPE) G1?

Synonyms: *Aquilegia canadensis - Asplenium X heteroresiliens* Herbaceous Vegetation (CEGL004269).
Ecological Systems: Southern Atlantic Coastal Plain Mesic Hardwood Forest (CES203.242).

Concept: Type covers vegetated outcrops of limestone ("marl") in the Coastal Plain. Subtype covers the typical (though still rare) examples on bluffs or non-flooded stream banks in the Coastal Plain. These outcrops are small and generally are substantially shaded by trees rooted in adjacent forests, but have very distinctive flora on the rocks. The rock is usually a mix of dry and wet microhabitats.

Distinguishing Features: Coastal Plain Marl Outcrops are distinguished by the presence of bare or vegetated limestone that is not regularly flooded. Calciphilic vascular plants such as *Asplenium heteroresiliens, Cystopteris tennesseensis,* and *Aquilegia canadensis* are usually present. Distinctive calciphilic bryophytes are believed to be present but are not well studied. The Bluff Subtype is distinguished by its environment, occurring on bluffs or stream banks, with substantial forest shading.

COASTAL PLAIN MARL OUTCROP (LAKE SHORE SUBTYPE) G1Q

Synonyms: *Adiantum capillus-veneris / Conocephalum conicum* Herbaceous Vegetation (CEGL004515).
Ecological Systems:

Concept: Subtype covers the unique limestone bluff on the north shore of Lake Waccamaw, exposed to spray and to storm waves, and not shaded by trees.

Distinguishing Features: The Lake Shore Subtype is distinguished by occurrence on an open lake shore. It is unlikely to be found anywhere other than Lake Waccamaw.

Granitic Flatrocks

GRANITIC FLATROCK (ANNUAL HERB SUBTYPE) G3

Synonyms: *Diamorpha smallii - Minuartia glabra - Minuartia uniflora - Cyperus granitophilus* Herbaceous Vegetation (CEGL004344).
Ecological Systems: Southern Piedmont Granitic Flatrock and Outcrop (CES202.329).

Concept: Type covers open, largely-treeless, primary successional communities of exfoliated granitic rocks in the eastern and central Piedmont. They are generally level or only gently sloping. They may locally include moderate slopes, but lack the extensive steeper slopes characteristic of Granitic Domes.

Subtype is a zone within a mosaic, representing the earlier stages of primary succession -- shallow soil accumulations, often in slight depression, and dominated by annual herbs, typically *Diamorpha smallii* and *Minuartia glabra* in North Carolina. Also implicitly included are the bare rock, lichen mats, and mats of *Grimmia laevigata* and other mosses.

Distinguishing Features: Granitic Flatrocks are distinguished from Granitic Domes by rock structure and by floristic differences, including the presence of characteristic species such as *Diamorpha smallii, Minuartia glabra, Packera tomentosa, Croton willdenowii (= Crotonopsis elliptica),* and the absence of plants more characteristic of the Blue Ridge. They are generally distinguished by gentler topography and the associated presence of small depressions, but the range of slopes can overlap with that of Granitic Domes. Granitic Flatrocks are distinguished from all other rock outcrop communities by the characteristic physical structure produced by exfoliation, with shallow depressions but few crevices, fractures, or deeper soil pockets.

The Annual Herb Subtype is distinguished from other zones by the dominance of mosses, lichens, or annual herbs, usually *Diamorpha* or *Minuartia,* but also including *Diodia teres, Cyperus granitophilus, Hypericum gentianoides,* and others.

Comments: The Annual Herb Zone and Perennial Herb Zone, as well as the smaller zones implicitly covered by them, are often interspersed in a fine-scale mosaic but sometimes occur in patches up to 10 meters or more across. They shift slowly over time as soil builds up around nuclei of vegetation, or is destroyed by windthrow. It is not entirely clear if it is useful to have the two subtypes distinguished, when they are so closely tied together. They may be lumped back together in a future approximation. However, they do occur in differing proportions on different outcrops, and they may respond differently to threats such as trampling and climate change.

GRANITIC FLATROCK (PERENNIAL HERB SUBTYPE) G3
Synonyms: *Packera tomentosa - Croton willdenowii - Schizachyrium scoparium - (Selaginella rupestris)* Herbaceous Vegetation (CEGL004298).
Ecological Systems: Southern Piedmont Granitic Flatrock and Outcrop (CES202.329).

Concept: Subtype covers portions dominated by perennial herbs, low shrubs, or stunted trees growing in shallow soil mats.

Distinguishing Features: The Perennial Herb Zone is distinguished from the Annual Herb Subtype by the dominance of perennial herbs or woody plants.

GRANITIC FLATROCK BORDER WOODLAND G3?
Synonyms: *Pinus (virginiana, taeda) / Juniperus virginiana - Chionanthus virginicus - Ulmus alata* Granitic Flatrock Border Forest (CEGL003993).
Ecological Systems: Southern Piedmont Granitic Flatrock and Outcrop (CES202.329).

Concept: Type covers open xerophytic forests and woodlands on shallow soils around Granitic Flatrocks, more xerophytic than the surrounding upland forests. They are generally dominated by *Pinus virginiana* or *Pinus taeda*, with abundant *Juniperus virginiana* and a varying mix of xerophytic hardwoods such as *Quercus stellata, Quercus marilandica, Ulmus alata, Carya glabra*, and *Carya tomentosa*. Some mesophytic and even a few wetland species may be present in minor amounts. *Quercus phellos* occurs in a number of examples, but is not a major component.

Distinguishing Features: The Granitic Flatrock Border Woodland is distinguished from all other upland forests and woodlands in its location on shallow soil over exfoliated granitic rock. The most closely related community, Piedmont Acidic Glade, is the only other Piedmont community that may be naturally dominated by *Pinus virginiana* or *Pinus taeda*. It also has a similarly xerophytic and acid-tolerant composition. However, it has a more open canopy, generally has *Quercus montana* as an important canopy component, and tends to have a well-developed shrub or herb layer. Piedmont Basic Glade also shares an open structure created by shallow soil and bedrock. It has a larger component of base-loving flora, though a few members (*Rhus aromatica, Chionanthus virginicus*) are sometimes shared with this type. Granitic Flatrock Border Woodlands can be particularly hard to distinguish from anthropogenic successional communities, which may also be dominated by pines, especially because they may often share an abundance of invasive non-native plants. Granitic Flatrock Border Woodlands are most easily distinguished by their site characteristics, including soils too shallow to plow, absence of evidence of cultivation, and association with rock outcrops. Their vegetation is less likely to be even-aged, more likely to have an abundance of *Juniperus,* and more likely to have a mix of pines and hardwoods of the same age.

Piedmont and Mountain Glades and Barrens

HIGH ELEVATION MAFIC GLADE G1

Synonyms: *(Kalmia latifolia, Physocarpus opulifolius) / Schizachyrium scoparium - Thalictrum revolutum - Sibbaldiopsis tridentata* Shrub Herbaceous Vegetation (CEGL004238).
Ecological Systems: Southern and Central Appalachian Mafic Glade and Barrens (CES202.348).

Concept: Gently sloping, high elevation amphibolite outcrops with patchy shallow soils supporting a mosaic of grass and shrub vegetation alternating with bare rock. Currently known only from Bluff Mountain, Mount Jefferson, and one site in Virginia.

Distinguishing Features: Distinguished by glade physiognomy of substantial grass and shrub dominance along with substantial bare rock, occurring at high elevations, combined with characteristic species composition of *Schizachyrium scoparium, Helianthemum bicknellii, Ionactis linariifolius (= Aster linariifolius), Coreopsis major, Danthonia spicata, Cladonia* spp., and *Cladina* spp.

Comments: Originally defined as a community that occurred only on Bluff Mountain, this type has been merged with two other high elevation amphibolites glades, at Mountain Jefferson and Buffalo Mountain in Virginia. The Bluff Mountain glade remains distinctive in being flat, which allows moisture to sit on the rock and enables the site to support *Cladonia* lichens which are scarce or absent on the other examples. The Bluff Mountain and Mount Jefferson communities are distinctive enough to recognize as variants.

LOW ELEVATION ACIDIC GLADE (GRASS SUBTYPE) G1G2
Synonyms: *(Quercus prinus) / Vaccinium pallidum / Schizachyrium scoparium - Danthonia spicata / Cladonia* spp. Herbaceous Vegetation (CEGL004990).
Ecological Systems: Southern Appalachian Granitic Dome (CES202.297).

Concept: Type covers communities on gently to moderately sloping outcrops of felsic igneous or metamorphic rocks with irregular or undulating surfaces but few crevices, and vegetation characterized by predominantly graminoids, low shrubs, and open trees, in fairly shallow soil mats. Subtype covers the drier examples where *Schizachyrium scoparium, Danthonia* spp., or other dry-site grasses predominate.

Distinguishing Features: Low Elevation Acidic Glades are distinguished from Low Elevation Granitic Domes by the predominance of somewhat deeper soil mats, capable of supporting grasses. Lichen-covered bare rock and thin mats dominated by *Selaginella* are often present but occupy only a small part of the area, while grassy mats and low shrub patches are more prominent. Trees may be dispersed throughout the community rather than largely confined to the edge or to rare microsites. Low Elevation Acidic Glades are distinguished from Low Elevation Mafic Glades by the absence of plant species characteristic of higher pH conditions, such as *Hylotelephium telephioides (= Sedum telephioides), Dodecatheon meadia, Sedum glaucophyllum, Cheilanthes lanosa, Arabis laevigata,* and *Penstemon canescens.* Low Elevation Acidic Glades are distinguished from Low Elevation Rocky Summits by having few crevices. They have abundant grassy or low shrub mats in shallow soil but relatively few forbs or woody plants rooted in crevices.

The Grass Subtype is distinguished from the Biltmore Sedge Subtype by having grassy mats predominantly consisting of *Schizachyrium scoparium, Danthonia spicata,* or other dry-site grasses or herbs rather than *Carex biltmoreana* or other *Carex* spp.

LOW ELEVATION ACIDIC GLADE (BILTMORE SEDGE SUBTYPE) G2G3
Synonyms: *Carex biltmoreana - Pycnanthemum* spp. - *Krigia montana* Herbaceous Vegetation (CEGL004523).
Ecological Systems: Southern Appalachian Granitic Dome (CES202.297).

Concept: Subtype covers more moist examples where *Carex biltmoreana* or other sedges are dominant. They generally occur as fairly small openings in forested areas, but may occur adjacent to High Elevation Granitic Dome or Low Elevation Granitic Dome communities as part of a complex.

Distinguishing Features: The Biltmore Sedge Subtype is distinguished from the Grass Subtype by having abundant *Carex biltmoreana*. It is similarly distinguished from Low Elevation Granitic Dome and High Elevation Granitic Dome, which may also contain *Smilax biltmoreana*, by greater cover of graminoids and herbs and smaller amounts of bare and lichen-covered rock and shallow mats dominated by *Selaginella*. While patches of *Smilax biltmoreana* may occur on Granitic Domes, one ones that are extensive enough to be a free-standing community should be considered this subtype.

LOW ELEVATION BASIC GLADE (MONTANE SUBTYPE) G2
Synonyms: *Selaginella rupestris - Schizachyrium scoparium - Hylotelephium telephioides - Allium cernuum* Herbaceous Vegetation (CEGL004991).
Ecological Systems: Southern and Central Appalachian Mafic Glade and Barrens (CES202.348).

Concept: Type covers communities of the Mountains and upper Piedmont on gently to moderately sloping low elevation outcrops with irregular or undulating surfaces but few crevices, and containing plants characteristic of higher pH conditions. In rock physical structure they are intermediate between Granitic Domes and Rocky Summits. Vegetation structure is somewhat closer to that of Low Elevation Granitic Dome in relative amounts of shallow *Selaginella* mats and deeper grassy mats than is the case for the Low Elevation Acidic Glade type. Subtype covers all examples in the Blue Ridge and Upper Piedmont other than the distinctive examples of the Brushy Mountains which are represented by the Brushy Mountain Subtype.

Distinguishing Features: Low Elevation Basic Glades are distinguished from both Low Elevation Granitic Domes and Low Elevation Acidic Glades by the presence of plants characteristic of higher pH soils, such as *Hylotelephium telephioides (= Sedum telephioides), Dodecatheon meadia, Sedum glaucophyllum, Cheilanthes lanosa, Arabis laevigata*, and *Penstemon canescens.* They are distinguished from High Elevation Mafic Glades by occurring below 4000 feet elevation and by the absence of characteristic high elevation species such as *Sibbaldiopsis tridentata*. Low Elevation Basic Glades are distinguished from Low Elevation Rocky Summits by having few crevices or fractures in the rock, by having fewer deep-rooted forbs, shrubs, and trees that depend on deeper soil, and by having more plant cover and less bare rock.

Comments: Both subtypes of Low Elevation Basic Glade are more common than the High Elevation Mafic Glade, of which only two examples are known. The type is called Basic rather than Mafic because many examples occur on felsic rocks which show floristic evidence of higher pH soils. The source of the basic or circumneutral pH environment on these outcrops is sometimes apparently seepage, and other times is unknown. Low Elevation Basic Glades often occur on dome-like undulating rocks that appear to be exfoliation surfaces that have become pitted. They may also occur on other kinds of unfractured rock, potentially including dip slopes of sedimentary or metamorphic rocks. Occurrences of this subtype are highly variable, and further study may recognize variants or more subtypes.

This association occurs in North Carolina and possibly in Virginia and South Carolina.

LOW ELEVATION BASIC GLADE (BRUSHY MOUNTAIN SUBTYPE) G2
Synonyms: *Selaginella rupestris - Croton willdenowii - Cheilanthes tomentosa - (Allium cuthbertii)* Herbaceous Vegetation (CEGL004992).
Ecological Systems: Southern Appalachian Granitic Dome (CES202.297).

Concept: Subtype covers the floristically distinctive examples currently known only in from the Brushy Mountains, distinguished by *Croton willdenowii (= Crotonopsis elliptica)* and a suite of other plant species.

Distinguishing Features: The Brushy Mountain Subtype is distinguished by a suite of distinctive plant species, including *Croton willdenowii (= Crotonopsis elliptica), Allium cuthbertii, Cheilanthes*

tomentosa, Pseudognaphalium obtusifolium (= Gnaphalium obtusifolium), Coreopsis tripteris, Hypericum denticulatum, Senna marilandica (= Cassia marilandica), and *Diodia teres*.

Comments: These communities were part of the Low Elevation Granitic Dome type in the 3rd Approximation. It has been uncertain whether they are best regarded as a subtype of Low Elevation Basic Glade or of Low Elevation Granitic Dome. It appears that most of the rock outcrops in the Brushy Mountains are the relatively vegetated glade communities covered by this type. A few of the largest outcrops have open areas that are better classified as Low Elevation Granitic Dome and which are not as distinct from Low Elevation Granitic Domes elsewhere. The glade communities appear to be distinct from the glades in the Blue Ridge, and to warrant this subtype. This is a rare, narrowly endemic subtype.

MONTANE RED CEDAR–HARDWOOD WOODLAND G2

Synonyms: *Carya (glabra, alba) - Fraxinus americana - (Juniperus virginiana var. virginiana)* Woodland (CEGL003752). Montane Red Cedar–Hardwood Woodland; Low Elevation Granitic Dome (in part) (Third Approximation).
Ecological Systems: Southern and Central Appalachian Mafic Glade and Barrens (CES202.348).

Concept: Type covers the rare open-canopy woodlands on shallow soils over bedrock, containing plants indicative of circumneutral soil conditions. *Juniperus virginiana, Fraxinus americana,* or *Carya* spp. are abundant, but *Quercus prinus* or other oaks are often also abundant. Subtype covers examples within the Blue Ridge, which occur at higher elevation and are different floristically from those in the upper Piedmont.

Distinguishing Features: Montane Red Cedar–Hardwood Woodlands are distinguished from other forest and woodland communities by having an open canopy that includes *Juniperus virginiana*, *Fraxinus americana*, or *Carya* spp. as an abundant component and having lower strata that include both species needing high light levels and species typical of circumneutral soil conditions. Characteristic species include *Schizachyrium scoparium, Danthonia* spp., *Coreopsis pubescens, Physocarpus opulifolius, Philadelphus hirsutus,* and *Dodecatheon meadia*. Montane Red Cedar–Hardwood Woodlands are distinguished from closely related rock outcrop communities by vegetation structure. The rock outcrop communities lack even an open tree canopy over most of their area, while the woodlands have at least 25 percent tree cover. Low Elevation Basic Glade communities may have more trees and more vegetation cover, but also are more open and have more bare rock than Montane Red Cedar–Hardwood Woodland. Granitic Dome Basic Woodland is similar, but has a denser canopy with less diverse shade-intolerant flora, and occurs in the upper Piedmont.

Comments: This community is primarily in North Carolina, but a couple of sites occur in Virginia. Though initially thought to occur in Tennessee, it now appears that it does not.

GRANITIC DOME BASIC WOODLAND G2

Synonyms: *Fraxinus americana - Carya glabra / Symphoricarpos orbiculatus - Rhus aromatica / Piptochaetium avenaceum* Woodland (CEGL003684). Basic Oak–Hickory Forest. [Called Montane Red Cedar–Hardwood Woodland (Piedmont Dome Subtype) in earlier drafts.]
Ecological Systems: Southern Piedmont Glades and Barrens (CES202.328).

Concept: Type covers the forests on shallow soils around the edges of exfoliated rock outcrops in the upper Piedmont. These communities contain some plants indicative of base-rich or circumneutral soils, despite the acidic nature of the granitic rocks. *Fraxinus americana* and *Carya* spp. are abundant, and oaks are scarce.

Distinguishing Features: The type is distinguished by closed or slightly open forest associated with Piedmont granitic dome exfoliated rock outcrops, with composition different from typical upland forests because of apparent higher base status and shallow soil. The concept should be reserved for substantial expanses of woodland or forest, not for the small woody patches that are a normal part of the Low Elevation Granitic Dome community.

Granitic Dome Basic Woodlands are conceptually similar to Montane Red Cedar–Hardwood Woodland, and are distinguished by their location in the Piedmont or lower Blue Ridge escarpment, and by a flora lacking most of the montane elements. Abundance of *Piptochaetium avenaceum* is often a good indicator. Granitic Dome Basic Woodlands are also conceptually similar to Granitic Flatrock Border Woodlands, but differ substantially in flora and can also be distinguished geographically.

Comments: *Quercus prinus - Quercus stellata - Carya glabra / Vaccinium arboreum - Viburnum rufidulum* Forest (CEGL004416) is an association with a somewhat confusing description, which may partly overlap this community type and the association synonymized above.

ULTRAMAFIC OUTCROP BARREN (PITCH PINE SUBTYPE) G1
Synonyms: *Pinus rigida - Quercus alba / Sporobolus heterolepis - Andropogon gerardii* Woodland (CEGL003768).
Ecological Systems: Eastern Serpentine Woodland (CES202.347).

Concept: Type covers the very rare forests and woodlands with distinctive structure and floristic composition associated with soils developed on ultramafic rock substrates. Characteristics include low overall plant species richness due to exclusion of some species by soil chemistry, unusual combinations of plants with different typical moisture tolerances, and generally, unusually open, grassy vegetation.

Subtype covers the more extremely developed examples at elevations above about 3000 feet, where *Pinus rigida* dominates or codominates a generally open canopy. A well-developed herb layer dominated by prairie grasses is generally present.

Distinguishing Features: Type is distinguished by occurrence on ultramafic rock substrate and unusually open, barren vegetation structure. The Pitch Pine Subtype is distinguished from the Virginia Pine Subtype by the predominance of *Pinus rigida* and scarcity of *Pinus virginiana*. It is distinguished from the White Oak Subtype by having a more open canopy with *Pinus rigida* dominant or codominant.

ULTRAMAFIC OUTCROP BARREN (WHITE OAK SUBTYPE) G1
Synonyms: *Quercus alba / Physocarpus opulifolius / Packera plattensis - Hexastylis arifolia var. ruthii* Forest (CEGL007296).
Ecological Systems: Eastern Serpentine Woodland (CES202.347).

Concept: Subtype covers the less barren examples at elevations above about 3000 feet, where *Quercus alba* or other more mesophytic species form an open to nearly closed canopy.

Distinguishing Features: The White Oak Subtype is distinguished from the Pitch Pine Subtype and the Virginia Pine Subtype by a greater canopy density and by the predominance of *Quercus alba* in the canopy, with only minority amounts of *Pinus rigida* or *Pinus virginiana* and other more xerophytic species. In the only known example the canopy is nearly closed, but it probably existed as an open savanna or woodland under the natural fire regime.

ULTRAMAFIC OUTCROP BARREN (VIRGINIA PINE SUBTYPE) G1
Synonyms: *Pinus virginiana - Pinus rigida - Quercus stellata / Ceanothus americanus - Kalmia latifolia / Thalictrum revolutum* Woodland (CEGL007721).
Ecological Systems: Eastern Serpentine Woodland (CES202.347).

Concept: Subtype covers lower elevation Blue Ridge examples with *Pinus virginiana* as a major canopy species. It has not been found intact in North Carolina but probably occurred in the past. Examples are present just over the border in Virginia.

Distinguishing Features: Subtype is distinguished from the higher elevation subtypes by occurrence at elevations below about 3000 feet and abundance of typically lower elevation plants such as *Pinus virginiana, Pinus echinata,* and *Quercus stellata*. It is distinguished from the Piedmont Subtype by the abundance of *Pinus virginiana*.

Comments: Originally tied to *Pinus virginiana - Pinus rigida - Quercus stellata / Ceanothus americanus - Kalmia latifolia / Thalictrum revolutum* Woodland (CEGL007721). *Pinus rigida - Quercus stellata / Andropogon gerardii - Packera paupercula* Woodland (CEGL004968) is a related community of Virginia.

ULTRAMAFIC OUTCROP BARREN (PIEDMONT SUBTYPE)
Synonyms: *Pinus echinata - Quercus velutina - Quercus marilandica / Piptochaetium avenaceum* Ultramafic Woodland (CEGL007045).
Ecological Systems: Eastern Serpentine Woodland (CES202.347).

Concept: Type covers the very rare forests and woodlands with distinctive structure and floristic composition associated with soils developed on ultramafic rock substrates. Characteristics include low overall plant species richness due to exclusion of some species by soil chemistry, unusual combinations of plants with different typical moisture tolerances, and generally, unusually open, grassy vegetation.

Subtype covers examples in the Piedmont region. Only a single depauperate example is known, at Adam Mountain in Wake County.

Distinguishing Features: Type is distinguished by occurrence on ultramafic rock substrate and unusually open, barren vegetation structure. Some ultramafic rock bodies in the Piedmont have vegetation that is not distinguishable structurally or floristically from those or ordinary mafic rock substrates, and these should not be classified here. The one known Piedmont example has an open canopy of *Quercus*

velutina and *Pinus echinata*, with an herb layer that includes *Piptochaetium avenaceum*, *Dichanthelium boscii*, and *Chasmanthium latifolium*, but any additional Piedmont occurrence of unusually open vegetation on ultramafic substrate should also be classified as this type.

Comments: As in other eastern serpentine barrens, fire is probably important in maintaining structure and composition, and the one known example may be degraded by its absence. However, this example occurs on a north-facing slope near a large creek, where fire effects may be mild. This subtype appears to be distinct from the more diverse serpentine barrens of Maryland and from the examples in Georgia and Alabama, and a different NVC association has been created for it.

ACIDIC SHALE SLOPE WOODLAND G2?

Synonyms: *Pinus virginiana / Vaccinium pallidum / Schizachyrium scoparium - Carex pensylvanica* Woodland (CEGL003624); Dry Rocky Slope; Montane Acidic Cliff (in part) (Third Approximation).
Ecological Systems: Appalachian Shale Barrens (CES202.598).

Concept: Type covers the rare *Pinus virginiana* woodlands of steep slopes on shale or similar fine-bedded, crumbly rock which form an unstable surface of small rock fragments. There is generally only sparse cover in the herb layer, but more stable patches may have a well-developed grassy ground cover. Weedy species are usually present, presumably because of periodic disturbance by movement of the unstable substrate.

Distinguishing Features: Acidic Shale Slope Woodlands are distinguished from all other communities by the combination of pine dominance, open canopy, and unstable, crumbled rock surface. *Pinus virginiana* dominates in all examples known, but other species are possible.

Comments: *Pinus virginiana - Quercus prinus - Quercus rubra / Vaccinium pallidum - Kalmia latifolia* Forest (CEGL007539) was an association in the NVC formerly defined as a closely related community in the Hot Springs area. It has been lumped with the association above.

CALCAREOUS SHALE SLOPE WOODLAND G2

Synonyms: *Quercus prinus - Juniperus virginiana - (Pinus virginiana) / Philadelphus hirsutus - Celtis occidentalis* Woodland (CEGL007720); Dry Rocky Slope, Montane Acidic Cliff (in part?) (Third Approximation).
Ecological Systems: Appalachian Shale Barrens (CES202.598).

Concept: Type covers the very rare hardwood woodlands on steep slopes of calcareous shale or similar fine-bedded, crumbly rock which forms an unstable surface of small rock fragments.

Distinguishing Features: Calcareous Shale Slope Woodlands are distinguished from all other communities by the combination of hardwood dominance, presence of plants characteristic of circumneutral or basic soils, open canopy, and unstable, crumbled rock surface.

Comments: Initially defined only from North Carolina, this type has been merged with related types in Virginia and Tennessee. It is very rare.

PIEDMONT ACIDIC GLADE G2

Synonyms: *Quercus prinus - Quercus stellata - (Pinus virginiana, Pinus echinata) / Vaccinium pallidum / Schizachyrium scoparium* Woodland (CEGL004910).
Ecological Systems: Southern Piedmont Glade and Barrens CES202.328).

Concept: Type covers open woodlands on shallow soils over irregular bedrock (not exfoliated granitic rocks), not showing any circumneutral or basic influence in their flora. These are generally moderately to steeply sloping and on dry slope aspects. They are more vegetated than cliff communities but are prevented from forming a closed forest by shallow rock and associated xeric conditions. Vegetation is generally patchy and open but contains substantial tree cover as well as having limited open rock and herb- or low-shrub-dominated areas.

Distinguishing Features: This type is distinguished from forest communities by having a persistent open tree canopy, ranging from woodland structure to sparser. The combination of tree species, *Quercus montana* along with *Quercus stellata* or xerophytic pines, is distinctive. It is distinguished from Xeric Piedmont Slope Woodland by having more open vegetation, shallow soil, and greater influence of rock. It is distinguished from Piedmont Cliff, Granitic Flatrock, and Low Elevation Rocky Summit by having soil with substantial herbaceous or shrub cover over most of the area, and limited area of bare rock. Plants characteristic of bare rock, such as *Phemeranthus teretifolius (= Talinum teretifolius), Crotonopsis elliptica, Selaginella rupestris*, and crustose lichens, may be present but are scarce and limited to the small areas of open rock outcrop.

This type is distinguished from Piedmont Basic Glade by lacking flora characteristic of circumneutral or basic sites. Generally the undergrowth is dominated either by grasses or by short clonal shrubs such as *Vaccinium pallidum* or *Gaylussacia baccata*. Grassy areas are generally dominated by *Schizachyrium scoparium*, but may include *Danthonia spicata, Piptochaetium avenaceum, Andropogon gerardii, Andropogon ternarius, Andropogon gyrans*, and *Sorghastrum nutans*. Species characteristic of less acidic soils, such as *Cercis canadensis, Rhus aromatica, Fraxinus americana, Cheilanthes tomentosa*, or *Aquilegia canadensis* are absent or extremely scarce. Species such as *Vaccinium arboreum, Chionanthus virginicus*, and *Carya* spp. may be present but occur in smaller proportions than in basic glades.

Comments: *Quercus prinus - Quercus stellata - Carya glabra / Vaccinium arboreum - Viburnum rufidulum* Forest (CEGL004416) is a xeric forest association that in some parts of its description sounds similar to Piedmont Acidic Glade or to Xeric Piedmont Slope Woodland. It was apparently originally defined based on two CVS plots in the area of greatest development of both of these communities, and the data from the two plots suggest they are transitional between the two.

These communities are likely partially dependent on fire. With more frequent burning, these dry sites would have more open canopies, less shrub cover, would support more diverse herbaceous layers, and might expand into adjacent marginal areas. However, shallow soil, rock, and periodic drought stress is sufficient to keep their canopies open in the absence of fire.

PIEDMONT BASIC GLADE (TYPIC SUBTYPE) G2

Synonyms: *Juniperus virginiana var. virginiana - Ulmus alata / Schizachyrium scoparium* Woodland (CEGL004443). Piedmont Mafic Cliff, Piedmont Calcareous Cliff (in part) (3rd Approximation).

Ecological Systems: Southern Piedmont Glade and Barrens (CES202.328).

Concept: Type covers open woodlands on irregular rock outcrops, showing circumneutral or basic influence in their flora. They are more vegetated than cliff communities. Vegetation is generally patchy and open but contains substantial tree cover as well as having limited open rock and extensive herb-dominated areas. Subtype covers most of the known examples, not fitting the distinctive characteristics of the Falls Dam Slope Subtype. There may be enough variation to warrant other subtypes.

Distinguishing Features: The Piedmont Basic Glade type is distinguished from Piedmont Cliff by having more vegetation cover, associated with a more gentle slope, more irregular rock outcrops, and more soil. Long-term natural tree cover is over 25 percent but less than the typical range of forests (which is more than 75 percent unless maintained by fire). They are distinguished from Xeric Hardpan Forest by having less tree cover and having substantial shallow soil and bedrock.

Comments: Though rare, these communities appear to be more numerous than the Piedmont Acidic Glades, despite the much greater abundance of acidic rocks. It is unclear why this is true.

There has been consideration of a different community type for the slate and shale slopes of Stanley and Anson counties and for Cedar Mountain in Rockingham County. All are places that have been suggested are somewhat like shale barrens, in having accumulations of small rock fragments whose instability is a crucial environmental influence. With the exception of the Falls Dam Slope Subtype, current evidence suggests these sites not are distinctive enough to call a subtype. Therefore, they are included in the Typic Subtype. They may be treated as a Slate/Shale Variant, in contrast to a more stable Typic Variant, where ongoing chronic slope movement is not a significant influence.

PIEDMONT BASIC GLADE (FALLS DAM SLOPE SUBTYPE) G1?
Synonyms: *Pinus echinata - Quercus stellata - Quercus marilandica / Andropogon gyrans - Chrysopsis mariana* Woodland (CEGL004447).
Ecological Systems: Southern Piedmont Glade and Barrens (CES202.328).

Concept: Subtype covers the distinctive example known at the Falls Dam Slope site, which contains substantial *Pinus echinata* and has a high species richness that includes a number of plants of prairie affinities. The cause of the distinctive character of this subtype is uncertain. It is believed to be related to a loose substrate of slate fragments, but recent fire also seems involved with its current composition.

DIABASE GLADE G1
Synonyms: *Sporobolus vaginiflorus var. ozarkanus - Diodia teres - Croton willdenowii - Ruellia humilis* Herbaceous Vegetation (CEGL004276).
Ecological Systems: Piedmont Hardpan Woodland and Forest (CES202.268).

Concept: Type covers extremely rare, naturally open, patchy glade communities of shallow soils over diabase outcrops, containing a diverse herbaceous flora that combines species of granitic flatrocks and of mafic and ultramafic rock communities.

Distinguishing Features: The Diabase Glade type is distinguished from all other open glade and rock outcrop communities by having a flora that contains outcrop species such as *Diodia teres* and *Croton willdenowii* with a large number of obligate base-loving species such as *Ruellia humilis, Berberis canadensis, Symphoricarpos orbiculatus, Matelea decipiens, Lithospermum canescens* and *Clematis ochroleuca*. It is distinguished from the more prairie-like Xeric Hardpan Forest subtypes and other basic woodlands by having a significant fraction of its area with very shallow, gravelly soil over flat-lying rock and having a substantial component of outcrop forbs.

Comments: Much of the area of the Diabase Glades is in shrub and tree patches. The NVC write-up for this association suggests that a separate association (*Juniperus virginiana - Ulmus alata - Fraxinus americana - Carya glabra* Forest) was intended for the woody component, but that association was not added to the NVC. Given the close association of herbaceous and woody patches in the few known examples, no subdivision seems necessary.

XERIC HARDPAN FOREST (BASIC HARDPAN SUBTYPE) G2G3

Synonyms: *Quercus stellata - Carya (carolinae-septentrionalis, glabra) - (Quercus marilandica) / Ulmus alata / (Schizachyrium scoparium, Piptochaetium avenaceum)* Woodland (CEGL003714).
Ecological Systems: Piedmont Hardpan Woodland and Forest (CES202.268).

Concept: Type covers Piedmont forests and woodlands dominated by *Quercus stellata*, with or without *Quercus marilandica, Carya carolinae-septentrionalis*, or pines, occurring in environments that are xeric because of restricted rooting depth caused by dense or shrink-swell clay, sometimes in combination with rock. Their flora indicates a drier environment than that of Dry Oak–Hickory Forest and the trees are often somewhat stunted. Canopy density is less than in dry forests, and depends more on fire and disturbance history. Subtype covers examples on broad upland flats developed over mafic rocks, where a clay hardpan sometimes creates wet as well as dry conditions and where acid-loving flora is absent or scarce and some basic indicators are present.

Distinguishing Features: Xeric Hardpan Forests are distinguished from Dry Oak–Hickory Forest and Dry Basic Oak–Hickory Forest by having a canopy of more xerophytic composition, with *Quercus stellata* or *Quercus marilandica* predominant and with *Quercus alba* and more mesic oaks uncommon. Fire-suppressed, degraded examples of Piedmont Longleaf Pine Forest may be dominated by *Quercus stellata* and other xerophytic species, but will not occur on flat hardpan soils or rocky mafic ridges, will generally have evidence of the past presence of Pinus palustris and its associates, and will have a flora with more Coastal Plain affinities. Xeric Hardpan Forests are distinguished from Montane Red Cedar–Hardwood Woodland and other rock outcrop-related woodlands by clayey soils and absence of characteristic rock outcrop flora.

The Basic Hardpan Subtype is distinguished from the Prairie Barren Subtype by the absence of a substantial component of the characteristic flora of prairie affinities(see the Prairie Barren Subtype for this flora), though widespread prairie species such as *Schizachyrium scoparium* may be present. It is distinguished from the Basic Rocky Subtype by occurrence on broad upland flats, generally with no rock outcrops, rather than on bouldery ridge tops or steep slopes. *Quercus phellos* or other species typical of wetter conditions are generally present in small numbers. No frequent plants are known to be exclusively in the Basic Rocky Subtype, but *Carya carolinae-septentrionalis, Piptochaetium avenaceum, Acer leucoderme, Vitis rotundifolia,* and *Parthenocissus quinquefolia* are generally much

more abundant than in the Basic Hardpan Subtype. The Basic Hardpan Subtype is distinguished from the Acidic Hardpan Subtype by a flora indicative of mafic substrate influence in the soil. Acid-loving flora such as *Chimaphila maculata, Vaccinium* species (other than *V. arboreum* and some *V. stamineum*), *Gaylussacia* spp., and *Oxydendrum arboreum* are absent or scarce. More base-loving flora such as *Clematis ochroleuca, Viburnum* spp., *Symphoricarpos orbiculatus, Rhus aromatica, Cercis canadensis, Fraxinus americana,* and *Ulmus alata* are usually common.

Comments: This community also occurs in Virginia, where there are about 10 examples, but the hardpan effect seems to be less extreme and the community is less distinct. *Quercus alba* is a more major component, unlike in ours, but the canopy still is open.

XERIC HARDPAN FOREST (NORTHERN PRAIRIE BARREN SUBTYPE) G1
Synonyms: *Quercus stellata - (Pinus echinata) / Schizachyrium scoparium - Echinacea laevigata - Oligoneuron album* Woodland (CEGL003558). Diabase Barren (common usage).
Ecological Systems: Piedmont Hardpan Woodland and Forest (CES202.268).

Concept: Subtype covers examples on mafic rock-derived soils in the Durham Triassic basin and adjacent areas, which contain a diverse and distinctive herbaceous flora of prairie affinities, and generally a higher species richness than the Basic Hardpan Subtype. The suite of prairie herbs is different for this region than for the range of the Southern Prairie Barren Subtype, apparently for biogeographic reasons.

Distinguishing Features: The Northern Prairie Barren Subtype is distinguished from the closely related Southern Prairie Barren Subtype by a suite of different species. Species characteristic of the Northern and absent in the Southern include *Echinacea laevigata, Oligoneuron album, Lithospermum canescens*, and *Baptisia australis var. aberrans*. Species characteristic of the Southern and absent in the Northern include *Symphyotrichum georgianum var. georgianum*, and *Helianthus schweinitzii*. Both subtypes are distinguished from the closely related Basic Hardpan Subtype and from all other subtypes by the presence of a substantial flora of prairie affinities, beyond widespread species such as *Schizachyrium scoparium*. *Silphium terebinthinaceum, Cirsium carolinianum, Elymus canadensis, Eryngium yuccifolium, Liatris squarrosa, Parthenium auriculatum, Parthenium integrifolium, Tragia urticifolia*, and *Sorghastrum nutans* are typical of the both Prairie Barren subtypes and not the other subtypes.

Comments: The few examples of this subtype, all in poor condition, are in the area near Butner and northeast Durham. This area has a large expanse of diabase, and the characteristic rich flora may represent a center of diversity associated with a large amount of habitat, with the more widespread Basic Hardpan Subtype representing naturally more depauperate communities away from this center. A similar large expanse of habitat on the gabbros of Mecklenburg County and adjacent South Carolina has a diverse but somewhat different flora, and is treated as the Southern Prairie Barren Subtype. It appears to represent a different kind of prairie barren, developed in a different concentration of habitat with a different pool of species.

XERIC HARDPAN FOREST (SOUTHERN PRAIRIE BARREN SUBTYPE) G1
Synonyms: *Quercus stellata - (Pinus echinata) / Schizachyrium scoparium - Symphyotrichum georgianum* Woodland (CEGL003711).

Ecological Systems: Piedmont Hardpan Woodland and Forest (CES202.268).

Concept: Subtype covers examples on mafic rock-derived montmorillonitic soils in Mecklenburg County and adjacent areas, which contain a diverse and distinctive herbaceous flora of prairie affinities, and generally a higher species richness than in the Basic Hardpan Subtype. The suite of prairie herbs is different for this region than for the range of the Northern Prairie Barren Subtype, apparently for biogeographic reasons.

Distinguishing Features: The Southern Prairie Barren Subtype is distinguished from the closely related Northern Prairie Barren Subtype by a suite of different species. Species characteristic of the Northern and absent in the Southern include *Echinacea laevigata, Oligoneuron album, Lithospermum canescens*, and *Baptisia australis var. aberrans*. Species characteristic of the Southern and absent in the Northern include *Symphyotrichum georgianum var. georgianum* and *Helianthus schweinitzii*. Both subtypes are distinguished from the closely related Basic Hardpan Subtype and from all other subtypes by the presence of a substantial flora of prairie affinities, beyond widespread species such as *Schizachyrium scoparium*. *Silphium terebinthinaceum, Cirsium carolinianum, Elymus canadensis, Eryngium yuccifolium, Liatris squarrosa, Parthenium auriculatum, Parthenium integrifolium, Tragia urens*, and *Sorghastrum nutans* are typical of the both Prairie Barren subtypes and not the other subtypes.

XERIC HARDPAN FOREST (ACIDIC HARDPAN SUBTYPE) G2

Synonyms: *Quercus stellata - (Quercus marilandica) / Gaylussacia frondosa* Acidic Hardpan Woodland (CEGL004413).
Ecological Systems: Piedmont Hardpan Woodland and Forest (CES202.268).

Concept: Subtype covers Xeric Hardpan Forests on acidic clays, having an acid-loving flora.

Distinguishing Features: The Acidic Hardpan Subtype can be distinguished from all other subtypes by the substantial presence of acid-loving flora, such as *Vaccinium tenellum, Vaccinium pallidum, Gaylussacia* spp., *Oxydendrum arboreum*, and *Chimaphila maculata*. The strongest basic indicators, such as *Symphoricarpos orbiculatus, Rhus aromatica, Clematis ochroleuca*, and the prairie species are absent, and weaker indicators such as *Cercis canadensis* and *Ulmus alata* are much less common. *Quercus falcata* may be abundant.

Comments: Less extremely developed parts of this community in the Gold Hill area of Rowan County have substantial *Quercus falcata* in the canopy. This subtype is rarer than the Basic Hardpan Subtype, and occurs mostly on a distinct geologic unit of slate, characterized by the Misenheimer soil series.

XERIC HARDPAN FOREST (BASIC ROCKY SUBTYPE) G2

Synonyms: *Quercus stellata - Carya carolinae-septentrionalis / Acer leucoderme / Piptochaetium avenaceum - Danthonia spicata* Woodland (CEGL003713).
Ecological Systems: Piedmont Hardpan Woodland and Forest (CES202.268).

Concept: Subtype covers the rare communities with Xeric Hardpan Forest composition on rocky ridge tops and steep slopes over mafic rocks. Soils between the rocks appear to have dense shrink-swell clay

layers and to restrict water movement and, presumably, root penetration. The composition is slightly different from examples on basic hardpan flats.

Distinguishing Features: The Basic Rocky Subtype is distinguished from the other basic subtypes by its occurrence on steep slopes or ridge tops and the presence of abundant rocks. The species indicative of wetter conditions, such as *Quercus phellos*, which are usually present in small numbers in the hardpan subtypes, are absent. No frequent plants are known to be exclusively to the Basic Rocky Subtype, but *Carya carolinae-septentrionalis, Piptochaetium avenaceum, Acer leucoderme, Vitis rotundifolia*, and *Parthenocissus quinquefolia* are generally much more abundant than in the Basic Hardpan Subtype. This subtype may grade conceptually into some of the glade communities. It is distinguished from them by its clayey soils and absence of characteristic rock outcrop flora.

XERIC PIEDMONT SLOPE WOODLAND G2?

Synonyms: *Pinus echinata - Quercus marilandica / Kalmia latifolia - Symplocos tinctoria* Woodland (CEGL004446).
Ecological Systems: Southern Piedmont Dry Oak-(Pine) Forest (CES202.339).

Concept: South-facing and west-facing slopes with an open canopy of dry-tolerant trees, including *Pinus echinata, Quercus stellata, Quercus marilandica,* and *Quercus montana,* and either a dense shrub layer or an herbaceous layer of drought-tolerant and sun-loving species.

Distinguishing Features: The Xeric Piedmont Slope Woodland is closely related to the Piedmont Acidic Glade type, and is distinguished by denser vegetation (open forest or fairly dense woodland if not recently disturbed), deeper soil, and more limited role of rock. It is distinguished from all other Piedmont upland forest communities by the xerophytic canopy composition, which may be dominated by either pines or hardwoods, but is dry enough to exclude *Quercus alba* and all other species with less tolerance of dry conditions.

Comments: This community was called Xeric Piedmont Pine Heath in earlier drafts of the 4th approximation.

There is some confusion with the NVC associations related to this type. The association synonymized is based on two rather different CVS plots. Both have dense shrub cover and little herb presence. Other examples of this type observed by Weakley and Weakley (pers. comm. 2011) are not densely shrubby and have a diverse herbaceous layer. The shrub layer may be an artifact of fire suppression. *Quercus prinus - Quercus stellata - Carya glabra / Vaccinium arboreum - Viburnum rufidulum* Forest (CEGL004416) is another xeric forest association, initially based on two other plots in the same vicinity. It could fit this type's concept as well, but may alternatively fit Piedmont Acidic Glade better.

This is a rare community type. At present, it is not known outside of the southeastern Badin unit of Uwharrie National Forest, an area of unusually extensive and diverse development of dry, acidic communities. These communities are likely partially dependent on fire for their natural character. With more frequent burning, comparable to that which occurred in most Piedmont forests, these dry sites would have more open canopies, less shrub cover, and would support diverse herbaceous layers.

Maritime Grasslands

DUNE GRASS (SOUTHERN SUBTYPE) G3

Synonyms: *Uniola paniculata - Hydrocotyle bonariensis* Herbaceous Vegetation (CEGL004040).
Ecological Systems: Southern Atlantic Coastal Plain Dune and Maritime Grassland (CES203.273).

Concept: Type covers the grassy communities of coastal foredunes and some dunes in the interior of barrier islands, influenced by salt spray as well as by the absence of soil development. These communities are dominated by a small set of specialized plants that includes *Uniola paniculata* or *Ammophila breviligulata, Schizachyrium littorale, Panicum amarum, Hydrocotyle bonariensis, Strophostyles helvula, Smilax auriculata*, and *Solidago sempervirens*. Subtype covers the typical examples in most of North Carolina, where *Uniola paniculata* dominates and *Ammophila breviligulata* and *Schizachyrium littorale* are absent, scarce, or present only because they were planted. Most occur on the seaward side of barrier islands, as a continuous or discontinuous line of foredunes. However, patches also occur on stabilized sand dunes in barrier island interiors, where they can be distinguished by vegetation.

Distinguishing Features: Dune Grass communities in natural condition are distinguished from all other communities by the dominance of the above species, particularly *Uniola paniculata* or *Ammophila breviligulata*. Live Dune Barren and Stable Dune Barren communities also occur on sand dunes in barrier island interiors, but are not dominated by these grasses and usually contain little grass.

The Southern Subtype is distinguished by the natural absence of *Schizachyrium littorale* and *Ammophila breviligulata*, though the latter may be present in small amounts in northerly examples. However, extensive planting of both *Uniola* and *Ammophila* confuses the distinction in some areas. The Northern Subtype does not occur south of Cape Hatteras and the Southern Subtype does not occur north of Nags Head. Dunes in the area between are typically the Southern Subtype. However, local zones of *Ammophila* dominance near Cape Hatteras, occurring seaward of *Uniola* dominance, may be a natural disjunct example of the Northern Subtype.

Comments: This subtype ranges from North Carolina to Florida. *Uniola* and *Ammophila* play an important geomorphic role, colonizing loose sand, binding it, and catching moving sand to build dunes. Dunes can grow rapidly. On the Fort Fisher spit, dunes destroyed by hurricane erosion and overwash re-developed in a few years. Because the dunes affect the frequency and extent of overwash, Dune Grass communities influence the dynamics of all barrier island communities. Despite the natural tendency for dune growth, artificial enhancement of dunes by sand fencing and planting of grass has made foredunes in many places larger and more continuous than they were naturally, with consequences across the affect islands.

Interior dunes may support Dune Grass, Stable Dune Barren, or Live Dune Barren communities. The distinction may be related to stability and age of the dunes. The largest, active dunes, with vegetation kept sparse by ongoing lack of stability, are Live Dune Barrens. Recently stabilized dunes support Dune Grass communities very similar to those on the foredunes. Stable Dune Barrens appear to be of greater age and to have little tendency for sand movement. Woody vegetation has often filled the adjacent swales. They are probably maintained more by excessive soil drainage.

Uniola paniculata Herbaceous Vegetation (CEGL004038) was defined as a more depauperate dune grass association of the Outer Banks. It was provisionally accepted as the Outer Banks Subtype in earlier

drafts of the 4th approximation, but has been dropped. Further study may prove it to be warranted, but present analysis and experience do not support it. All Dune Grass subtypes are floristically depauperate because of the harsh environment, and their flora consists mostly of specialist species not in mainland communities. Local species richness within Dune Grass communities is extremely variable over short distances. Examples on the most remote dunes of the Outer Banks do not appear to be more depauperate than many examples closer to the mainland. There is a recognizable difference in vegetation between foredunes and interior Dune Grass communities, and these may be recognized as variants.

DUNE GRASS (BLUESTEM SUBTYPE) G3

Synonyms: *Uniola paniculata - Schizachyrium littorale - Panicum amarum* Herbaceous Vegetation (CEGL004039).
Ecological Systems: Southern Atlantic Coastal Plain Dune and Maritime Grassland (CES203.273).

Concept: Subtype covers examples in which *Schizachyrium littorale* is a significant component in addition to *Uniola paniculata* and other species.

Distinguishing Features: The Bluestem Subtype is distinguished by having *Schizachyrium littorale* as a significant component, though *Uniola paniculata* may dominate. *Ammophila breviligulata* is absent unless planted. *Schizachyrium* is present in some other communities, but not in combination with *Uniola paniculata* on sand dunes.

Comments: The concept of this subtype in relation to the Typic Subtype needs further work. This subtype was initially characterized as being more southern, but *Schizachyrium littorale* has a patchy distribution rather than simply being indicative of more southern locations. It is present in several disjunct portions of the North Carolina coast but absent in others. It is absent from much of South Carolina but present farther south. It is unclear if its presence or absence correlates with the environment or with broader aspects of the community. However, it appears to be associated with a higher species richness and hints of less extreme site conditions.

DUNE GRASS (NORTHERN SUBTYPE) G2

Synonyms: *Ammophila breviligulata - Panicum amarum* var. *amarum* Herbaceous Vegetation (CEGL004043).
Ecological Systems: Northern Atlantic Coastal Plain Dune and Swale (CES203.264).

Concept: Subtype covers examples in the northern part of the state, north of Cape Hatteras, where *Ammophila breviligulata* rather than *Uniola paniculata* naturally dominates.

Distinguishing Features: The Northern Subtype is distinguished by the natural dominance of *Ammophila breviligulata*. The native range of *Ammophila* extends south roughly to Cape Hatteras. It is unclear how much this subtype naturally overlaps with the Typic Subtype. It has been observed on newly accreting dunes west of the cape within the Cape Hatteras area, where the Typic Subtype occurs on older dunes. The Typic Subtype appears to occur some distance northward along Hatteras Island as well. Dunes dominated by *Ammophila* much south of Cape Hatteras should be treated as degraded examples of one of the other subtypes rather than this subtype.

LIVE DUNE BARREN G1
Synonyms: *Vitis rotundifolia / Triplasis purpurea - Panicum amarum - Schizachyrium littorale* Mid-Atlantic Coastal Medaño Sparse Vegetation (CEGL004397).
Ecological Systems: Northern Atlantic Coastal Plain Dune and Swale (CES203.264).

Concept: Type covers the sparsely vegetated communities of rare large, unstabilized medaño dunes in the interior of barrier islands. In contrast to Dune Grass, the vegetation is affected more strongly by sand movement and less by salt spray. The vegetation consists largely of scattered patches of pioneer herbs, vines, and sub-shrubs in sheltered microsites. There is a distinctive invertebrate community.

Distinguishing Features: Live Dune Barrens are distinguished by very sparse vegetation associated with large unstabilized sand dunes. Dune Grass communities have denser vegetation dominated by *Uniola paniculata* or *Ammophila breviligulata*.

Comments: As defined, this type is endemic to North Carolina and is extremely rare. The large, active dunes that support it apparently are not present in adjacent states.

STABLE DUNE BARREN (SOUTHERN SUBTYPE) G2G3
Synonyms: *Smilax auriculata / Heterotheca subaxillaris - Strophostyles helvula - (Uniola paniculata)* Herbaceous Vegetation (CEGL004234).
Ecological Systems: Southern Atlantic Coastal Plain Dune and Maritime Grassland (CES203.273).

Concept: Type covers sparsely- to moderately-vegetated stable dunes and high sand flats of barrier island interiors, not dominated by *Uniola paniculata*, *Ammophila breviligulata*, or *Schizachyrium littorale*, or by other species characteristic of those communities. *Uniola paniculata* may be present in small amounts, but vegetation is dominated by *Dichanthelium* spp., *Smilax auriculata*, *Hudsonia tomentosa*, *Opuntia* spp., or other species that do not occur in Dune Grass communities. The community often includes substantial bare sand, but also may include open or patchy cover of woody vines, shrubs, and even trees.

Distinguishing Features: Stable Dune Barrens are distinguished from Maritime Dry Grassland and Dune Grass by the scarcity of the grasses characteristic of those types. They are distinguished from all other barrier island communities by low plant cover and abundant dry, bare sand. These communities often occur in fine-scale mosaics with Maritime Dry Grassland, Maritime Wet Grassland, Maritime Shrub, Maritime Vine Tangle, and young Maritime Evergreen Forest, in the heterogeneous environment created by irregular interior dunes. Interpretation of communities will depend on the scale at which these areas are viewed, with small clumps of trees, shrubs, or vines either regarded as part of the Dune Barren or as very small patches of other community types.

Comments: Interior dunes may support Dune Grass, Stable Dune Barren, or Live Dune Barren communities. The distinction may be related to stability and age of the dunes. The largest, active dunes, with vegetation kept sparse by ongoing lack of stability, are Live Dune Barrens. Recently stabilized dunes support Dune Grass communities very similar to those on the foredunes. Stable Dune Barrens appear to be of greater age and to have little tendency for sand movement. Woody vegetation has often filled the adjacent swales. They are probably maintained by excessive soil drainage rather than sand

movement. However, as in most open barrier island communities, they are undergoing primary succession and probably shrink slowly in the absence of natural disturbance. Most, but not all, examples occur in areas where the foredunes were artificially stabilized or built up in the past, cutting off overwash that once occurred. It is unclear how important this is for these communities. They occur on elevated areas that probably were not covered by overwash, but salt spray has also probably been reduced. These communities were not well accommodated in the 3rd Approximation, where they did not quite fit Dune Grass or Maritime Dry Grassland.

This subtype is very variable, and the variation is not well characterized. Further subdivision may be appropriate, but examples can be very heterogeneous over short distances. Patches may have heavy cover of *Smilax auriculata* only a few centimeters tall, may have substantial cover by *Dichanthelium aciculare*, or may have sparse vegetation dominated by *Opuntia pusilla*, *Diodia teres*, *Trichostema* sp. 1, or any of several other herbaceous species.

STABLE DUNE BARREN (BEACH HEATHER SUBTYPE) G2G3

Synonyms: *Hudsonia tomentosa* / *Panicum amarum* var. *amarulum* Dwarf-shrubland (CEGL003950).
Ecological Systems: Northern Atlantic Coastal Plain Dune and Swale (CES203.264).

Concept: Subtype covers northern examples, where *Hudsonia tomentosa* is a prominent component.

Distinguishing Features: The Beach Heather Subtype is distinguished by the presence of *Hudsonia tomentosa*, *Lechea maritima*, or other species confined to more northern locations.

Comments: This subtype is present in scattered patches on the Currituck Outer Banks southward to northern Bodie Island. It ranges northward to New Jersey. It often occurs as series of small patches embedded in Maritime Evergreen Forest or Maritime Shrub.

MARITIME DRY GRASSLAND (TYPIC SUBTYPE) G2G3

Synonyms: *Spartina patens* - *Schoenoplectus pungens* - *Solidago sempervirens* Herbaceous Vegetation (CEGL004097).
Ecological Systems: Northern Atlantic Coastal Plain Dune and Swale (CES203.264). Southern Atlantic Coastal Plain Dune and Maritime Grassland (CES203.273).

Concept: Type covers communities of sand flats in the interior and back side of barrier islands, where periodic salt water storm overwash and salt spray prevent woody vegetation development. Vegetation is typically sparse to moderate-density grassland dominated by *Spartina patens* or other grasses not in the Dune Grass type. Subtype covers the typical examples in most of North Carolina, dominated by *Spartina patens*.

Distinguishing Features: Maritime Dry Grassland is distinguished from Dune Grass, Live Dune Barren, and Stable Dune Barren by the dominance of *Spartina patens* or of grasses that don't include *Uniola paniculata* or *Ammophila breviligulata*. It may contain smaller numbers of these species and other species from the Dune Grass type. Despite the NVC name, *Schoenoplectus pungens* is not characteristic of this community in North Carolina but may sometimes spread in from wetter communities nearby. Maritime Dry Grassland is distinguished from Maritime Wet Grassland by the absence of wetland

species such as *Muhlenbergia filipes*, *Rhynchospora colorata*, *Fimbristylis castanea*, and *Juncus* spp. It is distinguished from Brackish Marsh, which may be dominated by *Spartina patens*, by higher location and drier soils, or by sites which are flooded with salt water only during overwash events but not by high tides. In contrast, Brackish Marshes are more frequently flooded by high tides and should show evidence of flooding at all times. Maritime Dry Grasslands lack associated species characteristic of marshes, such as *Juncus roemerianus* and *Distichlis spicata*. The Typic Subtype is distinguished by the dominance of *Spartina patens* in a low-diversity community, and is characteristic of the middle and southern parts of the North Carolina coast. *Morella pensylvanica (= Myrica pensylvanica)* is absent.

MARITIME DRY GRASSLAND (NORTHERN SUBTYPE) G2

Synonyms: *Morella (pensylvanica, cerifera)* / *Schizachyrium littorale - Eupatorium hyssopifolium* Shrub Herbaceous Vegetation (CEGL004240).
Ecological Systems: Northern Atlantic Coastal Plain Dune and Swale (CES203.264).

Concept: Subtype includes the examples typical of the Currituck Banks and states to the north, which are generally dominated by *Schizachyrium littorale* or *Panicum amarum var. amarulum*, with a larger component of forbs. It may include *Morella pensylvanica* and other species not found in the Southern Subtype. More than the other subtypes, the Northern Subtype may contain woody species, including *Morella pensylvanica, Diospyros virginiana*, or *Pinus taeda*, as a minor component. However, the widespread dune enhancement on the Currituck Banks makes it unclear if the woody component is natural or is a result of this alteration in overwash.

Distinguishing Features: The Northern Subtype is distinguished by its range and by dominance by the above species rather than *Spartina patens*, though the latter may be present. *Uniola paniculata* or *Ammophila breviligulata* may be present in small amounts but do not dominate.

Comments: This association was first described from Assateague Island in Virginia, and ranges north to New Jersey. It is sparsely present on the Currituck Outer Banks, and may once have been more widespread there.

MARITIME VINE TANGLE GNRQ

Synonyms: *Smilax auriculata - Toxicodendron radicans* Vine-Shrubland (CEGL003885).
Ecological Systems: Southern Atlantic Coastal Plain Dune and Maritime Grassland (CES203.273).

Concept: Type covers vegetation of barrier island sand flats or low dunes, dominated by woody vines but persistently lacking more than a few trees and shrubs. Patches are small, though a few are larger than would typically be regarded as a simple inclusion in another community.

Distinguishing Features: This type is distinguished from all other types by the dominance of *Smilax*, with or without *Toxicodendron*, in tangles a meter or more tall. Sparse shrubs may be present beneath the vines, but many tangles appear to be self-supporting masses of vines that may be up to 2 meters tall. Maritime Shrub communities and canopy gaps in Maritime Evergreen Forest often have heavy vine cover, but this type should be reserved for apparently persistent vegetation consisting almost solely of vines. Barren sand areas with only small patches of vines running along the ground should not be classified here, but should be treated as part of the grassland or dune barren community.

These communities often occur in fine-scale mosaics with Maritime Dry Grassland, Maritime Wet Grassland, Maritime Shrub, Stable Dune Barren,, and Maritime Evergreen Forest, in the heterogeneous environment created by irregular interior dunes. Interpretation of communities will depend on the scale at which these areas are viewed, with the smaller clumps of vines best regarded as part of the surrounding community.

Comments: This type is somewhat marginal for recognition as distinct, with most patches very small. However, it can be a prominent part of the mosaic of communities in barrier island interiors. It should be used only for the more extremely developed cases.

Maritime Upland Forests

MARITIME SHRUB (STUNTED TREE SUBTYPE) G3

Synonyms: *Quercus virginiana - (Ilex vomitoria)* Shrubland (CEGL003833).
Ecological Systems: Central Atlantic Coastal Plain Maritime Forest (CES203.261). Northern Atlantic Coastal Plain Dune and Swale (CES203.264). Southern Atlantic Coastal Plain Dune and Maritime Grassland (CES203.273).

Concept: Type covers naturally shrub-sized vegetation of barrier islands and comparable coast lines. Subtype covers examples that are dominated or codominated by *Quercus virginiana*, *Persea palustris*, *Juniperus virginiana* var. *silicicola*, *Ilex vomitoria*, or other species of Maritime Evergreen Forest, which are kept at shrub size by salt spray. They generally have a dense, streamlined canopy.

Distinguishing Features: The Maritime Shrub type is distinguished from Maritime Evergreen Forest (which may have similar flora to this subtype) by the stature of the canopy. The two often grade into each other, and may shift from one to the other in response to changes in salt spray deposition caused by growth or destruction of dunes. Maritime Shrub has a canopy persistently 5 meters tall or shorter. Usually the canopy is streamlined and visibly salt-pruned, and the flora is more depauperate. *Juniperus* is more often prominent in Maritime Shrub. Maritime Shrub is distinguished from Salt Shrub by species composition, which does not include any salt-tolerant wetland species other than possibly *Morella cerifera*.

The Stunted Tree Subtype is distinguished from other subtypes by dominance or codominance by species capable of becoming larger trees, usually *Quercus virginiana*, *Juniperus virginiana* var. *silicicola*, or *Persea palustris*.

Comments: The Stunted Tree Subtype usually occurs in association with Maritime Evergreen Forest. It occurs on the seaward side and forms a “leading edge” where the streamlined, salt-pruned canopy tapers down to the ground. It may also occur as small isolated patches that “crouch” behind high dunes in a matrix of Dune Grass.

MARITIME SHRUB (WAX-MYRTLE SUBTYPE) G3G5

Synonyms: *Morella cerifera / Spartina patens* Shrubland (CEGL003839)?

Ecological Systems: Central Atlantic Coastal Plain Maritime Forest (CES203.261). Northern Atlantic Coastal Plain Dune and Swale (CES203.264). Southern Atlantic Coastal Plain Dune and Maritime Grassland (CES203.273).

Concept: Subtype covers the less diverse examples dominated by shrub species, generally *Morella cerifera* alone or with *Ilex vomitoria*, without appreciable numbers of species capable of becoming large trees.

Distinguishing Features: The Wax Myrtle Subtype is distinguished from other subtypes by the absence of *Quercus virginiana*, *Pinus taeda*, or appreciable numbers of any larger tree species, and also the absence of *Morella pensylvanica*. It ranges throughout North Carolina and well to the north. The Wax Myrtle subtype is distinguished from Salt Shrub, which may also have substantial *Morella cerifera*, by the absence of an appreciable component of species of greater salt tolerance, such as *Iva frutescens*, *Baccharis halimifolia*, or *Borrichia frutescens*.

Comments: This was called the Shrub Subtype in earlier editions of the 4th approximation guide, and the Bayberry Subtype was called the Northern Subtype. After changes in the NVC, the association equivalent of the Wax Myrtle Subtype ranges well to the north of North Carolina, and the names were changed to reduce confusion.

This subtype can occur in association with Maritime Evergreen Forest, but more often occurs as isolated small patches in dune swales, surrounded by more open communities such as Dune Grass or Maritime Wet Grassland.

MARITIME SHRUB (BAYBERRY SUBTYPE) G2
Synonyms: *Morella pensylvanica / Diodia teres* Shrubland (CEGL003881).
Ecological Systems: Northern Atlantic Coastal Plain Dune and Swale (CES203.264).

Concept: Subtype covers examples with *Morella pensylvanica* as the dominant shrub, usually with stunted trees present at low density.

Distinguishing Features: This subtype is distinguished by the dominance or codominance of *Morella pensylvanica*.

Comments: This subtype was first defined in Virginia, and ranges northward to Delaware. It is present in North Carolina only on the Currituck Banks, the southernmost native range extent for *Morella pensylvanica*.

MARITIME EVERGREEN FOREST (MID ATLANTIC SUBTYPE) G2
Synonyms: *Quercus virginiana - Quercus hemisphaerica - Pinus taeda / Persea palustris - Ilex vomitoria* Forest (CEGL007027).
Ecological Systems: Central Atlantic Coastal Plain Maritime Forest (CES203.261).

Concept: Type covers evergreen hardwood-pine forests of barrier islands and comparable coast lines. Salt spray is a major environmental influence on these communities, and is generally indicated by a

distinctively streamlined canopy. The vegetation is dominated by some combination of *Quercus virginiana, Quercus hemisphaerica, Pinus taeda,* and *Juniperus virginiana* var. *silicola*. The Mid-Atlantic Subtype covers most of the maritime forests in North Carolina, where deciduous canopy trees are largely absent and where more southerly species, primarily *Sabal palmetto,* are absent.

Distinguishing Features: The Maritime Evergreen Forest type is distinguished from Coastal Fringe Evergreen Forest and Swamp Island Evergreen Forest by the strong predominance of the characteristic species, by the essential absence of deciduous trees in the canopy, and generally by a distinct streamlined canopy shape created by salt spray. Relative amounts of the dominant trees may vary, with some examples being nearly pure stands of one of the species but most being mixed. Maritime Evergreen Forest is distinguished from Marsh Hammock by having a broader set of the characteristic species, by generally having a streamlined canopy, and by the general absence of marsh and shade-intolerant herbs. It also occurs in a different setting, on barrier island interiors rather than on small raised patches within salt marshes.

These communities are periodically subject to heavy disturbance by hurricanes. Hard-hit examples may take some years to recover a closed canopy, but should be classified as Maritime Evergreen Forest unless major erosion has change the environment so that they cannot recover.

The Mid-Atlantic Subtype is readily distinguished from the South Atlantic Subtype in North Carolina by the absence of *Sabal palmetto*. Its southern range limit is north of the Smith Island complex, where the northern range limit of *Sabal palmetto* occurs. Examples in South Carolina should generally be treated as the South Atlantic Subtype even if *Sabal palmetto* is locally absent.

Comments: *Pinus taeda* / *Hudsonia tomentosa* Woodland (CEGL006052) is an open maritime forest known from southeasternmost Virginia. Comparable vegetation may occur on the Currituck Banks, but none is known. Maritime Forests on the Currituck Banks tend to be more open than farther south, and have openings containing *Hudsonia tomentosa,* but have more *Quercus virginiana*. They are considered part of this Maritime Evergreen Forest community. However, interpretation is confused by the tendency of pines to increase in examples that have been artificially cleared in the past. *Pinus taeda - Quercus (falcata, nigra) / Morella cerifera / Vitis rotundifolia* Forest (CEGL006040) is another pine-dominated open forest that occurs in maritime areas of Virginia. No natural vegetation of this kind is believed to exist in North Carolina, though anthropogenic successional communities may resemble it.

MARITIME EVERGREEN FOREST (SOUTH ATLANTIC SUBTYPE) G2
Synonyms: *Quercus virginiana - (Pinus elliottii var. elliottii, Sabal palmetto) / Persea borbonia - Callicarpa americana* Forest (CEGL007032).
Ecological Systems: Central Atlantic Coastal Plain Maritime Forest (CES203.261).

Concept: Subtype covers examples containing more southerly flora, with the northern extent marked by the northern range limit of *Sabal palmetto*. This subtype is present in North Carolina only in the Smith Island complex, the northernmost range limit for *Sabal palmetto,* and intermittently along the southern Brunswick County coast.

Distinguishing Features: Subtype covers examples containing *Sabal palmetto* or, further south, *Pinus elliottii* and other more southerly species.

Comments: *Sabal palmetto - Quercus virginiana* Saturated Forest (CEGL007040) is a hydric maritime hammock that NVC says occurs in North Carolina. While small wet *Sabal - Quercus* patches occur on Bald Head Island amid this Maritime Evergreen Forest, none are known that are extensive or distinctive enough to recognize as a distinct subtype or type there.

MARITIME DECIDUOUS FOREST G1?
Synonyms: *Quercus falcata - Pinus taeda - (Fagus grandifolia, Quercus nigra) / Persea palustris* Maritime Forest (CEGL007540).
Ecological Systems: Northern Atlantic Coastal Plain Maritime Forest (CES203.302).

Concept: Type covers forests of barrier islands (or potentially similar coastal areas) with codominant or dominant deciduous hardwood trees, generally a mixture of *Quercus falcata, Fagus grandifolia*, and *Pinus taeda*. These forests need more shelter from salt spray than Maritime Evergreen Forest, but have distinctive species combinations not found in mainland forests.

Distinguishing Features: Maritime Deciduous Forest is readily distinguished from all other upland forest types by the combination of barrier island setting and a canopy with a substantial component of deciduous hardwoods. The canopy of this type is generally mixed evergreen-deciduous rather than all deciduous, but the abundance of deciduous canopy trees is the most characteristic difference from Maritime Evergreen Forest.

Comments: This type is extremely rare. It apparently depends on wide, complex barrier islands that offer more shelter from salt spray. It occurs in a small portion of the Outer Banks, from Nags Head to Southern Shores, and at Cape Henry in Virginia.

COASTAL FRINGE EVERGREEN FOREST (TYPIC SUBTYPE) G2
Synonyms: *Quercus virginiana - Quercus hemisphaerica - Pinus taeda - Quercus falcata / Persea palustris* Forest (CEGL007026).
Ecological Systems: Central Atlantic Coastal Plain Maritime Forest (CES203.261).

Concept: Type covers evergreen hardwood-pine forests dominated by the characteristic species of maritime forests but which are not subject to salt spray or other disturbance processes of the immediate coast and therefore have a broader range of flora and more typical forest structure. They generally occur within a few miles of the coast, and contain many plants that are absent or scarce further inland. The Typic Subtype covers most examples, which normally are closed forests and do not have the characteristics of the Sand Spit Woodland Subtype.

Distinguishing Features: Coastal Fringe Evergreen Forest is distinguished from Maritime Evergreen Forest by occurring on the mainland and well inland of any communities of the coast line (Dune Grass, Maritime Dry Grassland, or Maritime Shrub). It lacks a streamlined canopy produced by salt spray. Examples generally contain more deciduous species in all strata, including *Quercus falcata* and *Carya glabra* in the canopy. *Quercus hemisphaerica* is generally more dominant, and *Quercus virginiana* less abundant than in Maritime Evergreen Forest, and may even be absent. Coastal Fringe Evergreen Forest is distinguished from Swamp Island Evergreen Forest by a greater diversity and abundance of maritime

forest plants. *Ilex vomitoria, Prunus caroliniana,* and *Quercus virginiana* are usually found in Coastal Fringe Evergreen Forests but are generally absent in Swamp Island Evergreen Forest. It is also easily distinguished by geographic setting, occurring on low upland flats near the coast rather than on inland swamp island ridges.

Comments: The global range of this community type is uncertain. The characteristic species reach their northern range limits in North Carolina's maritime forests, and are not confined to the coastal fringe farther south. This community may represent the attenuated extreme of a more diverse southern type.

COASTAL FRINGE EVERGREEN FOREST (SAND SPIT WOODLAND SUBTYPE) G1G3
Synonyms: *Quercus virginiana - Quercus hemisphaerica / Ilex vomitoria / Aristida condensata - Panicum amarum* var. *amarum* Forest (CEGL004399).
Ecological Systems: Central Atlantic Coastal Plain Maritime Forest (CES203.261).

Concept: Subtype covers the rare open woodland examples that occur on relatively young sand spits adjacent to estuarine rivers. This subtype has a distinctive component of plants of open areas and of native weeds (plants of disturbed soils). It appears to be intermediate in flora and ecology between the Typic Subtype, Pine/Scrub Oak Sandhill, Marsh Hammock, and Estuarine Beach communities, with characteristics of each.

Distinguishing Features: The Sand Spit Woodland Subtype can be distinguished from the Typic Subtype by a more open canopy and better developed herb layer that includes species such as *Andropogon ternarius, Aristida condensata, Carex arenaria, Cyperus grayi, Opuntia humifusa* var. *humifusa, Panicum amarum* var. *amarum,* and *Scleria flaccida*. The setting, on sand spits adjacent to tidal waters, is characteristic. It should not be confused with areas of the Typic Subtype which are transitional to Pine/Scrub Oak Sandhill, or with examples of Pine/Scrub Oak Sandhill which have seen proliferation of oaks due to fire suppression. The Sand Spit Woodland has a more varied flora in the lower strata, and one that contains marsh and coastal elements such as *Spartina patens, Panicum amarum* var. *amarum,* and *Eustachys petraea,* in addition to other elements not typically in sandhills, such as *Carex arenaria, Elymus virginicus, Scleria flaccida,* and *Cyperus* spp.

Comments: These communities likely represent a middle stage of long-term primary succession on relatively young sand spits, with exposure to salt water disturbance during hurricanes slowing succession. They share characteristics of several other communities, but do not fit any of them well. They share with Pine/Scrub Oak Sandhill (Coastal Fringe Subtype) an open structure and some herbaceous flora. However, they are unlikely to burn and do not have *Aristida stricta* or *Pinus palustris*. They share with Marsh Hammocks the presence of salt-tolerant herbs that are shared with adjacent marsh edges. They are similarly periodically disturbed by salt water during major storms. They share with Estuarine Beach the periodic wave disturbance and some weedy flora; however, they are drier and are less open and weedy. The dominant flora is shared with Coastal Fringe Evergreen Forest, and the setting is similar except for its exposure and the relative youth of the sand deposits. LeBlond called these communities Tidal Saltwater Levee Forest, because they occur along the estuarine river in a position analogous to the natural levees of inland rivers. However, these sand spits appear to have been created by estuarine tidal currents, wave action, and wind, rather than overbank flooding.

CALCAREOUS COASTAL FRINGE FOREST (NORTHERN SUBTYPE) G1
Synonyms: *Celtis laevigata - Tilia americana* var. *caroliniana / Aesculus pavia* Forest (CEGL007282).
Ecological Systems: Central Atlantic Coastal Plain Maritime Forest (CES203.261).

Concept: Type covers rare deciduous hardwood forests of shell-rich sandy soils of the coastal fringe. Coarse-textured calcareous soil, influence of coastal storms, maritime climate, and possibly mild salt spray likely determine their character, with calcareous soils differentiating them from Coastal Fringe Evergreen Forest. Subtype covers the more northerly examples, from middle and northern North Carolina, lacking Magnolia grandiflora and other more southerly species.

Distinguishing features: The Calcareous Coastal Fringe Forest type is distinguished from Coastal Fringe Shell Woodland by denser vegetation, occurring in more sheltered environments and having finer textured soils. It is distinguished from all other communities by the co-dominance of maritime forest species such as *Quercus virginiana* and *Ilex vomitoria* with substantial calciphilic flora and vegetation in a coastal fringe site. Lack of species restricted to more southern regions, especially *Magnolia grandiflora*, distinguishes the Northern Subtype from the Southern Subtype.

Comments: There has been confusion in the application of the NVC associations corresponding to the two subtypes, regarding whether the crucial distinction is one of biogeography or one of environmental differences such as moisture. They are here interpreted to represent biogeographic subtypes, marked by the presence or absence of southern indicator species. Each potentially spans a range of moisture levels and varies somewhat in the amount of evergreen versus deciduous canopy trees.

CALCAREOUS COASTAL FRINGE FOREST (SOUTHERN SUBTYPE) G2G3
Synonyms: *Quercus falcata - Tilia americana* var. *caroliniana - Magnolia grandiflora / Ilex vomitoria* Forest (CEGL007470).
Ecological Systems: Southern Atlantic Coastal Plain Maritime Forest (CES203.537).

Concept: Subtype covers more southerly examples, containing more southern species such as *Magnolia grandiflora*. In South Carolina, *Sabal palmetto* is also a frequent component. *Quercus hemisphaerica* appears to be the predominant maritime oak in samples of this subtype, while it is absent and *Quercus virginiana* dominates in the Northern Subtype, but the significance of this difference is unclear.

Comment: This subtype as currently defined is more abundant in South Carolina, though still rare. Only small and marginally developed examples occur in North Carolina. Much diversity is contained within the South Carolina occurrences, and it may warrant splitting into several subtypes there. Examples there include some with stunted or sparse tree cover in sites exposed to storm waves, and may vary with the amount of shells making up the soil.

MARSH HAMMOCK G3?
Synonyms: Maritime Evergreen Forest. *Juniperus virginiana var. silicicola - (Quercus virginiana, Sabal palmetto)* Forest (CEGL007813).
Ecological Systems: Atlantic Coastal Plain Embayed Region Tidal Salt and Brackish Marsh (CES203.260). Southern Atlantic Coastal Plain Salt and Brackish Tidal Marsh (CES203.270).

Concept: Type covers evergreen forests or woodlands of small upland islands surrounded by tidal marshes or related communities. They resemble Maritime Evergreen Forests but have a more shade-intolerant composition, a flora that is reduced in number of coastal species but contains some species of brackish marshes, and a canopy structure that lacks salt pruning but is often somewhat open. They may range in structure from forests to woodlands or savannas.

Distinguishing Features: Marsh Hammocks are distinguished from Maritime Evergreen Forest and Coastal Fringe Evergreen Forest by the greater importance of *Juniperus virginiana var. silicicola* in the canopy, by the absence of many characteristic maritime forest species, such as *Quercus hemisphaerica, Cornus florida, Carpinus caroliniana,* and *Prunus caroliniana*. They contain some plants shared with the adjacent marshes, such as *Juncus roemerianus, Cladium jamaicense, Panicum virgatum, Spartina patens,* or *Baccharis halimifolia*.

Comments: *Sabal palmetto* - (*Juniperus virginiana* var. *silicicola*) Woodland (CEGL003526) is another marsh hammock association defined for South Carolina to Florida, and has been suggested to occur in North Carolina but has not been found. It is classified as a woodland rather than a forest. It is not clear that this distinction is needed, given the natural variation in canopy density in these frequently-disturbed communities.

COASTAL FRINGE SHELL WOODLAND G2?
Synonyms: *Juniperus virginiana* var. *silicicola - Zanthoxylum clava-herculis - Quercus virginiana - (Sabal palmetto) / Sageretia minutiflora - (Sideroxylon tenax)* Woodland (CEGL003525).
Ecological Systems: Southern Atlantic Coastal Plain Maritime Forest (CES203.537). Central Atlantic Coastal Plain Maritime Forest (CES203.261).

Concept: Type covers rare open communities of shell deposits that support shrubby or woodland vegetation rather than forest due to the coarse soil or exposure to chronic disturbance. This is a more extremely developed version of the Calcareous Coastal Fringe Forest (both subtypes). It is typically associated with prehistoric shell middens or other deposits of nearly pure shell with poorly developed soil, on small islands within estuaries or on the mainland coast. While a number of well-developed examples occur in South Carolina, only a few small examples are known in North Carolina.

Distinguishing Features: This type is distinguished from all other communities by the occurrence of persistent open woody vegetation on coastal fringe shell deposits. The flora has at least some calciphilic component. The distinction from Calcareous Coastal Fringe Forest may be difficult to determine in the immediate aftermath of hurricanes, but the small stature, sparseness, and growth form of trees should make the persistent vegetation structure clear even at times of heavy mortality.

Dry Longleaf Pine Communities

DRY PIEDMONT LONGLEAF PINE FOREST G2
Synonyms: *Pinus palustris - Pinus echinata - (Pinus virginiana) / Quercus marilandica - (Quercus prinus) / Vaccinium pallidum* Woodland (CEGL008437).
Ecological Systems: Southeastern Interior Longleaf Pine Woodland (CES202.319).

Concept: Type covers woodlands or forests of the eastern Piedmont (primarily the Uwharries and areas adjacent to the Sandhills) in which *Pinus palustris* naturally dominates or codominates. *Pinus palustris* may be scarce in examples where past logging and fire suppression have removed it and allowed other pines or hardwoods to dominate.

Distinguishing Features: Dry Piedmont Longleaf Pine Forest is distinguished from all other Piedmont dry communities by having *Pinus palustris* dominant or codominant, or by having evidence that it once dominated. In degraded examples the canopy may resemble Dry Oak–Hickory Forest or Piedmont Monadnock Forest, or may be dominated by *Pinus taeda* and *Pinus echinata*, with only scattered *Pinus palustris*. It is distinguished from Wet Piedmont Longleaf Pine Forest by its overall dry to dry-mesic vegetation, lacking any appreciable amount of wetland species or even mesic species such as *Panicum virgatum* or *Chasmanthium laxum*. It is distinguished from most longleaf pine communities of the adjacent Coastal Plain by lacking *Aristida stricta, Quercus laevis, Quercus incana*, and *Quercus margarettiae*, as well as by its Piedmont location. The Northern Subtype of Pine/Scrub Oak Sandhill also lacks *Aristida stricta*, but contains the Coastal Plain scrub oaks.

Comments: This type covers a broader range of moisture and topographic positions than Piedmont hardwood forests. It may be that additional subtypes should be recognized, but their distinction is hidden by the universal alteration by past fire suppression in all remaining examples. *Pinus palustris - Quercus marilandica - Quercus prinus / Symplocos tinctoria* Woodland (CEGL004554), formerly considered distinct in the NVC, was merged with this type. It represent a single example in the Uwharrie Mountains, on a steep south slope.

SAND BARREN (TYPIC SUBTYPE) G2

Synonyms: Xeric Sandhill Scrub (Sand Barren Variant); *Pinus palustris / Quercus laevis / Aristida stricta / Cladonia* spp. Woodland (CEGL003584).
Ecological Systems: Atlantic Coastal Plain Fall-Line Sandhills Longleaf Pine Woodland (CES203.254). Atlantic Coastal Plain Upland Longleaf Pine Woodland (CES203.281).

Concept: Type covers the driest, most barren naturally occurring non-maritime sandy communities of the Coastal Plain, with low vegetation cover in all strata and a prominent suite of psammophyte plants. They typically are on Carolina bay rims or on the younger inland sand dunes. Subtype covers the typical examples in most parts of the Coastal Plain, which lack the plants characteristic of the Coastal Fringe Subtype.

Distinguishing Features: Sand Barrens are distinguished from Xeric Sandhill Scrub and all other longleaf pine communities in natural condition by low cover of grasses and high cover of specialized psammophytes, macrolichens, and bare sand. Characteristic plants include *Polygonella polygama, Stipulicida setacea, Minuartia caroliniana, Selaginella acanthonota*, and *Cnidoscolus stimulosus*. Typically all vegetation strata have low cover. Distinguishing natural Sand Barrens from disturbed sandhill communities of more mesic types can sometimes be difficult. Old-looking or gnarled-looking (though small) longleaf pines and turkey oaks, presence of wiregrass at least in more mesic microsites, a diversity of psammophytes, and absence of weedy plants such as *Andropogon virginicus, Eupatorium capillifolium*, and *Eupatorium compositifolium*, are indicators of natural conditions. The Typic Subtype is distinguished from the Coastal Fringe Subtype by the absence of plants that are (in North Carolina at

least) confined to the coastal zone -- *Cladina evansii*, *Rhynchospora megalocarpa*, *Ilex vomitoria*, and *Quercus geminata*.

SAND BARREN (COASTAL FRINGE SUBTYPE) G2

Synonyms: Xeric Sandhill Scrub (Coastal Fringe Variant); *Pinus palustris / Quercus laevis / Aristida purpurascens - Stipulicida setacea - (Rhynchospora megalocarpa, Selaginella acanthonota)* Woodland (CEGL003590).
Ecological Systems: Atlantic Coastal Plain Upland Longleaf Pine Woodland (CES203.281).

Concept: Subtype covers examples near the coast (at least in North Carolina) which have characteristic coastal fringe flora.

Distinguishing Features: The Coastal Fringe Subtype is distinguished by the presence of characteristic coastal fringe flora, such as *Cladina evansii*, *Rhynchospora megalocarpa*, *Ilex vomitoria*, and *Quercus geminata*. These species are indicators, and may be present only in small numbers or concentrated in moist microsites.

Comments: This subtype is not as strongly differentiated as most subtypes. The characteristic coastal fringe flora are only marginal in their tolerance of Sand Barren habitats, and are a less prominent part of the community than they are in the Coastal Fringe subtypes of Xeric Sandhill Scrub and Pine/Scrub Oak Sandhill. However, the climatic factors that support coastal fringe flora in all these community types are likely to have effects on other organisms in the community (animals, microbes) and on ecosystem processes, even in the extreme environment of Sand Barrens.

XERIC SANDHILL SCRUB (TYPIC SUBTYPE) G3?

Xeric Sandhill Scrub (Turkey Oak Variant); Xeric Sandhill Scrub (Coastal Plain Variant); *Pinus palustris / Quercus laevis / Gaylussacia dumosa / Aristida stricta* Woodland (CEGL003586). Ecological Systems: Atlantic Coastal Plain Fall-Line Sandhills Longleaf Pine Woodland (CES203.254). Atlantic Coastal Plain Upland Longleaf Pine Woodland (CES203.281).

Concept: The Xeric Sandhill Scrub type covers the widespread longleaf pine communities of dry, coarse, infertile sands, which have a low diversity scrub oak layer strongly dominated by *Quercus laevis*, but which have fairly high cover of *Aristida stricta* and other herbs rather than the sparse vegetation of the Sand Barrens. The Typic Subtype covers most examples of the Sandhills and Coastal Plain, where plants characteristic of the coastal fringe are absent.

Distinguishing Features: Xeric Sandhill Scrub is distinguished from Sand Barren by higher plant cover in the herb layer, especially of *Aristida stricta*. Lichens and specialized psammophytes such as *Stipulicida setacea* and *Minuartia caroliniana (= Arenaria caroliniana)*, may be present but are minor in abundance in comparison with *Aristida stricta*. Xeric Sandhill Scrub is distinguished from all other community types by the presence of a scrub oak layer strongly dominated by *Quercus laevis*, though *Quercus margarettae* and *Quercus incana* are often present. The Typic Subtype is distinguished from the Coastal Fringe Subtype by the absence of characteristic coastal fringe flora, such as *Cladina evansii*, *Rhynchospora megalocarpa*, *Ilex vomitoria*, and *Quercus geminata*.

Comments: This subtype is widespread in the Sandhills Region and is fairly common in the rest of the southern part of the Coastal Plain. There are floristic differences between examples in the Sandhills and the rest of the Coastal Plain, and these may be recognized as variants. The most important difference is the abundance of Fabaceae in the Sandhills Variant. This subtype ranges southward into South Carolina, to the "wiregrass gap" – the southern range limit of *Aristida stricta*.

XERIC SANDHILL SCRUB (COASTAL FRINGE SUBTYPE) G2?

Synonyms: *Pinus palustris / Quercus laevis - Quercus geminata / Vaccinium tenellum / Aristida stricta* Woodland (CEGL003589).
Ecological Systems: Atlantic Coastal Plain Upland Longleaf Pine Woodland (CES203.281).

Concept: The Coastal Fringe Subtype covers examples near the coast which contain characteristic coastal fringe plant species.

Distinguishing Features: The Coastal Fringe Subtype is distinguished from the Typic Subtype by the presence of characteristic coastal fringe flora, such as *Cladina evansii*, *Rhynchospora megalocarpa*, *Ilex vomitoria*, and *Quercus geminata*. The Coastal Fringe Subtype generally occurs within a few miles of the coast.

Comments: As with other coastal fringe communities, the interpretation of their distinctive character as maritime may only apply in North Carolina. Many of the species that mark them occur in inland areas in states farther south.

PINE/SCRUB OAK SANDHILL (BLACKJACK SUBTYPE) G2G3

Synonyms: *Pinus palustris / Quercus marilandica / Gaylussacia dumosa / Aristida stricta* Woodland (CEGL003595).
Ecological Systems: Atlantic Coastal Plain Fall-Line Sandhills Longleaf Pine Woodland (CES203.254). Atlantic Coastal Plain Upland Longleaf Pine Woodland (CES203.281) (rarely).

Concept: The Pine/Scrub Oak Sandhill type covers dry longleaf pine communities that are less xeric and infertile than the Xeric Sandhill Scrub type, and are characterized by a scrub oak layer containing a mixture of oak species. The Blackjack Subtype covers examples where *Quercus marilandica* is a significant component. They are associated with soils having clay below a sandy surface. These are common in the Sandhills region but occur only occasionally in other parts of the Coastal Plain.

Distinguishing Features: The Pine/Scrub Oak Sandhill type is distinguished from Xeric Sandhill Scrub and Sand Barren communities by the substantial presence of scrub oaks other than *Quercus laevis: Quercus marilandica, Q. incana, Q. margarettiae, Q. hemisphaerica,* or *Quercus geminata*. However, *Quercus laevis* may still be the most abundant oak. Pine/Scrub Oak Sandhill is distinguished from Mesic Pine Savanna and wetter longleaf pine communities by the presence of a substantial understory of scrub oaks, or a substantial shrub layer of scrub oak sprouts in recently burned examples. In sites where land managers have treated stands with herbicide, all scrub oaks may be absent and this type will have to be distinguished from Mesic Pine Savanna by the lack of the more mesophytic herbaceous and shrub spcies characteristic of that type. Fire-suppressed Mesic Pine Savannas may contain forest oaks such as *Quercus stellata, Q. falcata, Q. velutina,* and *Q. nigra,* but little or none of the scrub oaks characteristic

of this type. Pine/Scrub Oak Sandhill (other than the Northern Subtype) is distinguished from Piedmont Longleaf Pine Forest by the presence of *Aristida stricta* and by the absence of characteristic Piedmont upland forest species such as *Oxydendrum arboreum, Quercus montana,* and *Quercus coccinea,* and in the most natural examples, by the absence of a substantial component of *Pinus taeda.* Substrate and location readily distinguish these two types in altered examples where *Aristida* may have been lost.

The Blackjack Subtype is distinguished from the Mixed Oak Subtype by the presence of appreciable amounts of *Quercus marilandica*. It is distinguished from the Clay/Rock Hilltop Subtype by the presence of *Quercus laevis*, the absence of *Vaccinium crassifolium* and other wetland species, and the presence of sand at the soil surface. It is distinguished from the Mesic Transition Subtype by the absence of characteristic more-mesic herbs and shrubs; though the herb layer may be fairly diverse, it is less rich in plant species than the Mesic Transition Subtype. The Blackjack Subtype is distinguished from the Northern Subtype by the presence, at least historically, of *Aristida stricta*.

Comments: As with most of our other longleaf pine communities, the latitudinal range of this community is limited by the northern and southern range limits of *Aristida stricta* in central North Carolina and northern South Carolina.

PINE/SCRUB OAK SANDHILL (MIXED OAK SUBTYPE) G3?
Synonyms: *Pinus palustris / Quercus laevis - Quercus (incana, margarettiae) / Gaylussacia dumosa / Aristida stricta* Woodland (CEGL003591).
Ecological Systems: Atlantic Coastal Plain Fall-Line Sandhills Longleaf Pine Woodland (CES203.254). Atlantic Coastal Plain Upland Longleaf Pine Woodland (CES203.281).

Concept: The Mixed Oak Subtype covers examples on fine sands or on slightly silty soils without clay. They have a mixture of scrub oaks that does not include *Quercus marilandica* and which do not have the characteristics of the other subtypes.

Distinguishing Features: The Mixed Oak Subtype is characterized by abundant *Quercus laevis, Q. incana, Q. margarettae*, or occasionally *Q. hemisphaerica*. It is distinguished from the Blackjack and Clay/Rock Hilltop Subtypes by the absence of *Quercus marilandica*. It is distinguished from the Mesic Transition Subtype by a lower diversity herb layer (though it may still have fairly high diversity) that lacks mesic species. It is distinguished from the Northern Subtype by occurring within the range of *Aristida stricta*, and, at least historically, having it resent. It is distinguished from the Coastal Fringe Subtype by lacking plants that, in North Carolina at least, are largely confined to near the coast. These include *Quercus geminata, Quercus virginiana, Osmanthus americanus, Ilex vomitoria, Rhynchospora megalocarpa*, and *Cladina evansii*. *Quercus hemisphaerica* is more often abundant in the Coastal Fringe Subtype, but may also be abundant in the Mixed Oak Subtype.

Comments: This subtype is less well understood than the other subtypes. It appears to occur mostly in the middle Coastal Plain. Many examples are in isolated sites such as Carolina bay rims and are altered by fire suppression. In the absence of fire, *Quercus nigra* and *Gelsemium sempervirens* often become abundant.

PINE/SCRUB OAK SANDHILL (MESIC TRANSITION SUBTYPE) G2G3
Synonyms: Pine/Scrub Oak Sandhill (Loamy Soil Variant); "pea swales"; *Pinus palustris / Quercus incana / Aristida stricta - Sorghastrum nutans - Anthaenantia villosa* Woodland (CEGL003578).
Ecological Systems: Atlantic Coastal Plain Fall-Line Sandhills Longleaf Pine Woodland (CES203.254). Atlantic Coastal Plain Upland Longleaf Pine Woodland (CES203.281).

Concept: The Mesic Transition Subtype covers the generally very localized examples with loamy soil, greater fertility, or possibly closer proximity to the water table, which support a very diverse flora that includes mesic herb and shrub species. They share many plants with Mesic Pine Flatwoods, but have a significant scrub oak component.

Distinguishing Features: This subtype is often transitional to Mesic Pine Flatwoods, and should be distinguished by the presence of scrub oaks in significant numbers (these may be reduced in density and present as shrub-size sprouts if the site has been frequently burned). Communities in which oaks have been artificially eradicated may be difficult to distinguish, but will have a flora that will lack the small component of wetland species usually found in Mesic Pine Savanna.

The Mesic Transition Subtype is distinguished from all other subtypes by the substantial presence of characteristic mesic grasses, legumes, and composites, such as *Anthaenantia villosa, Sorghastrum nutans, Andropogon gerardii, Paspalum bifidum, Tridens carolinianus, Lespedeza capitata, Lespedeza hirta, Helianthus divaricatus, Sorghastrum elliottii, Sporobolus clandestinus, Onosmodium virginianum, Muhlenbergia capillaris, Ceanothus americanus,* and several *Desmodium* species. The scrub oaks may be less dense in this subtype than in the Blackjack Subtype under the same management regime.

Comments: This subtype occurs both in the Sandhills and in the outer Coastal Plain. There are enough differences in species composition to warrant recognition of variants, and possibly subtypes, in these two regions.

PINE/SCRUB OAK SANDHILL (CLAY/ROCK HILLTOP SUBTYPE) G2?
Synonyms: *Pinus palustris / Quercus marilandica / Vaccinium crassifolium / Aristida stricta* Woodland (CEGL003599).
Ecological Systems: Atlantic Coastal Plain Fall-Line Sandhills Longleaf Pine Woodland (CES203.254).

Concept: The Clay/Rock Hilltop Subtype covers the rare examples in the Sandhills Region where clay or consolidated rock is exposed at the soil surface, which generally support a sparser scrub oak layer that lacks *Quercus laevis* and which have *Vaccinium crassifolium* and *Pyxidanthera barbulata* as significant components.

Distinguishing Features: The Clay/Rock subtype is distinguished from all other subtypes by occurrence on sandstone or hard clay surfaces rather than sand, by the absence of *Quercus laevis* and the presence of *Vaccinium crassifolium* or *Pyxidanthera barbulata* in a hilltop location (a location that would otherwise be well drained).

Comments: These communities are extremely rare in North Carolina, with only a handful of examples, all in the Sandhills Region. Clay/Rock Hilltops are apparently more abundant in the South Carolina

Sandhills, but it is unclear how many occur within the range of *Aristida stricta* and thus represent this subtype.

PINE/SCRUB OAK SANDHILL (COASTAL FRINGE SUBTYPE) G2

Synonyms: Coastal Fringe Sandhill; *Pinus palustris - Pinus taeda / Quercus geminata - Quercus hemisphaerica - Osmanthus americanus var. americanus / Aristida stricta* Woodland (CEGL003577).
Ecological Systems: Atlantic Coastal Plain Upland Longleaf Pine Woodland (CES203.281).

Concept: The Coastal Fringe Subtype covers communities near the coast, which contain characteristic coastal fringe plants, including evergreen scrub oaks. It was formerly treated as a separate community type, but falls within the moisture range and broader concept of Pine/Scrub Oak Sandhill.

Distinguishing Features: The Coastal Fringe Subtype is distinguished by the presence of plant species that, at least in North Carolina, are confined to near the coast. These include *Quercus geminata, Osmanthus americanus, Ilex vomitoria, Rhynchospora megalocarpa,* and *Cladina evansii*. *Quercus hemisphaerica* is often abundant in the Coastal Fringe Subtype, but communities that have *Quercus hemisphaerica* and none of the other indicators are classified as the Mixed Oak Subtype.

Among the Coastal Fringe subtypes of the different sandhill types, these communities are distinguished by being more mesic and having greater overall plant cover and diversity than the Xeric Sandhill Scrub or Sand Barren. *Quercus geminata* often is more abundant than *Quercus laevis*, and *Q. hemisphaerica, Q. incana, Q. margarettiae,* and *Q. virginiana* are generally present. Bare sand is limited in extent and the most specialized psammophytes are not as abundant.

Comments: The Coastal Fringe Sandhill type of the 3rd approximation has been reduced to a series of subtypes under the other sandhill types in the 4th. This represents a conclusion that the ecological and floristic differences caused by differences in moisture regime are more important than those related to the coastal fringe. It is unclear what is responsible for the floristic differences of the coastal fringe subtypes. The presence of evergreen species that are more widespread farther south suggests that warmer temperatures may be important. The component of evergreen oaks may significantly affect fire dynamics, because their litter is less flammable than that of deciduous oaks.

PINE/SCRUB OAK SANDHILL (NORTHERN SUBTYPE) G1

Synonyms: *Pinus palustris / Quercus laevis - Quercus incana / Gaylussacia dumosa - Gaylussacia (baccata, frondosa)* Woodland (CEGL003592).
Ecological Systems: Atlantic Coastal Plain Upland Longleaf Pine Woodland (CES203.281).

Concept: The Northern Subtype covers the now-very-rare examples that are north of the natural range of *Aristida stricta*. This is conceptually a broader range of moisture and soil conditions than the other subtypes, but remaining examples are too few and too degraded to refine the category further.

Distinguishing Features: The Northern Subtype is distinguished from all other subtypes by its geographic location north of the natural range of *Aristida stricta*, roughly at Pamlico Sound and the Tar River. The only other dry longleaf pine community that naturally lacks *Aristida stricta* is the Piedmont Longleaf Pine Forest, of which none are known this far north and which differ in their composition and

substrate. The absence of *Aristida stricta* would have a substantial effect on the fire dynamics of these communities under natural conditions, as no other herb species are as flammable and none will carry fire under as wide a range of conditions.

MESIC PINE SAVANNA (COASTAL PLAIN SUBTYPE) G2G3

Synonyms: Mesic Pine Flatwoods (Coastal Plain Variant); *Pinus palustris / Amorpha herbacea var. herbacea / Aristida stricta - Sorghastrum nutans* Woodland (CEGL003569).
Ecological Systems: Atlantic Coastal Plain Upland Longleaf Pine Woodland (CES203.281).

Concept: The Mesic Pine Savanna type covers longleaf pine communities of environments intermediate between sandhills and wet savannas. The Coastal Plain Subtype covers the typical examples of the middle and lower Coastal Plain, which differ floristically and in landscape relations from the other subtypes.

Distinguishing Features: The Mesic Pine Savanna type is distinguished from Pine/Scrub Oak Sandhill and other sandhill types by the substantial absence of scrub oaks or by their presence combined with that of wetland species. Forest oaks such as *Quercus nigra, Q. falcata,* or *Q. stellata* may be present in fire-suppressed examples. Where land managers have treated Pine/Scrub Oak Sandhill with herbicide, scrub oaks may be absent and the communities can be difficult to tell from Mesic Pine Flatwoods. Most subtypes of Pine/Scrub Oak Sandhill will lack the distinctive mesic herbaceous flora. The Mesic Transition Subtype will share many of these species but will generally have them in lower abundance and diversity.

Mesic Pine Savannas are distinguished from the wet pine savannas by having a substantial component of mesophytic plants and only small amounts wetland plants, or having wetland plants in combination with scrub oaks. Mesic Pine Savannas contain a substantial and usually diverse component of legume species, which are largely absent in wetter pine savannas. Characteristic plants that occur in wet savannas and not in mesic savannas include *Sporobolus pinetorum, Ctenium aromaticum, Muhlenbergia expansa*, most *Rhynchospora* species, *Andropogon glomeratus, Eriocaulon* spp., *Bigelowia nudata, Zigadenus* spp., and all the carnivorous plants.

The Coastal Plain Subtype is distinguished from the other subtypes by floristic differences. It is distinguished from the Lumbee Subtype and the Little River Subtype by the absence of scrub oaks and lack of any appreciable amount of wetland plants. The distinction with the Sandhills Subtype is based on floristic differences that are less clear cut, but the two can readily be distinguished by geographic location, as no examples are known in North Carolina outside of their respective geographic areas. Plants that occur in the Coastal Plain Subtype and seldom or never in the Sandhills Subtype include *Amorpha herbacea var. herbacea, Carphephorus odoratissimus, Tephrosia hispidula, Liatris pilosa (= Liatris graminifolia),* and *Pterocaulon pycnostachyum*. Plants that occur in the Sandhills Subtype and seldom or never in the Coastal Plain include *Anthaenantia villosa, Paspalum bifidum, Liatris cokeri,* and *Tridens carolinianus*. The Coastal Plain Subtype usually occurs on flat terrain distant from drainages, in large to small patches, or often in a fine-scale mosaic with Wet Loamy Pine Savanna communities. The Sandhills Subtype usually occurs as small patches in upland swales or on lower slopes.

Comments: Though Mesic Pine Savanna represents a segment of a hypothetical moisture gradient between drier sandhill communities and wetter pine savannas, they occur as recognizable communities

only on finer-textured soils. In coarse sandy soils, wetter savannas usually adjoin Xeric Sandhill Scrub communities without a mesic community between. This presumably is because, with their lack of water-holding capacity, sands must either be excessively drained or saturated by the water table. However, nutrient-holding capacity may also play an important role in the absence of the characteristic mesic flora.

The distinction between the Coastal Plain and Sandhills subtypes needs further examination and clarification, but appears warranted, and is supported by analysis of plot data collected by the Carolina Vegetation Survey. However, these subtypes share virtually all of their dominant species.

The terms "savanna" and "flatwoods" have been used in various ways in the literature of the Coastal Plain (and in even more various ways in other regions). Communities named savannas may be wetter, shrubbier, or more diverse than those named flatwoods, with these usages sometimes contradicting each other. The 3rd Approximation used the name flatwoods for drier communities and savanna for wetter ones. This moisture-based use of the names has been dropped in favor of one based on diversity and possibly natural structure. Mesic Pine Savannas are not naturally shrubby under a natural fire regime, and can have extremely high species richness.

MESIC PINE SAVANNA (SANDHILLS SUBTYPE) G2G3
Synonyms: Mesic Pine Flatwoods (Sandhills Subtype); *Pinus palustris / Aristida stricta - Sorghastrum nutans - Anthaenantia villosa* Woodland (CEGL003570).
Ecological Systems: Atlantic Coastal Plain Fall-Line Sandhills Longleaf Pine Woodland (CES203.254).

Concept: The Sandhills Subtype covers the typical examples of the Sandhills Region, which differ floristically from the other subtypes.

Distinguishing Features: The Sandhills Subtype is distinguished from the Lumbee Subtype and the Little River Subtype by the absence of scrub oaks and lack of any appreciable amount of wetland plants. The distinction with the Coastal Plain Subtype is based on floristic differences that are less clear cut, but the two can readily be distinguished by geographic location, as no examples are known in North Carolina outside of their respective geographic areas. Plants that occur in the Coastal Plain Subtype and seldom or never in the Sandhills Subtype include *Amorpha herbacea var. herbacea, Carphephorus odoratissimus, Tephrosia hispidula, Desmodium tenuifolium, Liatris pilosa (= Liatris graminifolia),* and *Coreopsis linifolia (= Coreopsis oniscicarpa).* Plants that occur in the Sandhills Subtype and seldom or never in the Coastal Plain include *Anthaenantia villosa, Paspalum bifidum, Liatris cokeri,* and *Tridens carolinianus*. The Sandhills Subtype generally occurs in small patches, usually in swales surrounded by drier sandhill communities.

MESIC PINE SAVANNA (LITTLE RIVER SUBTYPE) G1
Synonyms: Mesic Pine Flatwoods (Little River Variant); *Pinus palustris / Vaccinium elliottii - Clethra alnifolia / Aristida stricta - Panicum virgatum* Woodland (CEGL003573).
Ecological Systems: Atlantic Coastal Plain Fall-Line Sandhills Longleaf Pine Woodland (CES203.254).

Concept: The Little River Subtype covers the rare examples on high river terraces in the Sandhills Region, which contain plants with large differences in typical moisture tolerance, and includes some

plants characteristic of floodplains. These communities are presently known only along the Little River of Cumberland, Hoke, and Moore counties.

Distinguishing Features: The Little River Subtype is distinguished from the Sandhills and Coastal Plain subtypes by having unusual combinations of plants that include some scrub oaks and some wetland species, though the overall "average" is mesic. It is distinguished from the Lumbee Subtype, which also has unusual combinations of species, by the presence of bottomland species such as *Vaccinium elliottii*, the absence of other characteristic species such as *Quercus pumila*, and by location on a river terrace.

Comments: This subtype is one of the rarest of our longleaf pine communities. Examples are currently known only from the Little River, which appears to be geomorphically unique, at least within North Carolina.

MESIC PINE SAVANNA (LUMBEE SUBTYPE) G1
Synonyms: Pine Savanna (Lumbee Variant); *Pinus palustris - Pinus taeda - Pinus serotina / Quercus marilandica / (Quercus pumila) / Aristida stricta* Woodland (CEGL003664).
Ecological Systems: Atlantic Coastal Plain Upland Longleaf Pine Woodland (CES203.281).

Concept: The Lumbee Subtype covers the rare examples on loamy inner Coastal Plain soils, which contain plants with large differences in typical moisture tolerance that are mesophytic on “average”. These communities are presently known in North Carolina only in Robeson County and its vicinity, in the inner Coastal Plain.

Distinguishing Features: The Lumbee Subtype is distinguished from the Sandhills and Coastal Plain subtypes by having unusual combinations of plants that include some scrub oaks and some wetland species, though the overall "average" is mesic. It is distinguished from the Little River Subtype, which also has unusual combinations of species, by the absence of *Vaccinium elliottii*, often by the presence of *Quercus pumila*, and by location on Coastal Plain flats rather than a river terrace.

Comments: This is now one of our rarest longleaf pine community types. It probably was once abundant in the southern inner Coastal Plain. Its soils are well suited to agriculture. It may occur in adjacent South Carolina, but apparently has not been recognized there.

Coastal Plain Floodplains

BROWNWATER LEVEE FOREST (HIGH LEVEE SUBTYPE) G3G5
Synonyms: *Celtis laevigata - Fraxinus pennsylvanica - Acer negundo - (Juglans nigra) / Asimina triloba / Carex grayi* Forest (CEGL004740).
Ecological Systems: Atlantic Coastal Plain Small Brownwater River Floodplain Forest (CES203.250). Southern Atlantic Coastal Plain Large River Floodplain Forest (CES203.066).

Concept: Type covers forests of natural levee deposits along brownwater Coastal Plain rivers, with a significant component of the suite of levee tree species: *Fraxinus pennsylvanica, Celtis laevigata, Platanus occidentalis, Betula nigra, Acer negundo,* and *Ulmus americana*. Subtype covers the communities of the highest levees, in the inner to middle Coastal Plain stretches of rivers, where rich-site species and marginal wetland species are a significant component. *Aesculus sylvatica, Lindera*

benzoin, Laportea canadensis, Nemophila aphylla (= Nemophila microcalyx), and *Corydalis flavula* are examples of such species.

Distinguishing Features: Brownwater Levee Forests usually are easily distinguished by their location adjacent to Coastal Plain Brownwater Rivers. However, they may extend a considerable distance back from the largest rivers, and they may occasionally occur on abandoned channel segments some distance from the present river location. They are distinguished from Bottomland Hardwoods communities by having a significant component of the suite of levee species that includes *Fraxinus pennsylvanica, Celtis laevigata, Platanus occidentalis, Betula nigra, Acer negundo,* and *Ulmus americana* in other than successional situations (*Platanus* and *Betula* in particular sometimes invade disturbed sites beyond the levee). *Liquidambar styraciflua* and various bottomland oaks may occur in Levee Forests but in smaller proportions than in Bottomland Hardwoods. Brownwater Levee Forests, especially this subtype, are similar to Piedmont Levee Forests, sharing much flora but showing differences in dominance and some regional differences. They can be distinguished readily by location. The abiotic dynamics of flooding and sediment deposition are significantly different, but examples right at the Fall Line may be difficult to place.

The High Levee Subtype is distinguished from the Medium Levee Subtype by the presence of characteristic drier site species, many of them shared with Piedmont Levee Forest. These include *Aesculus sylvatica, Lindera benzoin, Laportea canadensis, Nemophila aphylla (= Nemophila microcalyx),* and *Corydalis flavula*. There is a progression from the High Levee to Medium Levee to Low Levee Subtype as you move downstream, but large upstream levees also can have zoned vegetation. High levees sometimes drop off rapidly to sloughs or backswamps, but in other places have a broad zone of Medium Levee or even Low Levee on the side away from the river.

Comments: *Platanus occidentalis - Celtis laevigata - Fraxinus pennsylvanica / Lindera benzoin - Ilex decidua / Carex retroflexa* Forest (CEGL007730) is another NVC association which appears to be redundant with this.

Pinus taeda - Fraxinus pennsylvanica - Ulmus americana - Celtis laevigata Temporarily Flooded Forest [Provisional] (CEGL007559), previously treated as a separate High Pine subtype, is no longer recognized in the 4th approximation or in the NVC.

There is concern in these communities about excessive sediment deposition caused by anthropogenically-induced erosion in the watersheds over the last several centuries. This presumably has affected all examples -- raising ground levels, reducing flood frequency and duration, and probably altering plant composition. On the best-studied river in North Carolina, the Roanoke, the flood regime is also altered by dams. This makes determination of the natural state difficult, and our understanding of these communities may need revision in the future.

BROWNWATER LEVEE FOREST (MEDIUM LEVEE SUBTYPE) G4?
Synonyms: *Fraxinus pennsylvanica - Ulmus americana / Carpinus caroliniana / Boehmeria cylindrica* Forest (CEGL007806).
Ecological Systems: Atlantic Coastal Plain Small Brownwater River Floodplain Forest (CES203.250). Southern Atlantic Coastal Plain Large River Floodplain Forest (CES203.066).

Concept: Subtype covers levees of medium height, typically in the middle Coastal Plain stretches of rivers and sometimes on lower parts of high upstream levees. The rich-site species and marginal wetland species of the High Levee Subtype are minor or absent, plant species richness is generally lower, and more water-tolerant species are usually present in small numbers. Also included is one example dominated by a disjunct population of *Populus deltoides*, with an admixture of other levee species.

Distinguishing Features: The Medium Levee Subtype is distinguished from the High Levee Subtype by the absence of characteristic species of rich sites shared with Piedmont levees, such as *Aesculus sylvatica, Lindera benzoin, Laportea canadensis, Nemophila aphylla (= Nemophila microcalyx),* and *Corydalis flavula.* Species of wetter sites, such as *Carya aquatica, Nyssa aquatica*, *Quercus lyrata*, and *Taxodium distichum* may be present, but only in small numbers or in wetter microsites.

Comments: *Populus deltoides - Salix caroliniana* Forest (CEGL007343) may have been attributed to North Carolina, but it seems best to treat the forest with disjunct *Populus deltoides* as part of this subtype, since it occurs in a very similar site and is also floristically very similar.

As with the High Levee Subtype, these communities are subject to the impact of excessive sedimentation created by widespread upland erosion, and all examples in upstream parts of rivers may be altered. The best-studied examples, those on the Roanoke River, are also affected by the altered flood regime created by dams. Dam management has produced abnormally long low floods, which has affected these communities more than the higher levees or bottomland hardwoods. Excessive tree mortality, tree regeneration failure, and reduced herb and shrub layers appear to result.

BROWNWATER LEVEE FOREST (LOW LEVEE SUBTYPE) G3G4

Synonyms: *Fraxinus pennsylvanica - Quercus laurifolia - Quercus lyrata - Carya aquatica* Forest (CEGL004695).
Ecological Systems: Atlantic Coastal Plain Small Brownwater River Floodplain Forest (CES203.250). Southern Atlantic Coastal Plain Large River Floodplain Forest (CES203.066).

Concept: Subtype covers low levees, on the lower reaches of rivers or on lower parts of upstream levees, where more water-tolerant species such as *Quercus lyrata* and *Carya aquatica* are major components, but where characteristic levee species such as *Fraxinus pennsylvanica* and *Ulmus americana* are still significant. Also included here are communities of relict natural levees in the tidally influenced lower reaches of brownwater rivers, which have similar vegetation.

Distinguishing Features: The Low Levee Subtype is distinguished from other subtypes by the dominance of more water-tolerant tree species, particularly *Quercus laurifolia, Quercus lyrata, Carya aquatica, Nyssa aquatica*, and *Taxodium distichum,* in combination with characteristic levee species such as *Fraxinus pennsylvanica, Ulmus americana, Platanus occidentalis,* and *Betula nigra*. While *Taxodium distichum* and *Nyssa aquatica* are generally present, they do not dominate as they do in the Cypress-Gum Swamp type.. These communities also may look similar to Brownwater Bottomland Hardwoods (Swamp Transition Subtype), which can have a substantial amount of *Fraxinus pennsylvanica*, but which occurs farther from the river and lacks *Platanus occidentalis* and *Betula nigra*.

Comments: Most examples of this subtype occur far downstream, where excessive sedimentation and altered flood regimes created by Piedmont dams have less effect. However, examples on the lower parts

of upstream levees are affected by them. Examples in the most downstream reaches of rivers are being affected by rising sea level.

BROWNWATER LEVEE FOREST (BAR SUBTYPE) G4G5

Synonyms: *Betula nigra - Platanus occidentalis / Alnus serrulata / Boehmeria cylindrica* Forest (CEGL007312).
Ecological Systems: Atlantic Coastal Plain Small Brownwater River Floodplain Forest (CES203.250). Southern Atlantic Coastal Plain Large River Floodplain Forest (CES203.066).

Concept: Subtype covers recent deposits in the middle stages of primary succession from a bar community to one of the other subtypes. This category is included provisionally, because it is unclear if such communities occur in North Carolina in patches large enough to recognize as distinct communitires. Vegetation similar to the NVC description usually occurs as a narrow bank zone only a few feet wide along many river banks, and could occur in larger patches on point bars where river meanders are still migrating.

Distinguishing Features: The Bar Subtype is distinguished by dominance of tree species characteristic of primary succession, particularly *Platanus occidentalis, Betula nigra, Salix nigra, Salix caroliniana,* or *Acer saccharinum*. This phase occurs as part of the primary succession on bars, though similar vegetation may be artificially created by clearing of some of the subtypes of Brownwater Levee Forest. It is not clear if natural occurrences are ever large enough to distinguish as conservation targets.

Comments: *Populus deltoides - Salix caroliniana* Forest (CEGL007343) and *Salix nigra - Fraxinus pennsylvanica* Forest (CEGL007734) are additional bar forest associations that have been attributed to North Carolina. The limited development of these communities and their natural variability does not appear to warrant such fine distinctions.

BLACKWATER LEVEE/BAR FOREST G2G3

Synonyms: *Betula nigra - Quercus laurifolia - Taxodium (distichum, ascendens) / Crataegus aestivalis* Forest (CEGL004282).
Ecological Systems: Atlantic Coastal Plain Small Blackwater River Floodplain Forest (CES203.249).

Concept: Type covers forests and woodlands on the interior of point bars and along banks of blackwater rivers, with *Betula nigra* as a significant component. The communities are in the middle stages of primary succession on point bar deposits along migrating river meanders.

Distinguishing Features: The Blackwater Levee/Bar Forest type is distinguished from Blackwater Bottomland Hardwoods by the presence of more than very small amounts of *Betula nigra* or (on the lower Lumber and Waccamaw Rivers) *Planera aquatica* in a natural river bank or bar location. It is distinguished from Brownwater Levee Forest by the absence or near absence of *Platanus occidentalis, Fraxinus pensylvanica, Acer negundo, Acer saccharinum,* and other characteristic brownwater species.

Comments: Blackwater rivers do not generally develop natural levees of the sort created by overbank flooding on brownwater rivers, because of their low suspended sediment load. However, movement of sand does create point bars which are young substrates suitable for this community. This community is

analogous to the Bar Subtype of Brownwater Levee Forest. However, in contrast to that provisional subtype, the Blackwater Levee/Bar Forest definitely occurs in North Carolina along the larger blackwater rivers.

While the 3rd Approximation had a Blackwater Subtype of Coastal Plain Levee Forest which was conceived as being analogous to the Brownwater Subtype, good analogs to the other subtypes have not been found. A narrow bank zone often supports levee species along other parts of rivers, but these are too narrow and limited in area to be recognized as examples of this type.

BROWNWATER BOTTOMLAND HARDWOODS (HIGH SUBTYPE) G3G4

Synonyms: *Quercus laurifolia - Quercus michauxii - Liquidambar styraciflua / Carpinus caroliniana* Forest (CEGL004678).
Ecological Systems: Atlantic Coastal Plain Small Brownwater River Floodplain Forest (CES203.250). Southern Atlantic Coastal Plain Large River Floodplain Forest (CES203.066).

Concept: Type covers forests of brownwater river floodplain terraces and ridges other than active natural levees, lacking a significant component of levee tree species, and dominated by bottomland oaks, hickories, and sweetgum. Subtype covers examples that are higher above the river, flooded for relatively infrequently and for short periods, generally dominated by combinations of *Quercus michauxii, Quercus pagoda, Quercus laurifolia,* and *Liquidambar styraciflua*.

Distinguishing Features: Brownwater Bottomland Hardwoods are distinguished by occurrence on floodplains of brownwater rivers, but away from the river bank or natural levees. These are sites where overbank flooding is, or was in the past, important. The canopy is dominated by wetland oaks and *Liquidambar,* and characteristic levee species such as *Platanus occidentalis, Betula nigra,* and *Celtis laevigata* are generally absent except in disturbed areas. Other levee species such as *Fraxinus pennsylvanica, Acer negundo,* and *Ulmus americana* may be present in smaller numbers. In contrast to Nonriverine Wet Hardwood Forests with similar canopies, Brownwater Bottomland Hardwoods generally lack a significant component of acidic wetland shrubs such as *Lyonia lucida, Ilex glabra,* and *Cyrilla racemiflora,* and often have *Vaccinium elliottii*.

The High Subtype is distinguished from the Low Subtype by canopy dominance by the more mesophytic bottomland hardwoods such as *Quercus michauxii* and *Quercus pagoda,* with only a small component of wetter site species such as *Quercus lyrata, Carya aquatica,* and *Taxodium distichum*. *Quercus laurifolia* may be abundant in all subtypes and does not readily distinguish between them.

Comments: *Liquidambar styraciflua - Quercus (laurifolia, nigra) - (Pinus taeda) / Arundinaria gigantea / Carex abscondita* Forest (CEGL007732) has been attributed to North Carolina and probably would be redundant with this subtype. *Quercus michauxii - Quercus shumardii - Liquidambar styraciflua / Arundinaria gigantea* Forest (CEGL002099) may be equivalent to this, or may represent something not in NC.

The former High Pine - Oak Subtype (*Pinus taeda - Quercus (pagoda, michauxii, shumardii)* Temporarily Flooded Forest [Provisional] (CEGL007550)) has been lumped into this subtype.

BROWNWATER BOTTOMLAND HARDWOODS (LOW SUBTYPE) G4?
Synonyms: *Quercus lyrata - Carya aquatica* Forest (CEGL007397).
Ecological Systems: Atlantic Coastal Plain Small Brownwater River Floodplain Forest (CES203.250). Southern Atlantic Coastal Plain Large River Floodplain Forest (CES203.066).

Concept: Subtype covers examples on lower ridges, alluvial flats, and edges of higher ridges, dominated by more flood-tolerant species such as *Quercus lyrata, Carya aquatica, Ulmus americana*, and *Quercus laurifolia*. While this subtype conceptually lies between the High Subtype and Swamp Transition Subtype, it is not always developed in recognizable form.

Distinguishing Features: The Low Subtype is distinguished from the High Subtype by dominance by *Quercus lyrata, Carya aquatica*, or *Quercus laurifolia*, and absence or low numbers of more mesophytic species such as *Quercus michauxii* and *Quercus pagoda*. *Quercus laurifolia* may be abundant in all subtypes and does not readily distinguish between them.

Comments: In North Carolina, this subtype is less common than the other two, and often in smaller patches. As defined, it presumably occupies a narrower segment of the wetness gradient.

BROWNWATER BOTTOMLAND HARDWOODS (SWAMP TRANSITION SUBTYPE) G3G4
Synonyms: *Taxodium distichum - Fraxinus pennsylvanica - Quercus laurifolia / Acer rubrum / Saururus cernuus* Forest (CEGL007719).
Ecological Systems: Atlantic Coastal Plain Small Brownwater River Floodplain Forest (CES203.250). Southern Atlantic Coastal Plain Large River Floodplain Forest (CES203.066).

Concept: Sloughs and edges of backswamps with a mixture of Cypress-Gum Swamp and Bottomland Hardwoods species, generally *Quercus laurifolia, Quercus lyrata, Taxodium distichum, Populus heterophylla, Fraxinus profunda*, and *Fraxinus pennsylvanica*. Undergrowth is typically more like that of Cypress-Gum Swamp, with *Saururus cernuus, Boehmeria cylindrica,* and various *Carex* species most typical.

Distinguishing Features: The Swamp Transition Subtype is distinguished from other subtypes by the absence of the less water-tolerant species and by vegetation transitional to Cypress–Gum Swamp. It has significant *Taxodium, Nyssa,* or *Fraxinus*, and the shrub and herb layers are more similar to Cypress–Gum Swamp than to other subtypes of this type. Oaks are less strongly dominant, though *Quercus lyrata* or *Quercus laurifolia* are generally abundant. Though this subtype has a significant component of Cypress–Gum Swam, and the abundance of *Fraxinus pennsylvanica* may give it affinities with Levee Forest, it lacks the strong dominance of species typical of those communities. The Swamp Transition Subtype may resemble the Oak-Gum Slough subtype of Nonriverine Wet Hardwood Forest, but occurs on brownwater river floodplains rather than nonriverine wet flats. The distinction could become difficult on remote high river terraces that no longer flood, but no extant examples of such ambiguous situations are known. The Swamp Transition Subtype may also resemble Tidal Swamp, but may be distinguished by a substantial oak component.

Comments: This subtype is compositionally intermediate between Bottomland Hardwoods and Cypress-Gum Swamp. Vegetation structure resembles a Cypress-Gum Swamp, with a low-diversity herb layer containing species such as *Saururus cernuus*. It conceptually occurs between them as bottomland ridges

slope down into sloughs, but is not usually developed in recognizable form there. More often, these communities occur in shallow sloughs associated with other subtypes of Brownwater Bottomland Hardwoods, on upstream parts of rivers where Cypress-Gum Swamp is scarce. Relict ridges in the tidal reaches of brownwater rivers, but above the level of tidal flooding, may also support this community.

BLACKWATER BOTTOMLAND HARDWOODS (HIGH SUBTYPE) G3G4
Synonyms: *Pinus taeda - Quercus laurifolia / Vaccinium elliottii - Arundinaria gigantea* Forest (CEGL004736).
Ecological Systems: Atlantic Coastal Plain Small Blackwater River Floodplain Forest (CES203.249).

Concept: Type covers forests of blackwater river terraces and ridges, lacking a significant component of levee species. Subtype covers higher examples which have a significant component of *Pinus taeda* along with bottomland oaks, and lack significant *Quercus lyrata*. They generally are dominated by *Quercus laurifolia* and *Pinus taeda*, with varying amounts of *Quercus nigra, Quercus michauxii,* and *Liquidambar styraciflua*.

Distinguishing Features: Blackwater Bottomland Hardwoods are distinguished by occurrence on blackwater river floodplains, in sites where overbank flooding is, or has been, a significant ecological influence. They are distinguished from Brownwater Bottomland Hardwoods by more acid-tolerant composition and absence of brownwater species such as *Quercus pagoda, Fraxinus pennsylvanica, Acer negundo*, and *Asimina triloba*. Most of the plants typical of Blackwater Bottomland Hardwoods are also present in Brownwater Bottomland Hardwoods, but the more acid-tolerant species, such as *Persea palustris, Magnolia virginiana, Lyonia lucida,* and *Cyrilla racemiflora,* are not, and *Clethra alnifolia* is more likely to be in the blackwater type. Nonriverine Wet Hardwood Forests may share some of these acid-tolerant undergrowth plants, but generally are dominated by *Quercus pagoda, Quercus michauxii*, or *Liquidambar styraciflua*.

The High Subtype is distinguished from the Evergreen Subtype by the absence of *Quercus virginiana* and the absence or near absence of *Chamaecyparis thyoides*. It is distinguished from the Low Subtype and Swamp Transition Subtype by the absence or limited abundance of *Quercus lyrata*.

Comments: This subtype occurs as small to large stands along the Lumber, Black, and Northeast Cape Fear rivers. It is apparently replaced by the Evergreen Subtype on the Waccamaw River.

BLACKWATER BOTTOMLAND HARDWOODS (LOW SUBTYPE) G4?
Synonyms: *Quercus laurifolia - Quercus lyrata / Carpinus caroliniana - Persea palustris / Vaccinium elliottii* Forest (CEGL004737).
Ecological Systems: Atlantic Coastal Plain Small Blackwater River Floodplain Forest (CES203.249).

Concept: Subtype covers lower examples which have a significant component of *Quercus lyrata* and generally lack a significant component of *Pinus taeda*.

Distinguishing Features: The Low Subtype is distinguished from the High Subtype and the Evergreen Subtype by having abundant *Quercus lyrata*. It is distinguished from the Swamp Transition Subtype by having only small numbers of *Nyssa biflora* and *Taxodium distichum*, by having an herb layer

dominated by more mesophytic species than *Saururus cernuus*, and generally by a well-developed shrub layer.

Comments: *Quercus laurifolia* / *Carpinus caroliniana* / *Justicia ovata* Forest (CEGL07348) is an association of low blackwater bottomland hardwoods that has been attributed to NC. A little vegetation that appears to closely match it occurs on the Black River. However, it appears to overlap the concept of this subtype or the Swamp Transition Subtype, and does not seem distinct enough to warrant recognition as a separate element.

BLACKWATER BOTTOMLAND HARDWOODS (EVERGREEN SUBTYPE) G2?
Synonyms: *Pinus taeda - Quercus laurifolia - Chamaecyparis thyoides - (Quercus virginiana) / Vaccinium elliottii* Forest (CEGL007548).
Ecological Systems: Atlantic Coastal Plain Small Blackwater River Floodplain Forest (CES203.249).

Concept: Subtype covers examples on higher to medium-height ridges and terraces, that have a substantial component of *Quercus virginiana* or *Chamaecyparis thyoides*. This subtype is known to occur in North Carolina only on the Waccamaw River and its tributary Juniper Creek. It is unclear if it occurs in other states, other than along the South Carolina portion of the Waccamaw River.

Distinguishing Features: The Evergreen Subtype is distinguished from all other subtypes by having *Quercus virginiana* or *Chamaecyparis thyoides*. The Evergreen Subtype is distinguished from Coastal Fringe Evergreen Forest and Swamp Island Evergreen Forest by having floodplain species such as *Quercus laurifolia* and *Vaccinium elliottii*, by having acidic wetland species such as *Chamaecyparis thyoides*, and by lacking the drier upland species such as *Quercus hemispherica* and *Quercus geminata*. It can generally be distinguished by its topographic setting, but the Swamp Island Evergreen Forest occurs on some higher ridges along the Waccamaw River in close proximity to Blackwater Bottomland Hardwoods.

Comments: Two variants of this subtype exist, and may warrant recognition as separate subtypes. Higher examples have *Quercus virginiana* and limited *Chamaecyparis thyoides*, and apparently occur in all environments on the Waccamaw River that resemble those that support the High Subtype on other rivers. Lower examples lack *Quercus virginiana* and can have substantial *Chamaecyparis* and *Taxodium*. These may be an evergreen equivalent of the Swamp Transition Subtype, but the typical Swamp Transition Subtype is also present on the Waccamaw River.

The extent of this subtype is unclear. At present, it is known only from the Waccamaw River valley. It is unclear what makes the Waccamaw River unique, though its low gradient and variable flooding regime may be important. *Quercus virginiana* is a common component of bottomland hardwoods farther south, but *Chamaecyparis* is not. On the Waccamaw River this subtype grades to the Low Subtype on lower ridges and point bars.

BLACKWATER BOTTOMLAND HARDWOODS (SWAMP TRANSITION SUBTYPE) G3G5
Synonyms: *Quercus lyrata - Quercus laurifolia - Taxodium distichum / Saururus cernuus* Forest (CEGL004735).
Ecological Systems: Atlantic Coastal Plain Small Blackwater River Floodplain Forest (CES203.249).

Concept: Subtype covers the lowest examples, transitional to Cypress-Gum Swamp, with a substantial component of *Taxodium* or *Nyssa* and undergrowth characteristic of Cypress-Gum Swamps.

Distinguishing Features: The Swamp Transition Subtype is distinguished from other subtypes by having a significant component of *Taxodium* and *Nyssa*, by lacking most herbs less water-tolerant that *Saururus cernuus*, and usually by the absence of a well-developed shrub layer. It is distinguished from Cypress-Gum Swamp by having a substantial component of oaks.

Comments: This subtype is compositionally intermediate between Bottomland Hardwoods and Cypress-Gum Swamp. Vegetation structure resembles a Cypress-Gum Swamp, with a low-diversity herb layer containing species such as *Saururus cernuus*. These communities often occur in shallow sloughs associated with other subtypes of Blackwater Bottomland Hardwoods, often in places where Cypress-Gum Swamp is locally absent.

Quercus laurifolia / *Carpinus caroliniana* / *Justicia ovata* Forest (CEGL07348) is an association of low blackwater bottomland hardwoods that has been attributed to NC. It appears to overlap the concept of this subtype and the Low Subtype, but does not seem distinct enough to warrant recognition as a separate element.

CYPRESS–GUM SWAMP (BROWNWATER SUBTYPE) G5?

Synonyms: *Taxodium distichum - Nyssa aquatica / Fraxinus caroliniana* Forest (CEGL007431) .
Ecological Systems: Atlantic Coastal Plain Small Brownwater River Floodplain Forest (CES203.250). Southern Atlantic Coastal Plain Large River Floodplain Forest (CES203.066).

Concept: Type covers very wet forests that are flooded by river overbank flow for long periods, and are dominated by combinations of *Nyssa aquatica, Nyssa biflora, Taxodium distichum*, and *Taxodium ascendens*. Subtype covers examples along large brownwater (alluvial) rivers which receive clay-rich floodwaters and have *Nyssa aquatica* as the primary canopy hardwood species.

Distinguishing Features: The Cypress-Gum Swamp type is distinguished by canopy dominance by combinations of *Taxodium* and *Nyssa* in a river floodplain setting. Tidal Cypress-Gum Swamps are often difficult to distinguish from it where tidal amplitude is small or flooding is primarily from wind tides. Tidal Cypress-Gum Swamps contain a greater diversity of undergrowth plants. *Morella cerifera, Juniperus virginiana*, and any herbs associated with Tidal Freshwater Marsh communities are good indicators of tidal conditions. Tidal swamps usually have a more open canopy. Nonriverine Swamp Forests have a substantial component of acid-loving "pocosin" undergrowth species such as *Persea palustris, Magnolia virginiana, Lyonia lucida, Leucothoe axillaris,* and *Clethra alnifolia*, as well as occurring in sites remote from rivers.

The Brownwater Subtype is distinguished from the other subtypes by its association with brownwater rivers or backwater creeks and by the strong dominance of *Nyssa aquatica* with only minor *Nyssa biflora* in the canopy.

Comments: *Nyssa aquatica* Forest (CEGL002419), which was recognized provisionally as a Tupelo subtype in earlier 4th approximation draft, has been dropped. There is no clear way to distinguish

swamps that naturally lack *Taxodium* from those that have lost it because of early logging. Virtually all examples are dominated by *Nyssa*, with *Taxodium* occurring as a minority. It is unclear if any swamp forests that naturally lacked *Taxodium* occurred in North Carolina.

CYPRESS-GUM SWAMP (INTERMEDIATE SUBTYPE) G3G4

Synonyms: *Taxodium distichum - Nyssa aquatica - Nyssa biflora / Fraxinus caroliniana / Itea virginica* Forest (CEGL007432).
Ecological Systems: Atlantic Coastal Plain Small Brownwater River Floodplain Forest (CES203.250).

Concept: Subtype covers examples along Coastal Plain streams in regions of fine-textured soils and examples in somewhat isolated basins of brownwater floodplains, where *Nyssa aquatica* and *Nyssa biflora* are both important components of the canopy.

Distinguishing Features: The Intermediate Subtype is distinguished from other subtypes by a canopy containing substantial amounts of both *Nyssa aquatica* and *Nyssa biflora* in a setting with some, but not great, mineral sediment input.

Comments: *Nyssa aquatica - Nyssa biflora* Forest (CEGL007429) has been attributed to North Carolina as an intermediate swamp of floodplain edges that natural lack *Taxodium*. Given the widespread removal of *Taxodium* by logging, it is unclear if any such vegetation existed naturally in North Carolina. It does not seem sufficiently distinct to recognize as a distinct community. *Nyssa biflora - Liquidambar styraciflua / Glyceria septentrionalis - Hydrocotyle ranunculoides* Forest (CEGL007743) is an association described in southeast Virginia and questionably attributed to North Carolina. It is described as occurring both on the edges of larger floodplains and along small streams. It therefore appears to partly overlap this type, and it is not clear how it would be distinguished.

CYPRESS--GUM SWAMP (BLACKWATER SUBTYPE) G3G4

Synonyms: *Taxodium distichum - Nyssa biflora / Fraxinus caroliniana / Lyonia lucida* Forest (CEGL004733).
Ecological Systems: Atlantic Coastal Plain Small Blackwater River Floodplain Forest (CES203.249).

Concept: Subtype covers examples on Coastal Plain floodplains which lack clay sediment, where *Nyssa aquatica* is not a significant component of the canopy. They occur commonly both in sloughs of large blackwater rivers and filling the entire floodplain of many small streams. Soils in this subtype are often organic.

Distinguishing Features: The Blackwater Subtype is distinguished from the Intermediate and Brownwater subtypes by the absence of *Nyssa aquatica* as a significant canopy component, and by a more acid-tolerant flora in general. It is distinguished from the Blackwater Cove Subtype by a lack of the distinctive open canopy, large buttresses, and deep flooding of that subtype, and corresponding lack of abundant *Cephalanthus occidentalis* and *Planera aquatica*. The Blackwater Subtype is distinguished from Coastal Plain Small Stream Swamp, where occurring on small stream floodplains, by the strong canopy dominance by *Nyssa* or *Taxodium* (sometimes *Acer rubrum* in successional condition). Coastal Plain Small Stream Swamp is reserved for floodplain communities having a more mixed forest composition driven by more microsite heterogeneity or by shorter hydroperiod. The 3rd Approximation

was ambiguous about how to treat the wet small stream floodplains, but they should be classified as Cypress—Gum Swamp.

Comments: The concept of the Blackwater Subtype has been narrowed substantially from the 3rd Approximation, where it was defined to cover all streams with headwaters in the Coastal Plain. Here it includes only the most acidic and clay-free streams, most or all of which occur in the southern half of the state. This type still includes some variation. The examples with *Cyrilla racemiflora, Lyonia lucida*, and *Ilex myrtifolia* as prominent components and lacking *Fraxinus caroliniana*, known from the Juniper Creek and Waccamaw River system, may be worthy of recognition as a distinct variant or subtype. Their vegetation suggests a transition from blackwater to nonriverine conditions.

This subtype can occur in small to large patches. In the upper portions of blackwater rivers, it often is confined to narrow sloughs but may occur intermittently in larger basins. Downstream on blackwater rivers, it may cover much of the floodplain. Where it occurs along small to medium streams, it tends to fill the full width of a featureless, muck-filled floodplain. These may have a distinct channel, a network of anastomosing channels, or have no visible channel at all.

Nyssa biflora - (Taxodium distichum) Semi-natural Forest (CEGL004640) is an association for modified versions of this subtype, where *Taxodium* has been removed by logging. It is generally impossible to determine how much *Taxodium* was present before early logging. Remnants of decay-resistant stumps suggest it was a patchy minority component even long ago, but it is not clear if this reflects conditions before the first logging. For conservation purposes, all examples should be regarded as the same subtype, in varying conditions.

CYPRESS–GUM SWAMP (BLACKWATER COVE SUBTYPE) G2G3

Synonyms: *Taxodium ascendens / Fraxinus caroliniana - Cephalanthus occidentalis - (Planera aquatica)* Woodland (CEGL004289). Backwater (Schafale, Marty, and LeGrand 1985 - Waccamaw River study).
Ecological Systems: Atlantic Coastal Plain Small Blackwater River Floodplain Forest (CES203.249).

Concept: Subtype covers distinctive examples of abandoned channel segments connected to the river (common called coves or backwaters), deeply flooded and somewhat lake-like. The vegetation has an open to closed canopy of *Taxodium ascendens* and a substantial understory of *Fraxinus caroliniana*, *Cephalanthus occidentalis*, or *Planera aquatica*.

Distinguishing Features: The distinctive vegetation and environment distinguishes this subtype from the Blackwater Subtype. The canopy may be open to nearly closed, but the deep flooding and abundance of *Cephalanthus occidentalis* or *Planera aquatica* are distinct. Canopy trees are almost exclusively *Taxodium*, with *Nyssa* largely absent, and have unusually large buttresses. Coves are elongate, triangular, or round low areas that project upstream from the river channel, and are exposed only at very low water. This community may fill the cove, or it may form a rim around treeless open water. It often grades into the Acid Blackwater Subtype in a slough upstream from the cove, where the canopy is dense, *Nyssa biflora* a major canopy component, and *Cephalanthus* and *Planera* are absent.

SANDHILL STREAMHEAD SWAMP G4?
Synonyms: *Nyssa biflora - Liriodendron tulipifera - Pinus (serotina, taeda) / Lyonia lucida - Ilex glabra* Forest (CEGL004734).
Ecological Systems: Atlantic Coastal Plain Blackwater Stream Floodplain Forest (CES203.247).

Concept: Type covers very wet forests along mucky small streams in sandy terrain, which are dominated by combinations of *Nyssa biflora, Acer rubrum, Liriodendron tulipifera, Persea palustris,* and *Magnolia virginiana,* and have undergrowth of pocosin species. Either *Pinus taeda* or *Pinus serotina* may be present. The hydrology of sandhill streamheads differs from that of other stream and river floodplains, with constant saturation from upland seepage and relatively limited overbank flooding. They have been recognized only in the Sandhills region.

Distinguishing Features: The Sandhill Streamhead Swamp type is distinguished from Cypress-Gum Swamp by the well-developed shrub layer dominated by *Cyrilla racemiflora, Lyonia lucida, Ilex coriacea, Ilex glabra,* and other species shared with the Streamhead Pocosin type. There is usually a component of *Pinus serotina* or *Pinus taeda* and a complete absence of *Taxodium*. Nonriverine Swamp Forests also have a substantial component of pocosin species, but differ floristically. They are easily distinguishable by occurring in flat areas that lack seepage or overland flooding. Sandhill Streamhead Swamps are distinguished from the closely associated Streamhead Pocosins by having canopy dominance by hardwoods rather than pines. The lower strata are often very similar.

Comments: These communities were variously treated as Cypress-Gum Swamp (Blackwater Subtype) and Coastal Plain Small Stream Swamp (Blackwater Subtype) in the 3rd Approximation. They resemble the latter in the intermittent flooding regime, location along small streams, and common admixture of pines in the canopy. They resemble the former in usual dominance by *Nyssa biflora* and long hydroperiod. They are distinct from either in being closely related to Streamhead Pocosins, floristically and spatially. Almost all of the understory, shrub, vine, and herb layer plants are shared with Streamhead Pocosin communities; only the canopy differs. Like Streamhead Pocosins, most of the water apparently comes from seepage from the adjacent sandy soils, creating a permanently saturated environment different from that of other swamps. Usually Sandhill Streamhead Swamps occur downstream of Streamhead Pocosins, but in some places the types may alternate along the length of a stream, suggesting that subtleties of drainage or fire behavior determine which community occurs. It is possible that both community types exist in a shifting mosaic, along with beaver ponds.

COASTAL PLAIN SMALL STREAM SWAMP G4?
Synonyms: *Nyssa biflora - Quercus nigra - Quercus laurifolia - Pinus taeda / Ilex opaca - Carpinus caroliniana* Forest (CEGL007350).
Ecological Systems: Atlantic Coastal Plain Blackwater Stream Floodplain Forest (CES203.247).

Concept: Type covers small stream floodplains in the Coastal Plain with forest vegetation of mixed hydrological tolerances, due to a short and variable hydroperiod or to microsite heterogeneity. Fluvial depositional landforms such as natural levees and ridges are too small to differentiate separate communities such as Levee Forest and Bottomland Hardwoods.

Distinguishing Features: Distinguished from all other floodplain communities by having a mixed composition of plants with very different flooding tolerance growing in close association along a stream

with only small fluvial landforms. The canopy will usually include substantial *Nyssa* or *Taxodium* along with substantial bottomland oaks and other bottomland hardwoods. Pines are often present.

Comments: This type has been narrowed from the definition in the 3rd Approximation. Pocosin-like small stream bottoms in sandhill terrain have been put into the Sandhill Streamhead Swamp type, and those strongly dominated by *Nyssa* or *Taxodium* have been put into Cypress–Gum Swamp. This type remains for small streams that have highly mixed vegetation due to variable flooding regime and microtopography. The Brownwater Subtype in the 3rd Approximation has been dropped, as no well-developed examples are known.

These communities are highly variable, and recognition of variants or subtypes may be appropriate. However, the variation has not been sorted out enough to do so. Several associations in NVC appear to overlap this concept, but they do not fit the occurrences in North Carolina well and do not appear to represent a good division of subtypes for North Carolina occurrences. *Nyssa biflora - (Liquidambar styraciflua*) / *Itea virginica / Saururus cernuus* Forest (CEGL007847) is a broadly defined association of intermittent streams, questionably attributed to North Carolina. It may represent the wetter end of the spectrum of our occurrences. *Nyssa biflora - Liquidambar styraciflua / Glyceria septentrionalis - Hydrocotyle ranunculoides* Forest (CEGL007743) is an association described in southeast Virginia and questionably attributed to North Carolina. It is described as occurring both on the edges of larger floodplains and along small streams. It therefore appears to partly overlap this type, and it is not clear how it would be distinguished. Since *Hydrocotyle ranunculoides* is a floating aquatic plant of permanent water in North Carolina, it may not fit this type anyway. *Fraxinus pennsylvanica / Cornus foemina / Carex bromoides* Forest (CEGL007742) is another association defined in southeast Virginia and questionably attributed to North Carolina. It is described as a small stream floodplain community, but the vegetation suggests tidal influence.

OXBOW LAKE (BROWNWATER SUBTYPE)
Synonyms: Treated as a nonvegetated community in NVC.
Ecological Systems: Atlantic Coastal Plain Small Brownwater River Floodplain Forest (CES203.250).

Concept: Type covers permanently or semi-permanently flooded open water bodies in floodplains that are at least seasonally isolated from the river. Most are substantially unvegetated, but may contain sparse vegetation or patches of invading woody or herbaceous wetland plants of various kinds. Subtype covers those along brownwater rivers, which receive substantial mineral sediment input. They typically have an edge zone containing *Taxodium distichum, Nyssa aquatica, Platanus occidentalis, Betula nigra*, or *Fraxinus pennsylvanica*.

Distinguishing Features: Oxbow Lake communities are distinguished from Cypress-Gum Swamps by being wet enough to lack a closed tree canopy. They are distinguished from Semipermanent Impoundment communities by occurring in closed, undammed basins created by an abandoned river channel. This setting produces an aquatic community that is isolated from both the river and from stream input except in floods.

The Brownwater Subtype can usually easily be distinguished by the character of the river and the occurrence of brownwater communities adjacent to it. It typically has an edge zone containing brownwater species such as *Platanus occidentalis* or *Fraxinus pennsylvanica* as well as the more

widespread *Taxodium distichum* and *Betula nigra*.

Comments: These communities are not well known. The vegetated portions of them, if any, resemble the primary successional communities of bars or backwaters along the rivers. The aquatic animal and planktonic communities can be expected to be more distinctive, because they offer an environment that is free from interaction with the river community for long periods. These communities are substantially aquatic rather than terrestrial, but are part of the Palustrine System of Cowardin because of their small size. Brownwater Oxbow Lakes are very rare. Brownwater river channels appear to migrate less than blackwater river channels, creating fewer oxbow lakes. In addition, the ongoing deposition of sediments by brownwater rivers fills them, so that they have a shorter life span.

OXBOW LAKE (BLACKWATER SUBTYPE)
Synonyms: Treated as a nonvegetated community.
Ecological Systems: Atlantic Coastal Plain Small Blackwater River Floodplain Forest (CES203.249).

Concept: Subtype covers examples on blackwater rivers. They typically have an edge zone containing *Taxodium distichum, Nyssa biflora, Liquidambar styraciflua, Planera aquatica,* or *Cephalanthus occidentalis*.

Distinguishing Features: The Blackwater Subtype can usually easily be distinguished by the character of the river and the occurrence of blackwater communities adjacent to it. The edge zone will lack brownwater species such as *Platanus occidentalis* and *Fraxinus pennsylvanica,* and will probably contain only more broadly tolerant species such as *Taxodium distichum* and *Betula nigra*. On the Waccamaw and Lumber Rivers, as well as in states to the south, *Planera aquatica* may be abundant.

Comments: These communities are not well known. The vegetated portions of them, if any, resemble the primary successional communities of bars or backwaters along the rivers. The aquatic animal and planktonic communities can be expected to be more distinctive, because they offer an environment that is free from interaction with the river community for long periods. These communities are substantially aquatic rather than terrestrial, but are part of the Palustrine System because of their small size. The Blackwater Subtype is more common than the Brownwater Subtype. Our blackwater river channels seem to migrate more than the brownwater rivers, creating more oxbow lakes. In addition, the lack of substantial sediment deposition means they can persist for a long time. However, they are still uncommon to rare along most of North Carolina's rivers, with only the Waccamaw River having more than a couple. For reasons that are unclear, they seem to be more common in adjacent South Carolina.

SAND AND MUD BAR (BROWNWATER SUBTYPE)
Synonyms: No association created yet.
Ecological Systems: Atlantic Coastal Plain Small Brownwater River Floodplain Forest (CES203.250).

Concept: Type covers communities of sand and mud deposits along rivers throughout the state, where recent deposition, frequent reworking, or frequent scouring prevents development of forest vegetation. Most examples are in the Coastal Plain. Subtype covers examples along brownwater Coastal Plain rivers, where clay deposition and circumneutral water chemistry influence the community. This subtype is only provisional; it is unknown if there are significant vegetational differences between brownwater

and blackwater bars.

Distinguishing Features: The Sand and Mud Bar type is distinguished by the combination of occurrence on soft sediments along a river shoreline and lack of a well-developed tree canopy. Vegetation ranges from herbs to shrubs, and is usually of fairly low density. The Brownwater Subtype is distinguished by occurring on brownwater rivers. The vegetational distinctions are not known.

SAND AND MUD BAR (BLACKWATER SAND BAR SUBTYPE) G2G3
Synonyms: *Panicum rigidulum - Hibiscus moscheutos* Herbaceous Vegetation (CEGL004273).
Ecological Systems: Atlantic Coastal Plain Small Blackwater River Floodplain Forest (CES203.249).

Concept: Subtype covers examples on higher sandy bars along blackwater rivers, usually dominated by *Coleataenia* rigidula ssp, *rigidula* (= *Panicum rigidulum* var. *rigidulum*).

Distinguishing Features: The Blackwater Sand Bar Subtype is distinguished from the Blackwater Drawdown Bar Subtype by having a clean sand substrate, being exposed except during floods, and having vegetation dominated by *Coleataenia rigidula* ssp. *rigidula* or by other tall grasses or forbs. Tree seedlings may be present, as may a number of native or invasive weedy herbaceous species. *Hibiscus moscheutos* is common in these communities on some rivers .

SAND AND MUD BAR (BLACKWATER DRAWDOWN BAR SUBTYPE) G2
Synonyms: *Eragrostis hypnoides - Micranthemum umbrosum - Lipocarpha micrantha - (Juncus repens)* Herbaceous Vegetation (CEGL004341).
Ecological Systems: Atlantic Coastal Plain Small Blackwater River Floodplain Forest (CES203.249).

Concept: Subtype covers examples on lower shorelines of blackwater rivers, typically dominated by *Eragrostis hypnoides, Micranthemum umbrosum, Juncus repens,* or *Lipocarpha micrantha*.

Distinguishing Features: The Blackwater Drawdown Bar Subtype is distinguished from other subtypes by a wetter environment, soil that is somewhat mucky, exposure only during unusually low water, and dominance by the above species.

Comments: This subtype has been observed as a distinctive community only on the Waccamaw River in North Carolina, where it is abundant. Similar sites on the Lumber and Black rivers are unvegetated, but this community may exist on them in more specialized areas. In all cases, it is best developed on the floors of "backwaters," small bays off of the main river channel. The examples on the Waccamaw River are unique, with Sabatia kennedyana an important species, and may merit a separate subtype.

SAND AND MUD BAR (NARROWLEAF POND-LILY SUBTYPE) G3?
Synonyms: *Nuphar sagittifolia* Herbaceous Vegetation (CEGL004328).
Ecological Systems: Atlantic Coastal Plain Small Blackwater River Floodplain Forest (CES203.249).

Concept: Subtype covers nearly permanently flooded channel edges and backwaters dominated by *Nuphar sagittifolia* (= *Nuphar lutea* ssp. *sagittifolia*). These occur only along blackwater rivers in southeastern North Carolina.

Distinguishing Features: This community is distinguished from all others by dominance of *Nuphar sagittifolia* in a non-tidal, blackwater river setting.

Comments: A comparable *Nuphar advena* subtype may also exist, but has not been documented.

RIVERINE FLOATING MAT G3G4

Synonyms: *Hydrocotyle ranunculoides* - (*Sacciolepis striata*) Floating Herbaceous Vegetation (CEGL004305).
Ecological Systems: Atlantic Coastal Plain Small Blackwater River Floodplain Forest (CES203.249).

Concept: Type covers mats of floating plants along rivers and backwaters. *Hydrocotyle ranunculoides* typically dominates, but *Sacciolepis striata* sometimes overgrows the mats in the fall. Mats overgrown by *Alternanthera philoxeroides* but having substantial *Hydrocotyle* should be regarded as degraded examples of this type. *Alternanthera* mats where no *Hydrocotyle* mats existed previously should not be regarded as part of this type.

Distinguishing Features: The Riverine Floating Mat type is distinguished by dominance of native floating aquatic plants in river channels or waters connected to a river. *Hydrocotyle ranunculoides* typically dominates, but floating mats dominated by other native species should also be placed here.

Comments: These communities are intermittent along larger blackwater rivers. It is unclear whether well-developed examples occur along any brownwater rivers. They seldom occur on smaller streams.

COASTAL PLAIN SEMIPERMANENT IMPOUNDMENT (OPEN WATER SUBTYPE) G5

Synonyms: *Nuphar advena* - *Nymphaea odorata* Herbaceous Vegetation (CEGL002386); Atlantic Coastal Plain Small Brownwater River Floodplain Forest (CES203.250).
Ecological Systems: Atlantic Coastal Plain Small Blackwater River Floodplain Forest (CES203.249). Atlantic Coastal Plain Brownwater Stream Floodplain Forest (CES203.248). Atlantic Coastal Plain Blackwater Stream Floodplain Forest (CES203.247).

Concept: Type covers portions of Coastal Plain brownwater and blackwater floodplains affected by shallow impoundment by beaver dams or long-established small artificial dams. This includes drained impoundments that are still distinguishable from pre-impoundment conditions. They may occur on small creeks or on sloughs in larger river floodplains, either blackwater or brownwater.

Subtype is a zonal community that covers deeper portions of pond complexes, dominated by open water, submersed, floating, or floating-leaved aquatic plants, with little or no emergent component. As defined, it can occur in blackwater, brownwater, or Sandhills ponds.

Distinguishing Features: Type is distinguished by occurrence in the Coastal Plain in beaver ponds or in small artificial ponds that have similar environment and vegetation. It is not entirely clear what allows

artificial ponds to resemble natural beaver ponds. Good mimics are usually old mill ponds that have long been unused. Larger reservoirs and smaller farm ponds do not seem to develop similar communities, and have no natural community analogue.

The Open Water Subtype is distinguished by the absence of substantial emergent vegetation or tree cover. Some examples have no significant vascular plant cover. *Nymphaea odorata* is the most typical plant, but *Utricularia* spp., *Lemna* spp., *Myriophyllum* spp., and others may dominate instead.

Comments: *Nelumbo lutea* Herbaceous Vegetation (CEGL004323) might potentially describe some of our examples. The NVC associations do not distinguish natural and pseudo-natural impoundments from artificial lakes and from other natural basins, apparently even from tidal rivers; hence the correspondence is only partial.

COASTAL PLAIN SEMIPERMANENT IMPOUNDMENT (TYPIC MARSH SUBTYPE) G4?
Synonyms: *Polygonum (hydropiperoides, punctatum)* - *Leersia* spp. Herbaceous Vegetation (CEGL004290).
Ecological Systems: Atlantic Coastal Plain Small Brownwater River Floodplain Forest (CES203.250). Atlantic Coastal Plain Small Blackwater River Floodplain Forest (CES203.249). Atlantic Coastal Plain Brownwater Stream Floodplain Forest (CES203.248). Atlantic Coastal Plain Blackwater Stream Floodplain Forest (CES203.247).

Concept: Subtype covers portions or examples on mineral soils in brownwater or blackwater floodplains, with substantial emergent marsh vegetation but little or no tree cover.

Distinguishing Features: The Marsh Subtype is distinguished by dominance of emergent shrub or herbaceous vegetation and the lack of a substantial tree canopy. *Salix* or other early successional small trees may be present. The Typic Marsh Subtype is distinguished from the Sandhill Marsh Subtype by substantial floristic differences that correlate with nutrient richness and mineral or boggy character. Species indicative of the Typic Marsh Subtype include *Persicaria* spp., *Typha latifolia*, *Scirpus cyperinus*, and *Leersia hexandra*. Species indicative of the Sandhills Marsh Subtype include *Orontium aquaticum, Juncus trigonocarpus, Eriocaulon decangulare, Schoenoplectus subterminalis*, and *Schoenoplectus etuberculatus*.

Comments: This subtype is very heterogeneous. It may need to be split into several subtypes, but these communities are not well enough known to create a useful division at present. The NVC presently has a number of wide-ranging associations described only as being dominated by single species that often occur within this subtype, as well as in other habitats. Occurrences of this subtype could therefore be treated as a fine-scale mosaic of patch or zonal subtypes, some of which would correspond to NVC associations, while many new associations would need to be defined for other patch dominant species. A better solution is likely to be a small set of mixed subtypes/associations that incorporate the patches and that reflect broader scale differences among impoundments. Variations correlating with size of impounded stream, amount of mineral sediment vs. muck, presence of seepage, and biogeography may be a good basis for classifying these communities but are virtually unknown. Even within a region and stream type, beaver ponds vary substantially. An additional axis of variation is the cycle from new creation to maturity to abandonment and succession back to prevailing community types.

NVC associations that appear to partially overlap this subtype include *Cephalanthus occidentalis / Carex* spp. - *Lemna* spp. Southern Shrubland (CEGL002191); *Alnus serrulata* Saturated Southern Shrubland (CEGL003912); *Juncus effusus* Seasonally Flooded Herbaceous Vegetation (CEGL004112); *Scirpus cyperinus* Seasonally Flooded Southern Herbaceous Vegetation (CEGL003866); *Zizaniopsis miliacea* Coastal Plain Slough Herbaceous Vegetation (CEGL004139); *Typha (angustifolia, latifolia) - (Schoenoplectus* spp.) Eastern Herbaceous Vegetation (CEGL006153) (unlikely to be in NC, mainly a northern association). The NVC associations do not distinguish natural and pseudo-natural impoundments from artificial lakes and from other natural basins, apparently even from tidal rivers; hence the correspondence is only partial.

COASTAL PLAIN SEMIPERMANENT IMPOUNDMENT (SANDHILLS MARSH SUBTYPE)
G2?

Synonyms: *Orontium aquaticum - Schoenoplectus (etuberculatus, subterminalis) - Eriocaulon decangulare - Juncus trigonocarpus* Herbaceous Vegetation (CEGL007860).
Ecological Systems: Atlantic Coastal Plain Blackwater Stream Floodplain Forest (CES203.247).

Concept: Subtype covers examples in ponds without sediment input, where muck substrate and somewhat boggy vegetation occur. These are typical of the Sandhills Region, and may occur only there.

Distinguishing Features: The Sandhills Marsh Subtype is distinguished from the Typic Marsh Subtype by substantial floristic differences that correlate with organic substrate and extreme acidity and lack of nutrients. Species indicative of the Typic Marsh Subtype include *Persicaria* spp., *Typha latifolia, Scirpus cyperinus,* and *Leersia hexandra*. Species indicative of the Sandhills Marsh Subtype include *Orontium aquaticum, Juncus trigonocarpus, Eriocaulon decangulare, Schoenoplectus subterminalis, Schoenoplectus etuberculatus, Sagittaria engelmanniana, Habenaria repens,* and *Glyceria obtusa*.

The Sandhills Marsh Subtype is distinguished from the Sandhills Mire Subtype by having only a very limited woody component. The Sandhills Mire Subtype has a well-developed shrub layer and, though it shares substantial flora, has significant differences in vegetation. In particular, *Carex mitchelliana, Carex atlantica* ssp. *capillacea* (*= Carex howei), Carex stricta, Glyceria obtusa, Leersia oryzoides, Dichanthelium scabriusculum, Peltandra virginica, Dichanthelium dichotomum, Dulichium arundinaceum, Triadenum virginicum, Lycopus cokeri, Eupatorium resinosum, Carex atlantica* and *Woodwardia areolata* are frequent species in the Sandhills Mire Subtype.

COASTAL PLAIN SEMIPERMANENT IMPOUNDMENT (SANDHILLS MIRE SUBTYPE)
G2?

Synonyms: *Nyssa biflora - Alnus serrulata / Carex (mitchelliana, atlantica* ssp. *capillacea, stricta) - Glyceria obtusa - Peltandra virginica* Shrubland [Provisional] (CEGL004800).
Ecological Systems: Atlantic Coastal Plain Blackwater Stream Floodplain Forest (CES203.247).

Concept: Subtype covers drained impoundments of the Sandhills, where there is a deep muck substrate and dominance by open mire vegetation.

Distinguishing Features: The Sandhills Mire Subtype is distinguished by a distinctive flora that includes *Carex mitchelliana, Carex atlantica* ssp. *capillacea (= Carex howei), Carex stricta, Glyceria obtusa,*

Leersia oryzoides, Orontium aquaticum, Peltandra virginica, Triadenum virginicum, Dulichium arundinaceum, Woodwardia areolata, Eupatorium resinosum, and *Lycopus cokeri*. An open canopy (including young trees and remnant trees that survived the impoundment) and moderate shrub layer of *Nyssa biflora, Acer rubrum, Alnus serrulata*, and other species is generally present.

Comments: This community is well documented at Fort Bragg, where it is quite variable. Three variants are recognized: 1. Typic variant, which remains quite heterogeneous 2. Bog variant, which appears to occur where adjacent Sandhill Seeps feed acidic seepage water into the mire, and seep plants mix with those of the mire. 3. Tussock sedge variant, strongly dominated by *Carex stricta*, to the exclusion of most other herbaceous species. Hall (2005) suggested recognition of several additional types, most of which are more similar to each other than are these. The Tussock Sedge variant was the most distinct of his types. Also distinct in Hall (2005) were those dominated by *Dichanthelium scabriusculum* and *Dichanthelium dichotomum*, as opposed to the more typical mixed vegetation. These need more study, but appear to result from excessive sediment washing into a drained pond, and so may not be a natural variant.

These communities are currently known only from Fort Bragg. They may occur elsewhere in the Sandhills region, and conceivably in other parts of the Coastal Plain. However, all examples known in other parts of the Coastal Plain appear to fill with mineral sediment and to develop the Typic Marsh Subtype.

COASTAL PLAIN SEMIPERMANENT IMPOUNDMENT (CYPRESS-GUM SUBTYPE) G4G5
Synonyms: *Taxodium distichum / Lemna minor* Forest (CEGL002420).
Ecological Systems: Atlantic Coastal Plain Small Brownwater River Floodplain Forest (CES203.250). Atlantic Coastal Plain Small Blackwater River Floodplain Forest (CES203.249). Atlantic Coastal Plain Brownwater Stream Floodplain Forest (CES203.248). Atlantic Coastal Plain Blackwater Stream Floodplain Forest (CES203.247).

Concept: Subtype covers portions or examples supporting substantial canopy of *Taxodium* and *Nyssa*. These are generally the more shallowly flooded portions of impoundments created in areas previously dominated by these water-tolerant trees.

Distinguishing Features: The Coastal Plain Semipermanent Impoundment type is distinguished from all other Coastal Plain communities by occurring in places affected by permanent flooding produced by impoundment of drainage by beaver dams or old man-made dams that create a similar environment.

The Cypress-Gum Subtype is distinguished by an open or closed tree canopy, mostly of *Taxodium* or *Nyssa*, but potentially including *Acer rubrum* or other species.

Comments: This subtype is distinctive in that the flood tolerance of *Taxodium* and *Nyssa* allow them to persist for many years in shallower parts of ponds, creating a shaded pond environment with much structural diversity. This community can be a site-specific subtype, a temporal phase, or a zone within a pond complex. Some impoundments in flat swamps may have only this community, while in others it is a zone grading to the Open Subtype in deeper portions. In other cases it may occupy the deeper part of a pond where Cypress–Gum Swamp was already established, while the Typic Marsh Subtype occurs on the shallow edge that was occupied by less flood-tolerant trees. Because even cypress trees cannot

reproduce in permanent standing water, this subtype will eventually succeed to the Marsh or Open Water Subtype if the pond persists. But this may take longer than most Semipermanent Impoundments exist. Either subtype may succeed to this subtype if a pond is drained or established at a lower water level.

As currently defined, this subtype covers forested zones of both blackwater and brownwater ponds. This distinction may warrant separate subtypes. The canopy species are different, reflecting the differences in the canopy before impoundment. Differences in other plants and in animals may also occur between blackwater and brownwater streams, but are not known. The conditions of impoundment may override the influence of the river water chemistry, as brownwater sediments settle out in impounded waters.

The NVC association corresponding to this subtype is very broadly defined, probably too broadly.

Taxodium distichum Semipermanently Flooded Woodland (CEGL004442), another association overlapping this concept, has been merged in the NVC. A Successional Subtype, included in earlier drafts of the 4th approximation, but never incorporated into NVC, has been dropped. Successional ponds may be partially or fully drained, and may be affected by the vegetation established before drainage. Zonal communities can also succeed to each other even if a pond is not drained. Since the subtypes are broadly defined and overlap the kinds of successional vegetation, it seems best to treat most successional ponds as parts of the other subtypes, at least for the present.

Piedmont and Mountain Floodplains

MONTANE ALLUVIAL FOREST (SMALL RIVER SUBTYPE) G3

Synonyms: *Tsuga canadensis - Liriodendron tulipifera - Platanus occidentalis / Rhododendron maximum - Xanthorhiza simplicissima* Temporarily Flooded Forest (CEGL007143).
Ecological Systems: South-Central Interior Small Stream and Riparian (CES202.706).

Concept: Type covers forests of mountain river floodplains, consisting of a mixture of plants typically of cove forests and of floodplains. Subtype covers examples on the smaller or higher elevation rivers, where *Tsuga canadensis* or *Pinus strobus* are generally important components.

Distinguishing Features: Montane Alluvial Forests are distinguished from Rich Cove Forests and Acidic Cove Forests, with which they may share many species, by more than trace presence of some of a characteristic suite of wetland or alluvial indicator species, such as *Platanus occidentalis, Betula nigra*, and *Alnus serrulata*, coupled with evidence of flooding. The alluvial indicator species may dominate, codominate, or may be less abundant, but sites that lack them should be classified as cove forests or other upland communities. Flood-dispersed exotic plant species also are often abundant in Montane Alluvial Forests and are usually scarce in upland forests. *Microstegium vimineum, Lonicera japonica*, and *Murdannia keisak* may appear in uplands or non-riverine wetlands where they are severely disturbed, but are common even in relatively undisturbed floodplains. Montane Alluvial Forests are distinguished from Piedmont or other lowland floodplain forests by containing a substantial component of montane species, generally shared with Rich Cove Forests or Acidic Cove Forests. These may include *Tilia americana var. heterophylla, Aesculus flava, Betula lenta, Betula alleghaniensis, Tsuga canadensis, Halesia tetraptera*, and *Rhododendron maximum*.

The Small River Subtype, besides occurring in smaller, less well-developed floodplains, is distinguished from the Large River Subtype by being more like cove forests, having lesser abundance and richness of the suite of alluvial indicator plant species. *Platanus occidentalis* and *Xanthorhiza simplicissima* are the most frequent, *Betula nigra, Alnus serrulata, Arundinaria gigantea, Boehmeria cylindrica,* and a few others occasional. Also characteristic is a combination of acid-tolerant canopy species such as *Liriodendron tulipifera, Betula lenta, Acer rubrum, Betula alleghaniensis,* and *Halesia tetraptera* with lower strata of richer sites, such as *Asimina triloba, Lindera benzoin, Carpinus caroliniana, Amphicarpaea bracteata,* or any of a number of species shared with Rich Cove Forests. This is not always present, however, and lower strata are sometimes dominated by *Rhododendron maximum, Leucothoe fontanesiana,* or *Thelypteris noveboracensis*. The Large River Subtype generally has more abundance and diversity of alluvial indicator plant species present. This includes some species rarely or never found on smaller rivers, such as *Fraxinus pennsylvanica, Juglans cinerea, Acer negundo, Celtis laevigata, Liquidambar styraciflua, Quercus imbricaria, Quercus pagoda, Cornus amomum, Chasmanthium latifolium,* and *Elymus riparius*. The Large River Subtype also often has upland species of drier communities, such as oaks, *Oxydendrum arboreum, Nyssa sylvatica, Danthonia spicata,* and *Piptochaetium avenaceum,* while the Small River Subtype consists largely of mesophytic plants.

Comments: *Liriodendron tulipifera - Pinus strobus - (Tsuga canadensis) / Carpinus caroliniana / Amphicarpaea bracteata* Forest (CEGL008405) is an equivalent and fairly similar association in the Central Appalachians.

MONTANE ALLUVIAL FOREST (LARGE RIVER SUBTYPE) G2?
Synonyms: *Platanus occidentalis - Liriodendron tulipifera - Betula (alleghaniensis, lenta) / Alnus serrulata - Leucothoe fontanesiana* Forest (CEGL004691).
Ecological Systems: South-Central Interior Large Floodplain (CES202.705).

Concept: Subtype covers examples on the floodplains of larger, lower elevation rivers, which have a substantial component of plant species shared with lowland bottomland communities of adjacent provinces as well as a substantial component of montane species.

Distinguishing Features: The Large River Subtype is distinguished from the Small River Subtype by substantial floristic differences that include the presence of a large suite of lowland floodplain plants, such as *Liquidambar styraciflua, Celtis occidentalis, Quercus imbricaria,* and *Fraxinus pennsylvanica*. See the Small River Subtype description for more details. It is distinguished from the Montane Floodplain Slough Forest by drier conditions, with only temporary flooding. This is associated with a large suite of mesic species that are absent from the sloughs. It is distinguished from the High Terrace Subtype by dominance by mesophytic and alluvial species, though oaks and other upland species are also often present.

Comments: This subtype remains a broadly defined community, but there seems no good way to reliably subdivide it. The extensive alteration of floodplain forests throughout the mountains, by farming and pasturing, makes it difficult to distinguish fine differences in natural character. Brown (2002) found that data from the three rivers she studied, the Little Tennessee, Nolichucky, and New, were separated to some degree geographically as well as by landform and other environmental variables. However, widespread species predominated on all rivers, and the species distinct to each river were of low constancy or of obscure interpretation. The presence of *Quercus imbricaria, Pyrularia pubera,* and *Itea*

virginica only on the Little Tennessee, with *Carpinus caroliniana*, *Arundinaria*, and *Betula nigra* occurring primarily there, may suggest a distinct subtype of more southerly floodplains or of larger floodplains, but some of these species also occur on other rivers that don't fit this pattern.

Platanus occidentalis - Fraxinus pennsylvanica - Quercus imbricaria Forest (CEGL007339) is an association of Kentucky and Tennessee, which was attributed to NC on the basis of a single plot in a small grove of *Quercus imbricaria* in the Great Smoky Mountains. Other floodplains in NC also have *Quercus imbricaria*. It appears that this plot, along with the floodplain forest around it, falls within the range of variation represented by this subtype, and does not warrant recognition of a distinction in North Carolina.

Liquidambar styraciflua - Liriodendron tulipifera - (Platanus occidentalis) / Carpinus caroliniana - Halesia tetraptera / Amphicarpaea bracteata Forest (CEGL007880) is a floodplain association attributed to North Carolina. It appears to be a successional forest that would represent one of several degraded versions of this subtype. *Liquidambar styraciflua* is a low-constancy species on North Carolina mountain lowland rivers, but does not follow a pattern that would warrant recognizing a distinct association.

Betula nigra - Platanus occidentalis / Alnus serrulata / Boehmeria cylindrica Forest (CEGL007312) is a widespread association that has been attributed to NC for both the Piedmont and Mountains. Its relationship to other associations, including this one, needs to be clarified. Mountain examples would fall within the range of variation represented by this subtype. If present in the mountains of North Carolina, it would likely represent a depauperate segregate of this subtype or possibly a successional bar community.

MONTANE ALLUVIAL FOREST (HIGH TERRACE SUBTYPE) G4?

Synonyms: *Quercus (alba, coccinea, falcata, velutina) / Kalmia latifolia* Temporarily Flooded Forest (CEGL004098).
Ecological Systems: South-Central Interior Large Floodplain (CES202.705).

Concept: Subtype covers examples on higher terraces of medium to large rivers, where evidence of flooding and some characteristic alluvial species are present, but where upland oak species dominate.

Distinguishing Features: The High Terrace Subtype is distinguished by the dominance of upland oaks, with characteristic alluvial or floodplain species present but limited in abundance. Communities on terraces or seldom-flooded floodplains that show no significant evidence of alluvial species or processes should be regarded as Montane Oak–Hickory Forest, Acidic Cove Forest, or other upland communities.

Comments: The NVC synonymy of this type is questionable. The association was defined as a Cumberland Plateau community, but was extended to North Carolina based on a Blue Ridge Parkway plot at Sandy Bottom. A couple other examples which might fit it are known on the Little Tennessee River. An odd forest of Carya pallida on the Nolichucky River may also fit best here, as an example altered by fire. It may be that a different high terrace association is needed for areas east of the Cumberlands, but there is insufficient data at present. Though NatureServe ranks this association G4?, the NVC description says it is rare. It is extremely rare in North Carolina, though it likely was once more abundant in the larger river valleys.

MONTANE FLOODPLAIN SLOUGH FOREST G1
Synonyms: *Acer rubrum var. trilobum - Fraxinus pennsylvanica / Carex crinita - Peltandra virginica* Forest (CEGL004420).
Ecological Systems: South-Central Interior Large Floodplain (CES202.705).

Concept: Type covers lower areas of large mountain river floodplains, generally formed as abandoned channel segments or naturally blocked low areas, where long flooding duration restricts composition to a small number of hydrophytic species.

Distinguishing Features: The Montane Floodplain Slough Forest type is distinguished from the Montane Alluvial Forest Type by having a longer flooding period, which creates substantial floristic differences. Most of the plants of Montane Floodplain Slough Forests may be present in the Large River Subtype of Montane Alluvial Forest, but *Acer rubrum var. trilobum* is confined to this type and *Peltandra virginica, Carex crinita*, and species of similarly long flood tolerance are dominant in it.

PIEDMONT ALLUVIAL FOREST G4
Synonyms: Piedmont/Mountain Alluvial Forest. *Liquidambar styraciflua - Liriodendron tulipifera / Lindera benzoin / Arisaema triphyllum* Forest (CEGL004418).
Ecological Systems: Southern Piedmont Small Floodplain and Riparian Forest (CES202.323).

Concept: Type covers forests with a substantial component of alluvial species, on narrow floodplains of small streams or on large rivers where the floodplain is narrowed by bedrock. These are floodplains with limited differentiation of communities by depositional landforms, with natural levees, backswamps, and sloughs absent or too small to create separate communities. Flooding is of shorter duration and more variable than on larger floodplains, either because of the smaller watershed of small stream or because of the steeper gradient of confined floodplains of larger rivers. On large rivers, they occur only where the full width of the floodplain, rather than just one side, is narrow.

Distinguishing Features: Piedmont Alluvial Forests are distinguished from larger river floodplain forests by occurring on small floodplains that lack levees, bottomlands, and swamps large enough to support distinct communities. This correlates with a lower abundance and diversity of characteristic floodplain species. Most of the canopy is of widespread species such as *Liquidambar styraciflua* and *Liriodendron tulipifera*, and upland species may be present, mixing with characteristic alluvial species such as *Platanus occidentalis, Betula nigra*, or *Celtis laevigata*. Piedmont Alluvial Forests are distinguished from Piedmont Headwater Stream Forests by occurring on somewhat larger floodplains and in having a significant presence and diversity of characteristic floodplain such as *Platanus* and *Betula*. Upland species are often present but are of limited abundance, while in the Piedmont Headwater Stream Forests they are abundant.

Piedmont Alluvial Forests are distinguished from Mesic Mixed Hardwood Forests by the presence of characteristic alluvial and wetland species, such as *Platanus, Betula*, and *Xanthorhiza simplicissima*. Species such as *Lindera benzoin* and *Aesculus sylvatica* may be shared with Basic Mesic Forests, but are present in the floodplains even in the absence of basic rock substrate. Piedmont Small Stream Forests are distinguished from Montane Alluvial Forests by the lack of a significant portion of species

characteristic of the Blue Ridge, such as *Aesculus flava, Tsuga canadensis, Halesia tetraptera, Juglans cinerea,* and *Quercus imbricaria*. Floodplain communities in the upper Piedmont which have characteristic montane species should be classified as Montane Alluvial Forest.

Comments: This type was known as Piedmont/Low Mountain Alluvial Forest in the 3rd Approximation. However, all floodplain forests in the Mountains, and some in the upper Piedmont, have proved to fit better in Montane Alluvial Forest.

At the same time, this community type has been expanded from its 3rd Approximation concept, which was limited to floodplains of small streams only. Later field experience suggests that confined floodplains of large rivers, such as the Rocky and Haw, better resemble the mixed vegetation of this type than they do the geomorphically-differentiated communities of wide floodplains. This has been confirmed by a study of Piedmont floodplain communities (Matthews 2011).

Matthews (2011) included two communities that correspond to this type. The *Liriodendron tulipifera - Liquidambar styraciflua / Lindera benzoin / Amphicarpaea bracteata* community fits this type well. The *Liriodendron tulipifera - Betula nigra / Cornus florida / Sanicula canadensis var. canadensis* community has a larger upland component (e.g., *Oxydendrum arboreum* and *Quercus alba* and appears to be transitional to the Piedmont Headwater Stream Forest type. Plots from the smallest floodplains, recognized here as Piedmont Headwater Stream Forest, were not well represented in that study.

PIEDMONT HEADWATER STREAM FOREST (TYPIC SUBTYPE) G3G4

Synonyms: *Liriodendron tulipifera - Quercus alba - (Liquidambar styraciflua) / Ilex opaca / Polystichum acrostichoides* Piedmont Small Stream Forest (CEGL004900). Piedmont/Low Mountain Alluvial Forest (3rd Approximation).
Ecological Systems: Southern Piedmont Small Floodplain and Riparian Forest (CES202.323).

Concept: Type covers forests of floodplains of the smallest Piedmont streams, generally intermittent to 1st or 2nd order, where flooding and alluvial processes have some, but limited, influence on vegetation and most characteristic alluvial species are absent or scarce. They have vegetation that consists largely of species of broad ecological tolerance and of upland species, but occur on distinct floodplains, have vegetation in combinations not usually found in upland community types, and have a few floodplain species. The Typic Subtype covers most examples of typical small streams, excluding only those with the specialized characteristics of the Hardpan Subtype.

Distinguishing Features: Piedmont Headwater Stream Forests are distinguished from other floodplain communities by the absence of alluvial species such as *Platanus occidentalis, Betula nigra*, and *Celtis laevigata*, though other riparian species such as *Xanthorhiza simplicissima* or wetland species such as *Osmundastrum(Osmunda) cinnamomeum, Osmunda regalis*, or *Viburnum nudum* may be present. Widely tolerant species such as *Liriodendron tulipifera* and *Liquidambar styraciflua*, and upland species such as *Quercus alba, Quercus rubra*, and *Fagus grandifolia* are generally present in both this type and in Piedmont Alluvial Forest. However, upland species are more abundant and diverse in this type. Piedmont Headwater Stream Forests are distinguished from Mesic Mixed Hardwood Forest, with which they may share many species, by the presence of riparian and/or wetland species as well as by evidence of flooding.

The Typic Subtype is distinguished from the Hardpan Subtype by not occurring in broad, gently sloped bottoms with dense clay hardpan substrates. Generally, the soil in the Typic Subtype is coarse-textured. *Quercus phellos* and *Carya carolinae-septentrionalis* are both largely absent from the Typic Subtype.

Comments: *Fagus grandifolia - Quercus* spp. / *Kalmia latifolia - Hamamelis virginiana / Galax urceolata* Forest [Provisional] (CEGL004549) was initially described as a mesic forest of the Uwharrie area, but further examination of the plot attributed to it shows it to be a floodplain forest closely related enough to this type to be questionably distinct.

PIEDMONT HEADWATER STREAM FOREST (HARDPAN SUBTYPE) G2
Synonyms: *Quercus phellos - Quercus alba - (Quercus michauxii) - Carya carolinae-septentrionalis* Small Stream Forest (CEGL004042).
Ecological Systems: Southern Piedmont Small Floodplain and Riparian Forest (CES202.323).

Concept: Subtype covers rare examples of floodplains associated with gently sloped upper drainages in unusually flat terrain with dense clay hardpan soils. Limited rooting depth, lack of internal soil drainage, and soil texture give these sites a distinctive character midway between a typical floodplain community and an upland hardpan (Mixed Moisture Hardpan Forest).

Distinguishing Features: The Hardpan Subtype can be distinguished from the Typic Subtype by occurring in unusually gently-sloping bottoms with dense clay hardpan substrate, and by characteristic vegetation. *Quercus phellos*, or occasionally, *Quercus michauxii* are generally abundant in this subtype and largely absent in the Typic Subtype. This subtype can be distinguished from Mixed Moisture Hardpan Forest and Upland Depression Swamp by having evidence of flowing water, visible stream channels (often multiple braided or anastomosing channels), and by flora that includes at least some floodplain species. *Liquidambar styraciflua*, which is often abundant in Piedmont Headwater Stream Forest, is abundant in the other communities only in successional forests.

Comments: The community represented by this subtype looks very similar in some ways to the Mixed Moisture Hardpan Forest, and was not recognized in earlier site descriptions.

PIEDMONT LEVEE FOREST (TYPIC SUBTYPE) G3G4
Synonyms: *Fraxinus pennsylvanica - Platanus occidentalis - Celtis laevigata / Chasmanthium latifolium* Piedmont River Levee Forest (CEGL007013).
Ecological Systems: Southern Piedmont Large Floodplain Forest (CES202.324).

Concept: Type covers communities on natural levee deposits or river front riparian zones on Piedmont rivers and larger streams. Subtypes covers the common examples where characteristic levee species such as *Platanus occidentalis, Betula nigra, Celtis laevigata*, and *Acer negundo* are a significant component in combination with widespread species such as *Liquidambar styraciflua, Liriodendron tulipifera*, and *Acer rubrum*. *Fagus grandifolia* is scarce or absent. The Typic Subtype covers most examples, excluding the distinctive examples with abundant *Fagus grandifolia*.

Distinguishing Features: The type is distinguished from other communities of large Piedmont floodplains by significant presence of the characteristic levee species: *Platanus occidentalis, Betula*

nigra, Acer negundo, and *Celtis laevigata*. It is distinguished from Piedmont Alluvial Forest by occurring on larger floodplains, large enough to have differentiated levee, bottomland, and terrace zones large enough to support distinct communities. Where large rivers flow through gorges or other confined areas without extensive floodplain development, the narrow floodplains usually are more like Piedmont Alluvial Forest, with a mix of levee, bottomland, and upland species, and should be classified as that type. However, occasionally they will more resemble a Piedmont Levee Forest. While Piedmont Levee Forest usually occurs along large rivers, it also occurs in the wide floodplains that develop along fairly small creeks in Triassic basins.

Piedmont Levee Forest is distinguished from Montane Alluvial Forest by the absence of characteristic montane species such as *Tsuga canadensis, Pinus strobus*, and various herb species shared with Rich Cove Forest.

The Typic Subtype is distinguished by dominance by typical floodplain species, with little or no presence of *Fagus grandifolia* and little component of other upland species.

Comments : There has been much confusion in the NVC over Piedmont floodplain communities and over levee forests in various regions. The association synonymized above was created to cover Piedmont Levee Forests in North Carolina and adjacent states.

Betula nigra - Platanus occidentalis / Alnus serrulata / Boehmeria cylindrica Forest (CEGL007312) is a very broadly defined association that is attributed to North Carolina and synonymized to Piedmont Levee Forest in the NVC. It appears to be overlap the association above, but possibly may represent a specialized bank zone or succeeding bar forest.

Liriodendron tulipifera / Asimina triloba / Arundinaria gigantea ssp. gigantea Forest (CEGL004419) is an association apparently defined based on preliminary analysis of plot data from North Carolina, but its broader concept is unclear. It was not recognized in the broader analysis of Piedmont floodplain vegetation by (2011).

Platanus occidentalis - Liquidambar styraciflua / Carpinus caroliniana - Asimina triloba Forest (CEGL007340) is a wide-ranging and very broadly conceived association that seems to overlap the concept of Piedmont levees (as well as Piedmont Alluvial Forest). This subtype was synonymized to it in earlier drafts of the 4th approximation, but did not fit it well.

Matthews (2011) recognized two types of levee forests, corresponding floodplain size and location within the river course. *Ulmus americana - Celtis laevigata / Lindera benzoin / Osmorhiza longistylis* occurred in larger and more downstream floodplains within the Piedmont. *Fraxinus pennsylvanica - Platanus occidentalis / Acer negundo / Chasmanthium latifolium* occurs in slightly narrower floodplains farther upstream. However, she noted considerable overlap in range. These should be recognized as a Downstream Variant and Upstream Variant. They may warrant recognition as subtypes, but may overlap too much.

PIEDMONT LEVEE FOREST (BEECH SUBTYPE) G3?

Synonyms: *Fagus grandifolia - Acer barbatum / Asimina triloba / Toxicodendron radicans / Carex blanda* Forest (CEGL007321).

Ecological Systems: Southern Piedmont Large Floodplain Forest (CES202.324).

Concept: Subtype covers beech-dominated forests of high areas on Piedmont floodplains, where flooding occurs but is of short duration and soils are alluvial.

Distinguishing Features: The Beech Subtype is distinguished from the Typic Subtype by dominance or codominance by *Fagus grandifolia*. It is distinguished from Piedmont Alluvial Forest and Piedmont Headwater Stream Forest, by occurrence on a large floodplain with differentiated landforms, and by the presence of typical Levee Forest species with the *Fagus*. Piedmont Bottomland Forest (High Subtype) may sometimes also contain *Fagus*, but it will be a relatively minor component mixed with floodplain and upland oaks rather than levee species. The Beech Subtype is distinguished from mesic forests dominated by *Fagus* by the occurrence of alluvial species and by being located in a floodplain.

PIEDMONT BOTTOMLAND FOREST (HIGH SUBTYPE) G3G4

Synonyms: *Liquidambar styraciflua - Quercus (phellos, nigra, alba) / Carpinus caroliniana* Forest (CEGL007006).

Ecological Systems: Southern Piedmont Large Floodplain Forest (CES202.324).

Concept: Type covers communities on higher parts of large Piedmont floodplains, away from the river and not containing characteristic Piedmont Levee Forest species. These are sites that are flooded for brief to moderate periods in the growing season. These sites occur on terraces, on the higher parts of depositional ridge and swale systems, and on some wide flat floodplains. Natural vegetation is a mix of bottomland oaks, *Liriodendron tulipifera*, *Liquidambar styraciflua*, and sometimes *Fagus grandifolia*. Successional vegetation may consist solely of *Liriodendron, Liquidambar*, and Levee Forest species.

Subtype covers examples on the higher floodplains and terraces, where an appreciable number of upland oaks, hickories, and other plants mix with the bottomland species. Levee communities are often present adjacent to the river, but this subtype sometimes covers most of higher medium-size floodplains. Most examples have been found on medium size rivers, but examples probably once were more common on higher terraces of larger rivers as well.

Distinguishing Features: Piedmont Bottomland Forest is distinguished from Piedmont Levee Forest by lack or scarcity of the characteristic levee species. *Platanus occidentalis, Betula nigra*, and *Celtis laevigata* are generally absent, though they may briefly invade cleared areas. *Fraxinus pennsylvanica, Ulmus americana*, and *Acer negundo* may be present but are not as abundant as they are in the Piedmont Levee Forest or Piedmont Swamp Forest. Bottomland Forests may occasionally occur on wide flat floodplains without obvious levees, where they may extend up to the river bank.

Piedmont Bottomland Forest is distinguished from Piedmont Swamp Forest by shorter flooding duration and by vegetation reflecting the drier conditions. In the most intact examples, oaks are characteristic, along with *Liriodendron tulipifera, Liquidambar styraciflua*, and *Acer rubrum*. Upland species such as *Quercus alba* or *Fagus grandifolia* may be present in small numbers. While more water-tolerant trees such as *Quercus lyrata, Fraxinus pennsylvanica*, and *Ulmus americana* may be present, they are less abundant than in Piedmont Swamp Forests, and often occur only locally, in wet microsites.

The High Subtype is distinguished from the two low subtypes by having an appreciable component of

upland oaks and hickories, or *Fagus*, associated with a higher elevation above the river. Other strata of the vegetation also have more mesophytic, less water-tolerant composition. Matthews (2011) found a number of species that were more common in the High Subtype than the Low Subtype, or only present there, including *Amphicarpaea bracteata, Asarum canadense, Botrypus virginianus, Chasmanthium latifolium, Dichanthelium boscii, Dichanthelium laxiflorum, Hexastylis arifolia, Hypericum hypericoides, Polygonatum biflorum, Polystichum acrostichoides, Mitchella repens, Cornus florida, Fagus grandifolia*, and *Quercus nigra*. Although Matthews (2011) did not include samples of them, communities of high bottomlands with *Fagus grandifolia* dominant or co-dominant are included in this subtype.

Comments: There has been substantial confusion about the natural vegetation of these communities. *Liriodendron tulipifera* was listed as the characteristic dominant tree in the 3rd approximation. But it appears that any bottomland forest strongly dominated by *Liriodendron* is probably a successional forest developing after cultivation. Similar to their Coastal Plain analogs, more intact examples all appear to have a substantial oak component.

PIEDMONT BOTTOMLAND FOREST (TYPIC LOW SUBTYPE) G2?
Synonyms: *Quercus pagoda - Quercus phellos - Quercus lyrata - Quercus michauxii / Chasmanthium latifolium* Forest (CEGL007356).
Ecological Systems: Southern Piedmont Large Floodplain Forest (CES202.324).

Concept: Subtype covers most examples on lower terraces, ridges, and flat floodplains, without an appreciable component of upland species, and lacking the distinctive composition of the Northern Low Subtype. *Quercus lyrata* may be present but is not dominant.

Distinguishing Features: The Typic Low Subtype is distinguished by the predominance of bottomland species without an appreciable component of most upland species. Plants that Matthews (2011) found to be more common in this subtype and less common or absent in the High Subtype include *Saururus cernuus, Carex lupulina, Carex tribuloides, Elymus virginicus, Glyceria striata, Juncus effusus, Persicaria virginiana, Ulmus americana*, and *Quercus lyrata*. However a few characteristically upland species still occurred with some frequency in this type, including *Quercus alba* and *Carya ovata*. A number of more mesophytic species are largely absent in this subtype.

In examples cleared in the past, *Liquidambar* or *Liriodendron* may strongly dominate, so that distinguishing the subtypes is difficult. However, in more intact examples, at least some bottomland oaks will be present.

Comments: There has been substantial confusion in the nomenclature of Piedmont swamps versus bottomland forests. The oak-dominated, broad Triassic basin floodplains have been called swamps in some of the literature and bottomlands elsewhere. However, these floodplains include both wetter swamps that stay flooded for long periods, and slightly drier oak-dominated areas that correspond to this subtype. The 3rd Approximation contributed to the confusion by mixing descriptions of these heterogeneous floodplains. The 4th Approximation attempts to reduce confusion by defining Piedmont Bottomland Forest as the portion of the flooding gradient where most oaks occur, and defining Piedmont Swamp Forest as the wettest sites, where only the most water-tolerant trees (including *Quercus lyrata* but not most other oak species) predominate.

The Matthews (2011) community that corresponds closely to this type subtype is called *Quercus (phellos, pagoda, michauxii) - Ulmus americana / Ilex decidua / Arisaema triphyllum*. She noted that it generally occurred on wide, flat Triassic Basin floodplains. *Quercus lyrata* occurs in it, but only in wet inclusions.

PIEDMONT BOTTOMLAND FOREST (NORTHERN LOW SUBTYPE) G3?
Synonyms: *Quercus phellos - Quercus (palustris, lyrata) / Ilex decidua / Carex typhina - (Carex grayi)* Forest (CEGL006498).
Ecological Systems: Southern Piedmont Large Floodplain Forest (CES202.324).

Concept: The Northern Low Subtype covers examples that are similar in wetness to the Typic Low Subtype, but which contain an appreciable component of species that are common in Virginia but scarce in North Carolina, particularly *Quercus palustris*.

Distinguishing Features: The Northern Low Subtype is distinguished by all other floodplain communities by the abundant (though not necessarily dominant) presence of *Quercus palustris*.

Comments: This subtype is rare in North Carolina with examples known only from a couple of sites near the Virginia border. It has a rather narrow global range, limited to the southern half of Virginia.

PIEDMONT SWAMP FOREST GNR
Synonyms: *Acer rubrum - Fraxinus pennsylvanica / Saururus cernuus* Forest (CEGL006606).
Ecological Systems: Southern Piedmont Large Floodplain Forest (CES202.324).

Concept: Type covers communities of the wetter parts of large Piedmont floodplains, generally backswamps and large sloughs but possibly depressions on terraces. These areas are flooded for prolonged periods and support species tolerant of longer hydroperiod, such as *Fraxinus pennsylvanica, Ulmus americana, Acer rubrum var. trilobum,* and *Quercus lyrata*.

Distinguishing Features: Piedmont Swamp Forest is distinguished from all other Piedmont floodplain types by its flood-tolerant species composition, generally dominated by *Fraxinus pennsylvanica, Ulmus americana, Acer rubrum,* or *Quercus lyrata*. The lower strata are similarly water-tolerant, with a relatively depauperate herb layer, generally dominated by *Carex* spp., *Saururus cernuus*, or *Boehmeria cylindrica*.

Piedmont Swamp Forests and Floodplain Pools can both have standing water for long periods and both occur in linear sloughs or wider basins, but Floodplain Pools will have an area of deeper water that stays flooded much or all of the year and lacks rooted trees. Many Floodplain Pools have trees rooted at their edges, generally of the same species as those in Piedmont Swamp Forest. These areas should be regarded as ecotones of the Floodplain Pool rather than Piedmont Swamp Forest unless they cover a substantial area.

Floodplain areas that have become wetter due to artificial impoundment by roads, other fill, or by larger reservoirs, should not generally be classified as Piedmont Swamp Forest. They could be considered this

type in rare cases if the impoundment is configured so as to create an identical hydroperiod and enough time has passed for the vegetation to come to equilibrium with a composition resembling natural examples.

Comments: See comments under Piedmont Bottomland Forest (Low Subtype) on the confusion of swamp and bottomland forests. As defined in the 4th approximation, Piedmont Swamp Forest is not confined to Triassic Basins, but occurs as small patches elsewhere.

PIEDMONT/MOUNTAIN CANEBRAKE G2?

Synonyms: *Arundinaria gigantea ssp. gigantea* Shrubland (CEGL003836).
Ecological Systems: South-Central Interior Small Stream and Riparian (CES202.706); South-Central Interior Large Floodplain (CES202.705).

Concept: Type covers communities with dense thickets of *Arundinaria gigantea ssp. gigantea*, with low tree cover.

Distinguishing Features: Canebrakes are distinguished by lacking a well-developed tree canopy (generally less than 25 percent tree cover) and having a dense shrub layer of *Arundinaria gigantea*. Areas of cane that appear to be naturally developed, or are restored in plausible natural settings, should be regarded as this type.

Comments: These communities are described in historic sources, but it is not known if any well-developed natural examples remain. Their natural dynamics, the environments where they occurred, and even if they were of natural or anthropogenic origin are poorly known. There is currently renewed interest in them, and restoration efforts are being tried.

FLOODPLAIN POOL G3

Synonyms: *Peltandra virginica - Saururus cernuus - Boehmeria cylindrica / Climacium americanum* Herbaceous Vegetation (CEGL007696).
Ecological Systems: South-Central Interior Small Stream and Riparian (CES202.706). South-Central Interior Large Floodplain (CES202.705).

Concept: Narrow sloughs or rounded depressions in floodplains of the Piedmont and Mountains, holding water much or all of the year. Vegetation is sparse, and generally absent in the deepest water, but emergent or floating-leaved aquatic plants may be present in the larger examples. Most examples are small enough to be shaded by trees rooted in adjacent forest communities. Plant species vary widely, with some species of *Carex* almost always present but other plants quite variable.

Distinguishing Features: Floodplain Pools are distinguished from adjacent floodplain forests by their long hydroperiod, which prevents trees and most shrubs from being rooted within the pool. They are distinguished from Semipermanent Impoundments by the cause of flooding and corresponding differences in flood dynamics, as well as generally by differences in size scale. Floodplain Pools are generally much smaller than Semipermanent Impoundments, lack remnants of trees, and have a less well-developed aquatic plant flora. Though potentially subject to draining by channel movement or

erosion, Floodplain Pools tend to be stable for longer periods that Semipermanent Impoundments. The vascular plant species present in Floodplain Pools vary widely among examples.

Comments: Floodplain Pools are transitional between wetland vegetated communities and aquatic communities. They are more distinctive for their aquatic fauna (and probably microflora) than for their higher plant communities. Two distinct variants can be recognized based on the aquatic animal communities: Pools that are flooded often by overbank stream flow and seldom dry out support fish as the dominant animal component. Those that are flooded more rarely and dry out between floods lack fish most of the time and support significant amphibian communities. These differences are not known to be reflected in vegetation, but are important ecologically.

PIEDMONT/MOUNTAIN SEMIPERMANENT IMPOUNDMENT (OPEN WATER SUBTYPE) G4G5

Synonyms: *Nuphar advena* - *Nymphaea odorata* Herbaceous Vegetation (CEGL002386); *Nelumbo lutea* Herbaceous Vegetation (CEGL004323).
Ecological Systems: Southern Piedmont Large Floodplain Forest (CES202.324); Southern Piedmont Small Floodplain and Riparian Forest (CES202.323). South-Central Interior Small Stream and Riparian (CES202.706); South-Central Interior Large Floodplain (CES202.705).

Concept: Subtype covers portions of Piedmont and Mountain examples with open water or floating-leaved aquatic plants but with little emergent vegetation.

Distinguishing Features: The Open Water Subtype is distinguished by the absence of appreciable emergent vegetation, consisting instead of unvegetated water, submersed plants, or floating-leaved aquatic plants.

PIEDMONT/MOUNTAIN SEMIPERMANENT IMPOUNDMENT (MONTANE MARSH SUBTYPE) G2G3

Synonyms: *Juncus effusus* - *Chelone glabra* - *Scirpus* spp. Southern Blue Ridge Beaver Pond Herbaceous Vegetation (CEGL008433).
Ecological Systems: South-Central Interior Small Stream and Riparian (CES202.706); South-Central Interior Large Floodplain (CES202.705).

Concept: Type covers aquatic and emergent communities of active and abandoned beaver ponds and similar small impoundments in the Piedmont and Blue Ridge, as well as in the Ridge and Valley and Cumberlands. Subtype covers examples in the Blue Ridge.

Distinguishing Features: Semipermanent Impoundment communities are distinguished by vegetation and hydrology affected by impoundment by beavers. Small manmade impoundments are included if they produce a similar environment and vegetation, but most reservoirs in the Piedmont and Mountains bear little resemblance to natural beaver ponds and should not be treated as natural communities.

As presently defined, this subtype includes all examples with emergent or marshy vegetation in the Mountain Region. Open water examples in both the Mountain and Piedmont regions, with floating aquatic plants or without emergent plants, are classified as the Open Water Subtype. Shrub-dominated

edge zones and successional ponds are classified as the Shrub Subtype. The Montane Marsh Subtype is characterized by substantially different vegetation and flora than the Piedmont Marsh Subtype, with less dominance by large graminoids, more forbs, and often some flora shared with Southern Appalachian Bogs. Examples in the upper Piedmont are not well known, but should be classified here if their vegetation better matches this subtype than any of the Piedmont subtypes.

Comments: The communities of active and abandoned beaver ponds are not well known, and present many difficult classification issues. This subtype is defined broadly at present, and may warrant division into several subtypes. In particular, where beaver ponds have been created in bog communities, vegetation which is a mix of bog and marsh species often develops on the edges and in drained ponds. This presumably succeeds back to a bog community over time. Some boggy character can also occur in drained beaver ponds where acidic seepage is present. These areas may be recognized as a Boggy Variant.

Sparganium americanum - (Sparganium erectum ssp. stoloniferum) - Epilobium leptophyllum Herbaceous Vegetation (CEGL004510) is another beaver pond association attributed to North Carolina. It represents diverse marshy vegetation dominated by *Sparganium* spp. in states to the north. Examples of our Montane Marsh Subtype often have small patches of nearly pure *Sparganium americanum* associated with rivulets, but none large enough to merit recognition as a distinct subtype. *Juncus effusus* Seasonally Flooded Herbaceous Vegetation (CEGL004112) is another association attributed to North Carolina. It is a broadly defined association that would conceivably overlap this subtype. Patches of *Juncus effusus* dominance occur in the Montane Marsh Subtype, but are best regarded as part of a more diverse marsh community.

PIEDMONT/MOUNTAIN SEMIPERMANENT IMPOUNDMENT (PIEDMONT MARSH SUBTYPE) G4?
Synonyms: *Polygonum (hydropiperoides, punctatum) - Leersia* spp. Herbaceous Vegetation (CEGL004290).
Ecological Systems: Southern Piedmont Large Floodplain Forest (CES202.324). Southern Piedmont Small Floodplain and Riparian Forest (CES202.323).

Concept: Type covers aquatic and emergent communities of active and abandoned beaver ponds and similar small impoundments in the Piedmont and Mountains. Subtype covers portions of Piedmont examples with emergent vegetation. This may represent several subtypes, which may not correspond well to NVC associations.

Distinguishing Features: Semipermanent Impoundment communities are distinguished by vegetation and hydrology affected by impoundment by beavers. Small manmade impoundments are included if they produce a similar environment and vegetation, but most reservoirs in these regions bear little resemblance to natural beaver ponds and should not be treated as natural communities. Piedmont/Mountain Semipermanent Impoundments differ from Coastal Plain Semipermanent Impoundments in flora and generally in dominant vegetation. Most can be distinguished easily by geographic location, but those near the Fall Zone should be classified as the type their vegetation most resembles.

The Piedmont Marsh Subtype is distinguished by dominance by emergent non-woody vegetation with vegetation and flora characteristic of the Piedmont region. The floristic differences between it and the Montane Subtype have not been well defined but appear to be substantial, though many species are shared. The Piedmont Marsh Subtype tends to be dominated by large graminoids, with zones of coarse forbs, and has less of the smaller forbs and boggy species of the Montane Marsh Subtype. Marshy beaver ponds in the upper Piedmont should be classified as the subtype their vegetation best resembles.

Comments: The NVC treatment of these communities is problematic. The association treated as the primary synonym here does not fit much of our vegetation well, yet is also defined broadly enough to potentially apply to rather different vegetation in other regions. Other associations are defined based on one or a few species that are patch dominants in this subtype, so that they could apply. These include *Juncus effusus* Seasonally Flooded Herbaceous Vegetation (CEGL004112); *Scirpus cyperinus* Seasonally Flooded Southern Herbaceous Vegetation (CEGL003866); *Typha (angustifolia, latifolia) - (Schoenoplectus* spp.) Eastern Herbaceous Vegetation (CEGL006153). But if we were to attempt to name our vegetation patches as separate associations, many more associations would be required. In fact, most of our marshes have more mixed vegetation at the typical scale of measurement. However, they vary substantially from one part to another, as well as from one marsh to another, and the variation is not well characterized. It seems best to treat our Semipermanent Impoundments with a small set of subtypes based on structure and the regional floristic differences.

PIEDMONT/MOUNTAIN SEMIPERMANENT IMPOUNDMENT (SHRUB SUBTYPE) G4
Synonyms: *Alnus serrulata* Southeastern Seasonally Flooded Shrubland (CEGL008474).
Ecological Systems: Southern Piedmont Large Floodplain Forest (CES202.324). Southern Piedmont Small Floodplain and Riparian Forest (CES202.323). South-Central Interior Small Stream and Riparian (CES202.706); South-Central Interior Large Floodplain (CES202.705).

Concept: Subtype covers all Piedmont and Mountain examples with substantial shrub and young tree vegetation, including shallow water zones of mature ponds and natural successional vegetation of abandoned ponds. The vegetation may vary substantially, but *Alnus serrulata, Salix* spp., and *Acer rubrum* saplings are most common.

Distinguishing Features: The Shrub Subtype is distinguished by the dominance of shrubs or small trees, most often *Alnus serrulata, Salix* spp., or *Acer rubrum*, but potentially *Viburnum, Cephalanthus, Fraxinus*, or other species. It is distinguished from floodplain communities that would otherwise occupy the site by having different vegetation, usually more uniform and wetter, with a more depauperate herb layer or an herb layer composed of shade-intolerant species remaining from the pond rather than typical floodplain forest species.

Comments: This subtype as defined covers both Piedmont and Mountain examples. It may need to be subdivided when more information becomes available.

The NVC association synonymized with this subtype is problematic, in that it is very broadly defined and covers natural and artificial vegetation. *Cephalanthus occidentalis / Carex* spp. - *Lemna* spp. Southern Shrubland (CEGL002191) could potentially apply to some examples in North Carolina, but none are known.

ROCKY BAR AND SHORE (ALDER-YELLOWROOT SUBTYPE) G3G4
Synonyms: *Alnus serrulata - Xanthorhiza simplicissima* Shrubland (CEGL003895).
Ecological Systems: South-Central Interior Large Floodplain (CES202.705); South-Central Interior Small Stream and Riparian (CES202.706).

Concept: Type covers sparsely vegetated herb and shrub communities of bedrock and gravel areas where forest vegetation is prevented from developing by flood scouring or reworking of the substrate. Subtype covers shrubby examples of Mountain and possibly upper Piedmont rivers. They may be on bedrock, boulders, or cobble bars. Vegetation and floristic composition often varies widely among sites.

Distinguishing Features: The Rocky Bar and Shore type is distinguished from streamside forest communities such as Montane Alluvial Forest and Piedmont Alluvial Forest by the lack of a well-developed tree canopy. It is distinguished from the Sand and Mud Bar type by substrate and corresponding vegetational differences. It is distinguished from Spray Cliffs by the absence of regular spray from falling water and the corresponding general lack of bryophytes. It is distinguished from other non-forested wetland communities by occurring along the river, in areas subject to scouring. The boundary between bedrock Rocky Bar and Shore communities and upland Montane Cliff communities is potentially difficult in steep gorges. The boundary should be placed where flood scouring appears to cease being a significant influence.

The Alder-Yellowroot Subtype is distinguished by having a substantial (though still usually sparse) shrub presence, with *Alnus serrulata* or *Xanthorhiza simplicissima* generally most abundant.

ROCKY BAR AND SHORE (TWISTED SEDGE SUBTYPE) G3G4
Synonyms: *Carex torta* Herbaceous Vegetation (CEGL004103).
Ecological Systems: South-Central Interior Large Floodplain (CES202.705); South-Central Interior Small Stream and Riparian (CES202.706).

Concept: Subtype covers examples dominated by *Carex torta* or other shade-intolerant, tough-rooted herbs. They generally occur on low cobble or gravel bars and are often associated with the Alder-Yellowwood Subtype. All North Carolina examples are in the Mountains or upper Piedmont.

Distinguishing Features: The Twisted Sedge Subtype is distinguished from other subtypes by the dominance of *Carex torta* or other similar perennial herbs.

ROCKY BAR AND SHORE (WATER WILLOW SUBTYPE) G4G5
Synonyms: *Justicia americana* Herbaceous Vegetation (CEGL004286).
Ecological Systems: Southern Piedmont Large Floodplain Forest (CES202.324); South-Central Interior Large Floodplain (CES202.705); South-Central Interior Small Stream and Riparian (CES202.706).

Concept: Subtype covers examples dominated by *Justicia americana*, generally low cobble or gravel bars, mostly in the Piedmont but occasionally in the Mountains.

Distinguishing Features: The Water Willow Subtype is distinguished by the dominance of *Justicia americana*.

ROCKY BAR AND SHORE (MIXED BAR SUBTYPE) G4

Synonyms: *Platanus occidentalis / Dichanthelium clandestinum - Festuca subverticillata* Woodland (CEGL004031).
Ecological Systems: Southern Piedmont Large Floodplain Forest (CES202.324); South-Central Interior Large Floodplain (CES202.705).

Concept: Subtype covers communities consisting of mixtures of short-lived herbs with shrubs and shrub-sized to larger trees, on frequently scoured bars of boulders, cobbles, or mixed sand and rock. This subtype appears to be higher and drier than the other subtypes but perhaps to be subject to more severe flood disturbance.

Distinguishing Features: The Mixed Bar Subtype is distinguished by vegetation that includes varying amounts and statures of trees such as *Platanus occidentalis, Betula nigra, Fraxinus pennsylvanica*, shrubs in addition to *Alnus serrulata* and *Xanthorhiza simplicissima*, and a diverse mix of short-lived herbs. Herbaceous cover may be sparse to dense and may vary substantially from one bar to the next and from one time to the next. *Dichanthelium clandestinum, Rumex crispus*, and *Festuca subverticillata* are frequent, but a very large number of species may be present, including some typical of floodplain forests, wetlands, upland forests, prairies, and numerous exotic species. These communities are distinguished from Montane Alluvial Forest and the various Piedmont floodplain forests by having limited to no tree canopy, as a result of flood disturbance. Generally, the trees that are present are battered, stunted, or chronically young.

Comments: *Platanus occidentalis - Betula nigra - Salix (caroliniana, nigra)* Woodland (CEGL003896) and *Platanus occidentalis - Betula nigra / Cornus amomum / (Andropogon gerardii, Chasmanthium latifolium)* Woodland (CEGL003725) are related associations in the Central Appalachians and northern Piedmont.

Quantitative studies of these communities have found the highest species richness levels in the Mountain Region, higher than those of Rich Cove Forests.

ROCKY BAR AND SHORE (MOUNTAIN BEDROCK SCOUR SUBTYPE) G3

Synonyms: Southern Appalachian Bedrock Scour Herbaceous Vegetation (CEGL004033).
Ecological Systems: South-Central Interior Large Floodplain (CES202.705).

Concept: Subtype covers bedrock areas that are kept bare by flood scouring. They have relatively sparse vegetation consisting of herbaceous and woody plants rooted in bedrock crevices and small soil pockets.

Distinguishing Features: This subtype is distinguished from other mountain subtypes by occurring on stable bedrock rather than on bars that are reworked by flooding, and by the corresponding greater predominance of long-lived plants rooted in crevices rather than short-lived plants on finer substrates. Any comparable scour communities found in the upper Piedmont should also be classified as this subtype. The Yadkin Falls Scour Subtype is distinguished by the presence of *Solidago plumosa*. If other

bedrock scour communities are found in the eastern Piedmont, a new subtype will be needed for them. The boundary between bedrock Rocky Bar and Shore communities and upland Montane Cliff communities is potentially difficult in steep gorges. The boundary should be placed where flood scouring appears to be a significant influence.

Comments : These communities are little studied in North Carolina. The only descriptive data, two plots from the Nolichucky River (Brown 2002), had *Andropogon virginicus* as the most common herb, and had *Salix nigra, Platanus occidentalis,* or *Ulmus alata* as the most abundant woody species. However, other examples may have somewhat different vegetation. The NVC contains several associations for bedrock river scour communities in adjacent states. Most contain a substantial component of prairie grasses such as *Andropogon gerardii* and *Schizachyrium scoparium,* which seem to be lacking in North Carolina's examples.

ROCKY BAR AND SHORE (YADKIN FALLS BEDROCK SCOUR SUBTYPE) G1
Synonyms: *Schizachyrium scoparium - Solidago plumosa* Herbaceous Vegetation (CEGL004459).
Ecological Systems: Southern Piedmont Large Floodplain Forest (CES202.324).

Concept: Subtype covers examples in which *Solidago plumosa* is a prominent component, known only from the Falls of the Yadkin River in the Uwharrie Mountains. It consists of very open communities on bedrock along river shorelines, kept bare of soil by flood scouring but not flooded for significant periods. Substrate condition created by flood scouring is the most important aspect of being in the floodplain. Floods also bring nutrients and seed input, but these communities are not significantly affected by wetness.

Distinguishing Features: The Yadkin Falls Bedrock Scour Subtype is distinguished from all other communities by the presence of *Solidago plumosa*. It differs from the other Piedmont subtypes by having a substrate of hard bedrock, with plants rooted in crevices or limited soil pockets, in combination with a flooding regime that includes some flooding but not for appreciable periods of time. Vegetation thus is dominated by perennial herbs and is fairly stable. This is in contrast to the loose boulder, cobble, or gravel substrate and unstable vegetation of the other Piedmont subtypes. It is distinguished from the Mountain Bedrock Scour Subtype by geographic location and corresponding biogeographic differences. No other bedrock scour communities are known in the Piedmont. If any are found, at least in the central or eastern Piedmont, they will require a new subtype.

ROCKY BAR AND SHORE (RIVERWEED SUBTYPE) G3G5
Synonyms: *Podostemum ceratophyllum* Herbaceous Vegetation (CEGL004331).
Ecological Systems: Southern Piedmont Large Floodplain Forest (CES202.324); South-Central Interior Large Floodplain (CES202.705); South-Central Interior Small Stream and Riparian (CES202.706).

Concept: Subtype covers largely-submerged riffles where *Podostemum ceratophyllum* dominates, generally in nearly monospecific stands. Sparse emergent vegetation may be present.

Distinguishing Features: The Riverweed Subtype is distinguished from other subtypes by the dominance of *Podostemum ceratophyllum*.

Comments: This community is more aquatic than the other subtypes, and may warrant a separate community type. Its distribution and abundance are particularly poorly known.

ROCKY BAR AND SHORE (SOUTHERN WILD RICE SUBTYPE) G4?
Synonyms: *Zizaniopsis miliacea* Coastal Plain Slough Herbaceous Vegetation (CEGL004139).
Ecological Systems: Southern Piedmont Large Floodplain Forest (CES202.324).

Concept: Subtype covers areas dominated by *Zizaniopsis miliacea* on rocky river bars. It is known from the Cape Fear River system near the Fall Zone, but may occur on other rivers also.

Distinguishing Features: Subtype covers examples dominated or codominated by *Zizaniopsis miliacea*.

Comments: The NVC association was defined for still water marshes such as those in beaver ponds or Coastal Plain sloughs. This probably should be classified as a separate association.

Mountain Bogs and Fens

SWAMP FOREST–BOG COMPLEX (TYPIC SUBTYPE) G2
Synonyms: *Tsuga canadensis - Acer rubrum - (Liriodendron tulipifera, Nyssa sylvatica) / Rhododendron maximum / Sphagnum* spp. Forest (CEGL007565).
Ecological Systems: Southern and Central Appalachian Bog and Fen (CES202.300).

Concept: Type covers substantially forested wetlands of extensively or locally saturated stream bottom sites. The ground is generally irregular, so that wetness varies substantially on a fine scale. Herb-dominated boggy openings are almost always present, in a matrix of closed or open tree canopy and usually a dense shrub layer. Subtype covers most North Carolina examples, having canopies of the above species or of other trees (especially *Pinus rigida*, *Pinus strobus*, and *Betula lenta*) but lacking significant *Picea rubens*.

Distinguishing Features: The Swamp Forest–Bog Complex type is distinguished by the combination of a well-developed canopy with only small openings and by the presence of plants indicative of saturated soils at least in parts of the community. *Sphagnum* is generally patchy, and *Carex trisperma, Carex folliculata, Osmunda cinnamomea*, and other herbs shared with Southern Appalachian Bogs are present in the boggy openings. The generally dense shrub layer may consist largely of *Rhododendron maximum* and *Kalmia latifolia*, or may contain shrubs more restricted to wetlands, such as *Viburnum cassinoides, Viburnum nudum*, and *Alnus serrulata*. Boggy openings are small and floristically depauperate compared to Southern Appalachian Bog and French Broad Valley Bog communities. Openings as large as one acre, or smaller openings that have a diverse and characteristic bog flora, should be classified as an embedded bog community.

The Typic Subtype is distinguished from the other subtypes by lacking *Picea rubens* as a significant component.

Comments: The Typic Subtype remains rather heterogeneous, and more subtypes may possibly be warranted. While poorer in species, the boggy openings tend to contain plants characteristic of the larger bog communities in their region. Thus, it is possible to recognize a French Broad Valley variant, a Typic

Variant, and a Low Elevation Variant. While most examples have limited patches of saturated soil and herbaceous bog plants, a few examples are saturated throughout, and this difference may be worthy of recognition by a variant or subtype.

Glyceria striata - Carex gynandra - Chelone glabra - Symphyotrichum puniceum / Sphagnum spp. Herbaceous Vegetation (CEGL008438), a "poorly developed bog" has been attributed to North Carolina, and synonymized to Swamp Forest–Bog Complex, but may be better synonymized to Low Elevation Seep. Wichmann's (2009) Low Elevation Saturated Forests (*Acer rubrum var. rubrum / Viburnum cassinoides / Osmunda cinnamomea var. cinnamomea*) type fits this well, but she synonymized it also with CEGL008438 and two other associations not reported from North Carolina. She also noted that it is heterogeneous and might be subdivided with more data.

SWAMP FOREST–BOG COMPLEX (SPRUCE SUBTYPE) G2?
Synonyms: *Picea rubens - (Tsuga canadensis) / Rhododendron maximum* Saturated Forest (CEGL006277).
Ecological Systems: Southern and Central Appalachian Bog and Fen (CES202.300).

Concept: Subtype covers the rare examples that have *Picea rubens* dominant or codominant. They generally have a larger component of northern species and a minimal component of species shared with the Coastal Plain.

Distinguishing Features: The Spruce Subtype is distinguished from the Typic Subtype by having *Picea rubens* as a canopy dominant or codominant.

Comments: The NVC association synonymized with this subtype extends northward into New York. It is much rarer in North Carolina than the Typic Subtype.

SOUTHERN APPALACHIAN BOG (TYPIC SUBTYPE) G1G2
Synonyms: *Carex atlantica - Solidago patula var. patula - Lilium grayi / Sphagnum bartlettianum* Herbaceous Vegetation (CEGL004158).
Ecological Systems: Southern and Central Appalachian Bog and Fen (CES202.300).

Concept: Type covers open, acidic, permanently saturated wetlands of flat stream bottoms or gentle slopes, with a distinctive bog flora. However, this type lacks the additional distinctive southern and Coastal Plain flora characteristic of French Broad Valley Bog and Low Mountain Seepage Bog, and often has some members of a distinctive set of northern disjunct species. Physiognomy is generally mixed, with varying amounts of shrubs and sometimes with moderate amounts of tree cover, but with a well-developed, dense herbaceous layer and, generally, extensive *Sphagnum* cover. These wetlands generally appear to have a substantial amount of ground water input, and therefore would be considered poor fens in classifications of northern mires.

Subtype covers boggy wetlands of mid elevations, containing many northern plant species but lacking the distinctive flora of the Long Hope Valley area. They are typically above 3000 feet elevation north of Asheville and above 3700 feet south of Asheville.

Distinguishing Features: Southern Appalachian Bogs are distinguished from Southern Appalachian Fen by the absence or scarcity of high pH wetland species, such as *Muhlenbergia glomerata, Triantha glutinosa (= Tofieldia glutinosa),* and *Sphagnum subsecundum*. They are distinguished from French Broad Valley Bogs and Low Mountain Seepage Bogs by floristic differences that include an abundance of northern disjunct species such as *Carex trisperma, Carex buxbaumii, Rhynchospora alba, Filipendula rubra, Dryopteris cristata, Thelypteris simulata, Spiraea alba, Schizachyrium scoparium var. scoparium, Lilium grayi, Pogonia ophioglossoides, Juncus subcaudatus, Ilex collina, Picea rubens, Vaccinium macrocarpon,* and *Micranthes (Saxifraga) pensylvanica*. They lack other species characteristic of French Broad Valley Bogs and Low Mountain Seepage Bogs, including many southern species but also some generally northern species. Species largely or completely lacking in Southern Appalachian Bog include *Sarracenia* spp., *Smilax laurifolia, Eubotrys racemosa (= Leucothoe racemosa), Viburnum nudum, Rhododendron viscosum, Dulichium arundinaceum, Carex collinsii, Helonias bullata, Woodwardia virginica, Woodwardia areolata, Cinna arundinacea, Eryngium integrifolium, Andropogon glomeratus, Fuirena squarrosa, Helianthus angustifolius, Rhynchospora gracilenta, Rhynchospora rariflora, Scleria ciliata, Scleria muehlenbergii, Gratiola pilosa, Xyris jupicai, Polygala cruciata, Drosera capillaris, Saccharum giganteum (= Erianthus giganteus), Eupatorium pilosum, Juncus canadensis,* and *Panicum virgatum*.

Southern Appalachian Bogs are distinguished from High Elevation Boggy Seeps by structural and floristic differences; seeps are moderately to steeply sloped and have a mixture of plants of bogs and of more fertile wetlands. The floristic differences need further clarification. Southern Appalachian Bogs are distinguished from Swamp Forest–Bog Complex by structure and corresponding floristic differences. Swamp Forest–Bog Complexes are persistently forested over most of their area, with boggy herbaceous vegetation generally permanently confined to small patches that are in distinctly wetter microsites. The herbaceous vegetation in these openings is a subset of the flora of bogs, but is much lower in species richness. The vegetation structure of Southern Appalachian Bogs has proved extremely variable and unstable in recent years, but it naturally has larger areas of open herbaceous vegetation. Openings of 1 acre or more in size may be treated as Southern Appalachian Bogs, even if surrounded by Swamp Forest—Bog Comlex. Openings smaller than this may be treated as boggy openings in Swamp Forest–Bog Complex, unless they were naturally larger in the past or contain a diverse bog flora.

The Typic Subtype is distinguished from the Low Elevation Subtype by occurrence at higher elevation (above 3000 feet north of Asheville and above 3700 feet south of Asheville) and by floristic differences that include a greater number and abundance of more “northern” species in the Typic Subtype. Species Wichmann (2009) found more abundant in her equivalent of the Typic Subtype than in the Low Elevation Subtype include *Osmunda cinnamomea, Carex echinata, Hypericum punctatum, Dryopteris cristata, Picea rubens,* and *Salix sericea*. Species more common in the Low Elevation Subtype include *Eriophorum virginicum, Osmunda regalis, Carex atlantica, Carex folliculata, Eriocaulon decangulare,* and *Dichanthelium lucidum*.

The Typical Subtype is distinguished from the Long Hope Valley Subtype by a smaller component of “northern” species and by the absence of characteristic species such as *Taxus canadensis, Menyanthes trifoliata, Lonicera canadensis, Lonicera dioica,* and *Ilex collina*.

Comments: The natural structure and dynamics of Southern Appalachian Bogs remains the subject of much debate. Most examples of all subtypes show a tendency for rapid invasion by shrubs and trees, which can threaten the distinctive shade-intolerant herbaceous flora. Many bogs have changed

drastically in vegetation structure in recent years. Virtually all bogs have a history of past grazing, usually accompanied by clearing of woody vegetation in the bog and the surrounding area. Some bogs have been affected by impoundment by beavers or by man-made ponds. Managers of bogs in conservation have often responded to increases in woody plants by cutting trees and shrubs. Therefore, the appropriate natural vegetation structure for bogs is not known. The presence of a distinctive, apparently conservative, shade-intolerant flora indicates that they are naturally open, while the presence of distinctive woody species indicates that they were not purely herbaceous meadows. The ecological forces that kept bogs open in the past are not known. Periodic beaver impoundment, fire, grazing by large native herbivores, wetness, and competitiveness of undisturbed bog vegetation are all being debated, as is the possibility that bogs were short-lived successional communities that followed beaver ponds.

The classification of bog communities remains one of the most difficult in North Carolina. While they are complex and highly variable communities, the difficulty is increased by the widespread alterations and the lack of examples that are free from them. Wichmann (2009) conducted the only thorough quantitative study on a broad set of these communities. She found the most distinctive vegetation groupings to be those associated with changes. Vegetation disturbed by clearing, grazing, and beaver impoundment, vegetation heavily dominated by shrubs, once-open bogs now dominated by trees, and a depauperate herbaceous type formed strong groups that were not well associated with differences in environment or biogeography. The large number of plots in these categories left a much smaller set to identify underlying characteristic natural patterns that would be more appropriate for classification for conservation purposes. However, groups that are equivalent to the three subtypes recognized here also emerged, and are the basis for many of the distinguishing features. These subtypes also correspond fairly well to those recognized in Weakley and Schafale (1994).

Earlier drafts of the 4th approximation, and the NVC, recognized separate herbaceous and shrub subtypes within what is now treated as the Typic Subtype. These were conceived as zones. Given the reality of the variation and rapid change in shrub cover, this distinction is problematic and potentially misleading for conservation action, and has been dropped. *Alnus serrulata - Kalmia carolina - Rhododendron catawbiense - Spiraea alba / Carex folliculata - Lilium grayi* Shrubland (CEGL003915) and *Rhododendron maximum / Sphagnum* spp. Shrubland (CEGL003849) were the shrub-dominated typic bog associations.

Carex (atlantica, echinata, leptalea, lurida) - Solidago patula Herbaceous Vegetation (CEGL004156) is a broadly defined, depauperate bog association attributed to all of the states neighboring North Carolina. Its concept probably overlaps several North Carolina subtypes, but it is not considered to occur here.

SOUTHERN APPALACHIAN BOG (LOW ELEVATION SUBTYPE) G1G2

Synonyms: *Alnus serrulata - Rhododendron viscosum - Rhododendron maximum / Juncus gymnocarpus - Chelone cuthbertii* Shrubland (CEGL003916). Southern Appalachian Bog (Southern Floodplain Variant), (Southern Appalachian Bog (Low Elevation Variant) (Third Approximation). .
Ecological Systems: Southern and Central Appalachian Bog and Fen (CES202.300).

Concept: Subtype covers bogs of lower elevations and more southerly areas, generally less floristically rich and lacking most northern plants. They are generally below 3000 feet elevation north of Asheville and below 3700 feet south of Asheville.

Distinguishing Features: The Low Elevation Subtype is distinguished from other subtypes by floristic differences. See the Typic Subtype for species more characteristic of each subtype. The French Broad Valley Bog type also occurs as low elevation, and shares more species with the Low Elevation Subtype than with other subtypes. It has a distinct set of species of Coastal Plain affinities, which are largely or completely lacking in the Low Elevation Subtype. However, a few southern examples of the Low Elevation Subtype are intermediate and have some of these species. The French Broad Valley Bog type has been narrowed from earlier usage, and should only be used for examples, mostly near Hendersonville, which have a substantial number of the characteristic species. Other bogs in the upper French Broad and Mills River drainages are treated as the Low Elevation Subtype.

Comments: Weakley and Schafale (1994) recognized a Southern Floodplain subtype. It is not recognized in the 4th approximation. Wichmann (2009) did not find a grouping corresponding to it. Because all southern bogs she sampled fell into one of the categories of altered vegetation, this is not definitive. However, examination of whole-site floristics failed to find any differences related to biogeography or distinctive environmental factors. Almost all southern bogs are at lower elevations and fit this subtype. However, the substantial distance and moderate disjunction of the southern examples makes it possible that biogeographic differences will be found that warrant a distinct subtype.

SOUTHERN APPALACHIAN BOG (LONG HOPE VALLEY SUBTYPE) G1
Synonyms: *Carex atlantica - Rhynchospora alba - Parnassia asarifolia / Sphagnum warnstorfii* Herbaceous Vegetation (CEGL004157).
Ecological Systems: Southern and Central Appalachian Bog and Fen (CES202.300).

Concept: Subtype covers bogs of Long Hope Valley and related high elevation bogs, with a distinctive set of northern disjunct flora that includes species such as *Menyanthes trifoliata, Ilex collina,* and *Taxus canadensis*.

Distinguishing Features: The Long Hope Valley Subtype is distinguished from the Typic and Low Elevation subtypes by floristic differences. It contains a characteristic set of northern disjunct plant species, including *Taxus canadensis, Menyanthes trifoliata, Lonicera canadensis, Lonicera dioica,* and *Ilex collina* and lacks many species of mid to lower elevations.

Comments: The Long Hope Valley Subtype has long been regarded as unique to that site, but should not be regarded as exclusive. Wichmann (2009) found an additional site that fit this group. Wichmann also found that a number of the bogs in Long Hope Valley did not cluster with this subtype but with the group equivalent to the Typic Subtype. However, they overlapped in elevation and location within the valley, and it is unclear if that difference is related to alteration.

Earlier drafts of the 4th approximation, and the NVC, recognized separate herb and shrub subtypes for Long Hope Valley bogs. These have been combined in the 4th approximation. *Rhododendron (maximum, catawbiense) - Ilex collina - Salix sericea / Carex trisperma - Eriophorum virginicum* Shrubland (CEGL003913) is the Long Hope Valley shrub association.

SOUTHERN APPALACHIAN BOG (SKUNK CABBAGE SUBTYPE) G1
Synonyms: *Pinus rigida / Toxicodendron vernix / Gaylussacia baccata / Symplocarpus foetidus* Woodland (CEGL003667).
Ecological Systems: Southern and Central Appalachian Bog and Fen (CES202.300).

Concept: Subtype covers low-diversity examples with *Symplocarpus foetidus* as a significant component.

Distinguishing Features: The Skunk Cabbage Subtype is distinguished by having *Symplocarpus foetidus* present in more than trivial amounts. This type is extremely rare, with only several examples known in North Carolina. The examples are more forested than most Southern Appalachian Bogs. The corresponding NVC association is named as a woodland, and Wichmann (2009) included its sites in a more broadly defined High Elevation Saturated Forest type, along with Swamp Forest–Bog Complex (Spruce Subtype). However, given their rarity and the apparent alteration of all known examples, it is unclear if they are naturally more forested or if this represents uncharacteristic tree encroachment. Further study may lead to this subtype being reclassified as a subtype of Swamp Forest–Bog Complex.

FRENCH BROAD VALLEY BOG G1
Synonyms: *Alnus serrulata - Viburnum nudum var. nudum - Chamaedaphne calyculata / Woodwardia areolata - Sarracenia rubra ssp. jonesii* Shrubland (CEGL003918).
Ecological Systems: Southern and Central Appalachian Bog and Fen (CES202.300).

Concept: Type covers open herb- and shrub-rich acidic wetlands of flat stream bottoms or gentle slopes, containing a distinctive flora that includes species shared with Southern Appalachian Bog, species of Coastal Plain affinities, and some additional species that are scarce or absent in the Southern Appalachian Bog and Low Mountain Seepage Bog types. Such bogs are known only from the upper French Broad River valley in the vicinity of Hendersonville, but do not include all bogs in the French Broad basin. They are considered non-forested, but contain some trees.

Distinguishing Features: The French Broad Valley Bog type is distinguished from Southern Appalachian Bog by floristic differences. Plants present in Southern Appalachian Bogs but not in French Broad Valley Bogs include *Carex trisperma, Carex buxbaumii, Rhynchospora alba, Filipendula rubra, Dryopteris cristata, Thelypteris simulata, Spiraea alba, Schizachyrium scoparium var. scoparium, Lilium grayi, Pogonia ophioglossoides, Juncus subcaudatus, Ilex collina, Picea rubens, Vaccinium macrocarpon,* and *Micranthes* (*Saxifraga) pensylvanica*. The Low Elevation Subtype is the most similar to French Broad Valley Bogs, but it too lacks most of the suite of species of Coastal Plain affinities, such as *Smilax laurifolia, Eubotrys racemosa (= Leucothoe racemosa), Viburnum nudum, Rhododendron viscosum, Dulichium arundinaceum, Carex collinsii, Woodwardia virginica,* and *Woodwardia areolata*. Additional species that are distinct to French Broad Valley Bogs include *Myrica gale, Chamaedaphne calyculata, Gaylussacia orocola (= Gaylussacia dumosa var. bigeloviana),* and *Sarracenia jonesii*.

French Broad Valley Bog is distinguished from Low Mountain Seepage Bog by floristic differences as well as by differences in environment and biogeography. Both contain a number of species of Coastal Plain affinities, but the suite of species is quite different. Besides the species mentioned above that are distinct only to French Broad Valley Bogs, the follow species occur only in Low Mountain Seepage

Bogs: *Sarracenia oreophila, Cinna arundinacea, Eryngium integrifolium, Andropogon glomeratus, Fuirena squarrosa, Helianthus angustifolius, Rhynchospora gracilenta, Rhynchospora rariflora, Scleria ciliata, Scleria muehlenbergii, Gratiola pilosa, Xyris jupicai, Polygala cruciata, Drosera capillaris, Saccharum giganteum (= Erianthus giganteus), Eupatorium pilosum, Juncus canadensis*, and *Panicum virgatum*.

Comments: Previous usage in earlier 4th approximation drafts attributed all bogs in the upper French Broad basin to this type. The type has been narrowed in the final 4th approximation to include only those bogs with a substantial number of the characteristic plants named above, or examples that plausibly once had them. Bogs in the Mills River drainage and most bogs upstream of the Hendersonville valley share some limited flora but are now treated as other types, generally Southern Appalachian Bog (Low Elevation Subtype).

French Broad Valley Bogs were not recognized by Wichmann (2009). This appears to be a result of inadequate sampling rather than true evidence that they are not distinct. The only plots from a French Broad Valley Bog (under the new, narrowed definition) were classified in the altered vegetation types and included few of the distinctive plants.

LOW MOUNTAIN SEEPAGE BOG G1

Synonyms: *Alnus serrulata - Rhododendron arborescens / Sarracenia oreophila - Rhynchospora rariflora* Shrubland (CEGL003914).
Ecological Systems: Southern and Central Appalachian Bog and Fen (CES202.300).

Concept: Type covers non-forested, shrub- or herb-dominated acidic wetlands of low elevation, gentle, seepage-fed slopes, containing a distinct suite of plants that includes numerous Coastal Plain disjuncts but is floristically different from the French Broad Valley Bog type.

Distinguishing Features: Low Mountain Seepage Bogs are distinguished from French Broad Valley Bogs and Southern Appalachian Bogs by substantial floristic differences. Low Mountain Seepage Bogs contain a suite of primarily Coastal Plain disjunct species not found in other mountain wetlands. These include *Sarracenia oreophila, Cinna arundinacea, Eryngium integrifolium, Andropogon glomeratus, Fuirena squarrosa, Helianthus angustifolius, Rhynchospora gracilenta, Rhynchospora rariflora, Scleria ciliata, Scleria muehlenbergii, Gratiola pilosa, Xyris jupicai, Polygala cruciata, Drosera capillaris, Saccharum giganteum (= Erianthus giganteus), Eupatorium pilosum, Juncus canadensis*, and *Panicum virgatum*.

SOUTHERN APPALACHIAN FEN (BLUFF MOUNTAIN SUBTYPE) G1

Synonyms: *Cladium mariscoides - Sanguisorba canadensis / Sphagnum subsecundum* Herbaceous Vegetation (CEGL004167).
Ecological Systems: Southern and Central Appalachian Bog and Fen (CES202.300).

Concept: Type covers primarily herb-dominated wetlands fed by base-rich waters seeping from amphibolite or ultramafic rocks. Subtype covers the floristically distinct example known only from Bluff Mountain.

Distinguishing Features: The Southern Appalachian Fen type is distinguished by the presence or abundance of a suite of calciphilic species of northern affinities, such as *Muhlenbergia glomerata, Triantha glutinosa (= Tofieldia glutinosa),* and *Sphagnum subsecundum,* which are absent or scare in more acidic mountain herbaceous or shrubby wetlands. The Bluff Mountain Subtype is distinguished from the Glades Subtype by floristic differences. These differences are not well defined, as no good examples of the Glades Subtype occur in North Carolina.

Comments: In broader classifications of mires in glaciated regions farther north, this type would likely be considered an intermediate, possibly a rich, fen, while Southern Appalachian Bog and French Broad Valley Bog, which appear to be fed by acidic ground water, would be considered poor fens.

Carex leptalea - Parnassia grandifolia - Rhynchospora alba Herbaceous Vegetation (CEGL004997) is defined from Buffalo Mountain, Virginia, but said to "probably" occur at Bluff Mountain. The basis for this is unclear.

SOUTHERN APPALACHIAN FEN (GLADES SUBTYPE) G1
Synonyms: *Alnus serrulata / Sanguisorba canadensis - Parnassia grandifolia - Helenium brevifolium* Shrubland (CEGL003917). *Alnus serrulata / Sanguisorba canadensis - Calamagrostis canadensis* Shrubland (CEGL004252).
Ecological Systems: Southern and Central Appalachian Bog and Fen (CES202.300).

Concept: Subtype covers the floristically distinct examples from The Glades and adjacent areas of Alleghany County and Virginia. Only a very degraded example occurs in North Carolina, and more intact examples are unlikely to be found.

Distinguishing Features: The Glades Subtype is distinguished from the Bluff Mountain Subtype by floristic differences, but these need further clarification.

Comments: Only one highly degraded example is known from North Carolina. Well developed examples occur in Virginia with a few miles of the state line.

Upland Seepages and Spray Cliffs

SPRAY CLIFF G2
Synonyms: *Vittaria appalachiana - Heuchera parviflora var. parviflora - Houstonia serpyllifolia / Plagiochila* spp. Herbaceous Vegetation (CEGL004302).
Ecological Systems: Southern Appalachian Spray Cliff (CES202.288).

Concept: Type covers communities of rock outcrops kept constantly wet by spray from falling water, sometimes supplemented by seepage. These communities are largely herbaceous, but may contain some shrubs and trees. They are often small, sometimes vertical or nearly so, and may be partially shaded by trees rooted in adjacent forests.

Distinguishing Features: These communities may be distinguished by the presence of spray from falling water. They generally have well-developed bryophyte cover compared with adjacent dry Montane Cliff

communities. They are distinguished from forests by the absence of a closed tree canopy, due to steepness and lack of soil, though they may have substantial shade from trees rooted in adjacent forests.

Comments: This type may warrant division into subtypes. The association above was named based on the typical spray cliffs of the southern escarpment area. The *Spartina pectinata*-dominated spray cliff of Rainbow Falls is the most distinctive. It may be recognized as a Sloughgrass Variant, in contrast to the Typic Variant, and may be worthy of a subtype. Spray cliffs in the northern part of the state may also be different, but this needs more study.

HIGH ELEVATION BOGGY SEEP G2

Synonyms: *Carex gynandra - Platanthera clavellata - Drosera rotundifolia - Carex ruthii - Carex atlantica / Sphagnum* spp. Herbaceous Vegetation (CEGL007697). High Elevation Seep (Third Approximation).
Ecological Systems: Southern Appalachian Seepage Wetland (CES202.317); Southern and Central Appalachian Bog and Fen (CES202.300)?

Concept: Type covers sloping seeps of high elevations, having significant *Sphagnum* development and containing flora shared with Southern Appalachian Bogs. They are generally graminoid-dominated in the center, but some have enough tree or shrub cover to be considered woodlands or shrublands. Additionally, most are small enough that they have substantial cover by trees rooted on the edges. Characteristic species include *Carex gynandra,* a wide variety of other *Carex* spp., *Glyceria striata, Glyceria melicaria, Chelone lyonii,* and *Drosera rotundifolia*.

Distinguishing Features: High Elevation Boggy Seeps are distinguished from Rich Montane Seeps by having *Sphagnum* present and generally by having graminoid-dominated vegetation that includes *Glyceria* spp. or *Carex* species shared with Southern Appalachian Bogs. They generally lack *Rudbeckia laciniata, Laportea canadensis, Monarda didyma,* and *Diphylleia cymosa*. They may contain *Circaea alpina, Impatiens pallida, Oxypolis rigidior,* or *Micranthes* (*Saxifraga) micranthidifolia*. High Elevation Boggy Seeps are distinguished from Southern Appalachian Bogs most readily by topography, generally occurring on a pronounced slope at high elevation, and also by floristic differences.

Comments: These communities are intermediate conceptually between Southern Appalachian Bogs and Montane Rich Seeps, though they are floristically closer to the former. They generally occur at higher elevations than Rich Montane Seeps, usually surrounded or formerly surrounded by Red Spruce–Fraser Fir Forest or by the highest Northern Hardwood Forests. Similar topographic settings and seeps at lower elevation do not have a similarly bog-like character, and it is likely that the high rainfall and low evaporation at high elevations are important to their occurrence. High Elevation Boggy Seeps are best developed in the Great Balsam Mountains, but occur scattered throughout the high mountains of North Carolina.

Wichmann's (2009) *Betula* spp./*Carex ruthii - Avenella flexuosa / Sphagnum* spp. fits this type well.

RICH MONTANE SEEP G3

Synonyms: *Impatiens (capensis, pallida) - Monarda didyma - Rudbeckia laciniata var. humilis* Herbaceous Vegetation (CEGL004293). *Diphylleia cymosa - Saxifraga micranthidifolia - Laportea canadensis* Herbaceous Vegetation (CEGL004296). High Elevation Seep (Third Approximation). Ecological Systems: Southern Appalachian Seepage Wetland (CES202.317).

Concept: Type covers non-boggy seeps, having lush, forb-dominated or sometimes sedge-dominated herb layers and generally lacking *Sphagnum*. They may or may not have trees rooted within the seep, but are generally small enough to be shaded by trees from adjacent forests. They occur as small patches embedded in Rich Cove Forest or Northern Hardwood Forest.

Distinguishing Features: The type is distinguished by saturated soil and an herb layer that includes a combination of the more water-tolerant Rich Cove Forest species along with some distinctive seep species. The characteristic acid-tolerant wetland herbs of the bog communities are absent or scarce and limited to a few species. Any combination of the nominal species in the two associations named above may dominate patches, and several species of *Carex* may also dominate patches.

Comments: Earlier drafts of this guide distinguished two subtypes, a Cove Subtype and a High Elevation Subtype, corresponding to the two associations named above. These subtypes have not proved distinguishable. The nominal species of both may occur in any combination, without any discernable correlation with elevation, often in different small patches in the same seep. A number of *Carex* species may also dominate patches. Wichmann's (2009) *Betula* spp./*Viburnum cassinoides*/*Athyrium asplenioides* type fits this type well. She noted that it was extremely variable and would probably warrant further subdivision with more data, but did not find a pattern matching the two NVC associations that have been lumped here.

LOW ELEVATION SEEP (TYPIC SUBTYPE) G3?

Synonyms: *Acer rubrum var. trilobum / Viburnum nudum var. nudum / Osmunda cinnamomea - Saururus cernuus - Impatiens capensis* Forest (CEGL004426). Rich Foot-slope Seeps (Seymour 2011). Ecological Systems: Piedmont Seepage Wetland (CES202.298).

Concept: Type covers seepage-fed wetlands that lack the distinctive species composition and other characteristics of Hillside Seepage Bog, High Elevation Seep, Rich Montane Seep, or Sandhill Seep. They may occur in any region of the state. Sites include small hollows on slopes, slope breaks, toe slopes, or edges of floodplains. They can be quite small, but have wetland vegetation which contrasts sharply with adjacent communities. Subtype covers examples of the Piedmont and Coastal Plain which occur on lower slopes or edges of bottomlands but not on well-developed floodplains. These are the most typical examples, lacking the distinctive physical and floristic features of the other subtypes. They are fairly common, though they are small and many examples are overlooked.

Distinguishing Features: Low Elevation Seeps are distinguished by abundant wetland vegetation, without the characteristic composition and setting of other seepage wetlands. *Sphagnum* is not generally abundant but may be present in limited amounts. Many species may be shared with Southern Appalachian Bogs and other mountain bog communities, including *Viburnum nudum, Viburnum cassinoides, Impatiens capensis, Osmundastrum (Osmunda) cinnamomeum, Osmunda regalis, Woodwardia areolata*, and *Carex* spp. However, other species indicative of less nutrient-poor conditions, such as *Saururus cernuus, Lycopus virginicus*, and *Lindera benzoin*, are also present. Rich

Montane Seeps share some species but have a number of species not found in this type, such as *Laportea canadensis, Diphylleia cymosa, Rudbeckia laciniata, Micranthes micranthidifolia (= Saxifraga micranthidifolia), Lilium superbum,* and *Lilium grayi*.

The Typic Subtype may be distinguished from the Floodplain Subtype by occurring in uplands or at the heads of small streams, rather than on the edge of larger floodplains. It consequently lacks the admixture of floodplain and alluvial species found in the Floodplain Subtype, such as *Acer negundo, Fraxinus pennsylvanica*, and *Celtis laevigata*, as well as species of wetter areas such as *Peltandra virginica, Sagittaria* spp., and *Cephalanthus occidentalis*.

Comments: This subtype corresponds to the group Seymour (2011) called Rich Foot-slope Seeps, but also includes examples in the Coastal Plain which may be a bit different. Soil analysis and flora indicate that it is more fertile than any other except the Floodplain Subtype, but it too is an acidic wetland that has few or no species characteristic of rich sites.

The NVC association linked to this subtype does not describe the range of vegetation of this type well. In addition, it can be difficult to characterize the vegetation structure of these communities. Examples usually have a tree canopy above them, but often are small enough that most canopy cover comes from upland trees rooted outside of the community. Hence wetland canopy trees are absent. Some other communities with similar vegetation structure are treated as herbaceous vegetation associations rather than forests.

Acer rubrum - Nyssa sylvatica - Magnolia virginiana / Viburnum nudum var. nudum / Osmunda cinnamomea - Woodwardia areolata Forest (CEGL006238) is a seepage swamp of states to the north, primarily in the Coastal Plain. It may be related.

LOW ELEVATION SEEP (MONTANE SUBTYPE) G2G3

Synonyms: *Glyceria striata - Carex gynandra - Chelone glabra - Symphyotrichum puniceum / Sphagnum* spp. Herbaceous Vegetation (CEGL008438).
Ecological Systems: Southern Appalachian Seepage Wetland (CES202.317).

Concept: Type covers seepage-fed wetlands that are not attributable to other distinctive types such as Southern Appalachian Bog, High Elevation Boggy Seep, Rich Montane Seep, or Sandhill Seep. They are typically on edges of bottomlands or in small recesses on lower slopes. They can be quite small, but have wetland vegetation which contrasts sharply with adjacent communities. Subtype covers examples of the Mountains and upper Piedmont, containing montane flora and occurring on slopes, in small streamheads, or along small cove bottoms.

Distinguishing Features: The type is distinguished by saturated soil and be a wetland flora that includes species tolerant of saturated conditions that are intermediate in nutrient levels between the distinctive acid-tolerant species of Southern Appalachian Bogs and those of Rich Montane Seeps. The Montane Subtype is distinguished by floristic differences, with the presence of species that are scarce or absent in Piedmont seeps, such as *Micranthes (Saxifraga) micranthidifolia, Houstonia serpyllifolia,* and *Thalictrum clavatum*. It is distinguished from the Floodplain Subtype by not occurring in a medium to large floodplain, lacking evidence of flooding, and by lacking the characteristic species of that subtype.

Comments: These communities are poorly studied. Few examples are recorded, but they likely are overlooked because of their small size and occurrence at lower elevations.

The association (CEGL008438) synonymized with the subtype is problematic. It was described as a "poorly developed bog", and linked to Swamp Forest–Bog Complex. However, its description is not characteristic of bogs or Swamp Forest–Bog Complex, and many of the plants described, especially *Glyceria striata*, are found in seeps. It may thus not be typical of the range of Low Elevation Seeps. Another association may need to be defined.

Defining the structure of this type is problematic. Patches tend to be small, and often are largely shaded by trees rooted in adjacent communities, in combination with only a few trees rooted in the seep. The association for this subtype is named as herbaceous vegetation, while those synonymized to other subtypes are named as a forests, but the vegetation structure is very similar.

LOW ELEVATION SEEP (BEDROCK SUBTYPE)
Synonyms: Oxypolis rigidior – Drosera rotundifolia – Platanthera clavellata – Rhexia mariana var. mariana Seep Herbaceous Vegetation (CEGL007043). Cataract Bog (various usages).
Ecological Systems: Southern Appalachian Seepage Wetland (CES202.317).

Concept: Subtype covers large seeps in shallow soil over smooth bedrock, such as the edges of granitic domes or along bedrock stream courses.

Distinguishing Features: The Bedrock Subtype is distinguished from other subtypes by occurring on shallow soil over smooth bedrock and having a distinctive flora that includes some bog species. Small seepage patches are common in various rock outcrop communities and in Spray Cliffs, but this subtype is reserved for larger patches that are well-differentiated from the adjacent community and have a substantial wetland flora. Examples should be at least several meters wide and tens of meters long, and species such as *Drosera rotundifolia, Oxypolis rigidior, Andropogon glomeratus,* wetland orchids, or other Coastal Plain disjunct species or mountain bog species should be present.

Comments: Distinctive bedrock seepage communities called cataract bogs are known in the Blue Ridge escarpment in South Carolina, and are important habitat for several rare plant species. North Carolina's bedrock seeps appear to be of similar size but are less diverse and do not contain rare plants. However, examples with fairly diverse flora that includes regionally rare species and species of Coastal Plain affinities are known. These communities have not been widely explored in North Carolina, and additional information may lead to modification of the classification. They are closely tied to rock outcrop communities, and it is unclear if Low Elevation Seep is the best community type to place them in.

LOW ELEVATION SEEP (PIEDMONT/MOUNTAIN SPRINGHEAD SUBTYPE) G2
Synonyms: *Acer rubrum / Viburnum nudum - Photinia pyrifolia / Smilax laurifolia / Carex debilis var. pubera* Seepage Forest (CEGL007041). Infertile Swampy Seeps (Seymour 2011).
Ecological Systems: Piedmont Seepage Wetland (CES202.298). Southern Appalachian Seepage Wetland (CES202.317).

Concept: Subtype covers examples of very acidic seeps of the upper Piedmont and Mountains, with a component of Coastal Plain species such as *Nyssa biflora, Viburnum nudum*, and *Smilax laurifolia*. They occur along small streams or on toe slopes near larger floodplains. These communities appear to be rare.

Distinguishing Features: This subtype is distinguished from all other subtypes by the combination of wetland flora more characteristic of the Coastal Plain with saturated wetlands in the upper Piedmont or Mountains, while lacking the distinctive flora of Hillside Seepage Bog, French Broad Valley Bog, Low Mountain Seepage Bog, and Southern Appalachian Bog, and not occurring in larger floodplains. It is most similar to the Typic Subtype. Seymour (2011) found no geographic overlap, with the Typic Subtype occurring only further east, but it is possible that examples of the Typic Subtype could be found in the western Piedmont. Species that tend to occur in this subtype but not in the Typic Subtype include *Viburnum nudum var. nudum, Aronia arbutifolia, Alnus serrulata, Smilax laurifolia,* and *Ilex opaca*. Species indicative of the Typic Subtype and scarce or absent in this subtype include *Arisaema triphyllum, Saururus cernuus, Boehmeria cylindrica,* and *Carpinus caroliniana*.

Wetlands that are known to once have had more distinctive open bog herbs typical of the Hillside Seepage Bog type, such as *Sarracenia flava, Sarracenia purpurea,* and *Helenium brevifolium,* should be treated as degraded Hillside Seepage Bogs rather than as this subtype.

Comments: The communities in this subtype have been extremely difficult to classify in previous classifications, and have variously been called Hillside Seepage Bog, Southern Appalachian Bog, Piedmont Boggy Streamhead, and Low Elevation Seep. Seymour (2011) identified this as one of five distinct types of Piedmont seeps. Its vegetation grouped most closely with the less acidic and more widespread seeps of lower slopes (the Typic Subtype), but was distinctly more acidic and nutrient-poor. It is also distinctive in occurring in the upper Piedmont but having characteristically Coastal Plain species that are lacking in most eastern Piedmont seeps (but many of which are present in French Broad Valley Bogs). Seymour (2011) included the Piedmont *Sagittaria fasciculata* sites of South Carolina with this group, but the distinctly more diverse flora of those sites may warrant recognition as a different subtype. She also included a number of sites in Iredell County which are known to be degraded examples of Hillside Seepage Bogs that have lost most of their characteristic open bog flora. Their settings are a bit different, however, and they are better not treated as this subtype.

LOW ELEVATION SEEP (FLOODPLAIN SUBTYPE) G4

Synonyms: *Acer rubrum* / *Alnus serrulata – Lindera benzoin* / *Glyceria striata – Impatiens capensis –* Forest (CEGL007031). Floodplain Seep (Seymour 2011).
Ecological Systems: Southern Piedmont Seepage Wetland (CES202.298). Southern Appalachian Seepage Wetland (CES202.317).

Concept: Subtype covers seepage-fed wetlands on the edge of medium to large floodplains, where upland seepage dominates hydrology but where flooding, alluvial deposition, blocking of drainage by alluvial landforms, or beaver impoundment are also influences.

Distinguishing Features: The Floodplain Subtype generally is readily distinguished by the physical environment, which has at least occasional flooding as well as seepage. It general has alluvial soils. These communities are distinct floristically. Species frequent in the Floodplain Subtype and seldom in other seepage wetlands include *Cinna arundinacea, Persicaria sagittata, Carex tribuloides, Carex*

laevivaginata, *Carex lurida*, *Impatiens capensis*, species of wetter areas such as *Peltandra virginica*, *Sagittaria* spp., and *Cephalanthus occidentalis*, and floodplain species such as *Acer negundo*, *Fraxinus pennsylvanica*, and *Betula nigra*. They also tend to have non-native species characteristic of floodplains and scarce in uplands, including *Microstegium vimineum*, *Murdannia keisak*, and *Persicaria longiseta*. Other species that are often dominant and that are most common in the Floodplain Subtype (compared to other subtypes) include *Boehmeria cylindrica*, *Glyceria striata*, *Saururus cernuus*, *Leersia oryzoides*, and *Lindera benzoin*. Species seldom found in the Floodplain Subtype include *Vaccinium fuscatum*, *Viburnum nudum*, *Ilex opaca*, *Osmunda cinnamomea*, *Osmunda regalis*, *Platanthera* spp,, *Arisaema triphyllum*, *Viola primulifolia*, and *Woodwardia areolata*.

Comments: This subtype may occur in all three physiographic provinces of the state. It is rare in the Mountains and is either rare or overlooked in the Coastal Plain. Piedmont and Mountain variants should be recognized, and may prove distinctive enough to be recognized as subtypes in the future.

This subtype lies at the conceptual border between non-alluvial seepage wetlands and floodplain communities. It appears that seepage is the more important influence, and hence it is placed with the other seeps. Seymour (2011) found this to be the most distinctive of her five types of Piedmont seeps, in analysis of plot data from other Low Elevation Seeps, Hillside Seepage Bogs, and Piedmont Boggy Streamheads. Recognition as a full type rather than a subtype may be appropriate, but a large number of species are shared with other subtypes of Low Elevation Seep, especially the Typic Subtype.

These communities are particularly subject to degradation by invasive plants. Many examples have heavy cover of *Microstegium vimineum*, *Lonicera japonica*, or *Murdannia keisak*. Several extensive, very wet, marsh-like communities that have been called Piedmont Fens are included here. They need further study to clarify their ecological character.

HILLSIDE SEEPAGE BOG G2

Synonyms: *Acer rubrum var. trilobum / Morella caroliniensis - Gaylussacia frondosa / Andropogon glomeratus - (Sarracenia flava)* Woodland (CEGL004781). Headwater Boggy Seep (Seymour 2011). Ecological Systems: Piedmont Seepage Wetland (CES202.298).

Concept: Covers gently sloping wetlands of the Piedmont that have a distinctive acid-loving flora that generally includes *Sarracenia flava* or *Sarracenia purpurea*, along with other herbaceous species of Coastal Plain affinities.

Distinguishing Features: Hillside Seepage Bogs share many plants with Piedmont Boggy Streamheads, including *Sphagnum*, *Smilax laurifolia*, *Osmundastrum (= Osmunda) cinnamomeum*, or *Osmunda regalis*. They are distinguished from Piedmont Boggy Streamheads as well as from Low Elevation Seep by occurring in more isolated upland locations, having more seepage but less influence by flowing water, and by having a more boggy, acid-tolerant, herbaceous flora. *Sarracenia flava* or *Sarracenia purpurea* are good indicators of this type, but are not always present. When examples are burned, a variety of other distinctive herbaceous species are present, including *Symphyotrichum dumosum (= Aster dumosus)*, *Rhexia mariana*, *Danthonia sericea*, *Eupatorium leucolepis*, and *Drosera brevifolia*. Piedmont Boggy Streamheads lack most of these species, though they share many woody wetland species, including many of Coastal Plain affinities. They also contain a few more widespread floodplain

species such as *Lindera benzoin* and *Xanthorhiza simplicissima*, as well as upland species such as *Quercus alba* and *Liriodendron tulipifera*.

Low Elevation Seep (Piedmont/Mountain Springhead Subtype) shares many woody species of Coastal Plain affinities with this type, such as *Viburnum nudum* and *Smilax laurifolia,* but lacks the distinctive herbaceous species. It is known only from the upper Piedmont and Mountains, while Hillside Seepage Bogs are known only from the middle and lower Piedmont. When Hillside Seepage Bogs have been degraded by woody encroachment related to lack of fire and to hydrologic alteration, they may come to resemble the Piedmont/Mountain Springhead Subtype or Piedmont Boggy Streamhead. However, sites that are known to have once harbored the more distinctive herbaceous species should be regarded as degraded Hillside Seepage Bogs rather than as one of the other kinds of communities.

Other subtypes of Low Elevation Seep share some wetland species with Hillside Seepage Bogs, but are less similar. Species such as *Arisaema triphyllum ssp. triphyllum, Glyceria striata, Boehmeria cylindrica*, and *Saururus cernuus* are Low Elevation Seep species not characteristic of this type. Low Mountain Seepage Bogs share a similar topographic and hydrologic setting with Hillside Seepage Bogs, along with sharing some species, but their location in the western Mountains leads to a substantially different flora.

Comments: Hillside Seepage Bogs occur in two clusters, one in Iredell County and the other in the Uwharrie Mountains area (Montgomery and Randolph County). These are recognized as variants, and may warrant eventual recognition as subtypes.

Seymour (2011), in her study of Piedmont seep vegetation, recognized a Headwater Boggy Seep type that corresponded to Hillside Seepage Bogs. It was more narrowly defined, encompassing only two of the sites that have been recognized as Hillside Seepage Bogs grouped in it. This appears to be because these bogs had been burned, promoting a more diverse herbaceous flora that stood out, while the loss of distinctive flora in the degraded examples made them indistinguishable in analysis from Low Elevation Seeps. Nevertheless, for Natural Heritage purposes, sites that are known to have once had pitcher plants or other distinctive bog plants should be regarded as degraded Hillside Seepage Bogs. Seymour (2011) found this to be the most acidic and infertile of her five groups of Piedmont seep communities, but with soils high in clay.

These communities have suffered tremendous degradation and loss over recent decades. A number of sites that were known as bogs with pitcher plants and rare plant species have become densely forested and have lost their distinctive herbaceous flora. In many bogs of the Iredell County variant, this appears to have accompanied entrenchment or headward erosion of adjacent streams, which has altered hydrology. But in the Uwharrie variant, increase of woody vegetation appears to have occurred without hydrologic alteration. The few bogs that remain diverse communities with abundant herbaceous vegetation in the Uwharries are those that have had prescribed burning. It appears that fire is needed to maintain Hillside Seepage Bogs, at least in the Uwharrie variant.

PIEDMONT BOGGY STREAMHEAD G2G3

Synonyms: *Acer rubrum var. trilobum - Liriodendron tulipifera / Ilex opaca var. opaca / Osmunda cinnamomea* Forest (CEGL004551). Streamhead Seep (Seymour 2011).
Ecological Systems: Piedmont Seepage Wetland (CES202.298).

Concept: Type covers seepage areas along small headwater streams (generally intermittent or 1st to 2nd order), and occasional other seepage wetlands far from lower slopes or larger streams, which lack the characteristics of Hillside Seepage Bogs. Known examples are all in the eastern and central Piedmont, geographically separated from the Upper Piedmont Springhead Subtype. Vegetation is a mix of widely-tolerant acidic seepage species and of species shared with Piedmont Headwater Stream Forests and uplands, often with some characteristic Coastal Plain species.

Distinguishing Features: This type is distinguished from other seepage wetland communities by occurring in upland or headwater settings while lacking the characteristic species of Hillside Seepage Bogs, such as *Sarracenia flava* and *Sarracenia purpurea*. Wetlands that have been known once to have had more distinctive open bog herbs typical of the Hillside Seepage Bog type, such as *Sarracenia flava, Sarracenia purpurea,* and *Helenium brevifolium*, should be treated as degraded Hillside Seepage Bogs rather than as this type.

Piedmont Boggy Streamhead is distinguished from Low Elevation Seep by a more upland setting and by floristic differences. Species characteristic of this type but scarce or absent in Low Elevation Seeps include *Osmunda regalis, Eubotrys racemosa, Vaccinium fuscatum, Vaccinium formosum, Cyrilla racemiflora,* and *Smilax laurifolia*. More species are shared with the Piedmont/Mountain Springhead Subtype of Low Elevation Seep than with the other subtypes (e.g., *Vaccinium* spp., *Viburnum nudum, Ilex opaca, Smilax laurifolia, Woodwardia areolata*). However, Piedmont/Mountain Springheads tend to lack other characteristic species such as *Liquidambar styraciflua, Eubotrys racemosa, Osmunda regalis, Morella caroliniensis (= Myrica heterophylla), Cyrilla racemiflora, Gaylussacia frondosa, Pinus taeda*, and *Chasmanthium laxum*. They tend to have species such as *Alnus serrulata, Ilex verticillata, Decumaria barbara,* and *Carex allegheniensis* that are absent in Piedmont Boggy Streamheads. There is also a geographic separation. No Piedmont Boggy Streamheads (as defined here) are known from the western Piedmont or Mountains. (Some communities in the western Piedmont were previously called Piedmont Boggy Streamheads). Other subtypes of Low Elevation Seep have greater floristic differences, including a number of additional species such as *Saururus cernuus, Boehmeria cylindrica, Arisaema triphyllum, Leersia* spp., *Glyceria striata, Acer negundo, Fraxinus pennsylvanica, Celtis laevigata, Peltandra virginica, Sagittaria* spp., and *Cephalanthus occidentalis*).

Piedmont Boggy Streamheads occur along headwater streams, and can show some evidence of flowing water. They are distinguished from Piedmont Headwater Stream Forest by a greater proportion of seepage wetland species and a scarcity of upland species. Many of the species are shared, including *Osmundastrum (Osmunda) cinnamomeum* and *Viburnum nudum*, but are minor components in Piedmont Headwater Stream Forest.

Comments: The Piedmont Boggy Streamhead was not recognized in the 3rd Approximation, but was recognized and tracked shortly thereafter. Definition of the conceptual boundary with Hillside Seepage Bog has always been difficult because of the loss of herbaceous flora in many Hillside Seepage Bogs. Some examples may remain ambiguous. However, analysis by Seymour (2011) found this to be a distinct group of communities, and its retention as a type seems appropriate. These communities are rare.

COASTAL PLAIN SEEPAGE BANK G4
Synonyms: *Pallavicinia lyellii - Sphagnum* sp. Nonvascular Vegetation (CEGL004779). Little River Seepage Bank.
Ecological Systems:

Concept: Type covers rare communities of very steep clay banks along Coastal Plain rivers, dominated by liverworts, mosses, and only sparse vascular plants.

Distinguishing Features: Coastal Plain Seepage Banks are distinguished from cliff communities by having a substrate composed primarily of dense clay which is permanently or semi-permanently wetted by seepage, and by having predominantly wetland plants. *Viola primulifolia* appears to be the most common vascular plant. Cliff communities may have local saturated seepage zones, but these are limited in extent and tend to support denser vegetation. Edges of this community may have sandy soil which is also saturated and supports wetland shrubs.

Comments: This community type was not known in 1990 and had no close equivalent in the 3rd Approximation. Originally known only from the Little River, this community occurs primarily along the deeply entrenched western tributaries of the middle Cape Fear River in the Sandhills and adjacent Coastal Plain. However, several examples are known from elsewhere in the Coastal Plain, and more should be sought. Along the Little River, they support regionally rare species such as *Drosera rotundifolia*. Communities considered to be the same type are also known from Mississippi and Texas, and may occur in between. They are largely overlooked, but appears to also be genuinely rare.

Piedmont and Mountain Upland Pools and Depressions

UPLAND DEPRESSION SWAMP FOREST G2G3
Synonyms: *Quercus phellos / Carex (albolutescens, intumescens, joorii) / Climacium americanum* Forest (CEGL007403).
Ecological Systems: Piedmont Upland Depression Swamp (CES202.336).

Concept: Type covers forested isolated wetlands in depressions on upland ridges and flats with impeded soil drainage, where water stands for part of the year but wetness is not great enough to prevent a closed tree canopy from developing. They occur on unusually flat areas with hardpan soils derived from mafic rocks or slates, or in small topographic basins on ridgetops of volcanic rock. The forests are usually dominated by *Quercus phellos*, sometimes codominant with or replaced by *Quercus lyrata, Quercus bicolor, Quercus michauxii*, or *Liquidambar styraciflua*. Successional examples may be dominated by *Acer rubrum* or *Liquidambar styraciflua*.

Distinguishing Features: The Upland Depression Swamp Forest type is distinguished from Upland Pool by having (or potentially having, if recently disturbed) a closed canopy across the basin, and therefore lacking shade-intolerant shrubs and herbs. Upland Pools may have trees on the edge but lack them in the center and have a much less diverse flora because of the long hydroperiod.

Upland Depression Swamp Forests are distinguished from floodplain forests of various kinds by their isolated upland location and lack of channel flow or overbank flooding, which is indicated by the lack of most characteristic bottomland trees, the usual predominance of *Quercus phellos,* and the usual presence of *Sphagnum lescurii* and *Climacium americanum*. Ambiguous and transitional examples are possible

where small streams originate in upland flats. Piedmont Headwater Stream Forest (Hardpan Subtype) occurrences may be dominated by *Quercus phellos*, and have sometimes been called Upland Depression Swamp Forests in the past, but have a visible channel and have a more diverse flora that includes floodplain species.

Comments: *Liquidambar styraciflua - Acer rubrum / Carex* spp. - *Sphagnum* spp. Forest (CEGL007388) was a problematic association that was attributed to a single Upland Depression Swamp in North Carolina as well as depressional wetlands elsewhere. Further examination of the North Carolina example found it not to be a natural Upland Depression Swamp, and the association was removed from North Carolina. *Liquidambar styraciflua* is often present in Upland Depression Swamp Forests, and sometimes comes to dominate or codominate after major disturbances such as logging. These are better viewed as degraded examples of this association than as a different community type.

Seymour (2011) identified four different groups of Upland Depression Swamp communities, divided by wetness and by rock substrate: wet felsic, dry felsic, wet mafic, and dry mafic. The strongest vegetational differences were between drier and wetter swamp communities. However, these differences consisted largely of the presence of a few upland species, such as *Danthonia spicata* and *Quercus alba*, that may be ecotonal, confined to drier microsites, or short-lived. Differences between felsic and mafic substrates were slightly less but may be more worthy of recognition for our purposes. Mafic depressions had some species that are associated with other mafic-substrate communities, such as *Fraxinus* sp., *Ulmus americana, Ulmus alata,* and *Trachelospermum difforme*. Felsic depressions had a few species that are recognizable as acid-tolerant, such as *Sphagnum* sp. and *Vaccinium* spp., but differences in other distinguishing species such as *Liquidambar styraciflua* and *Acer rubrum* are probably coincidental. Plot samples and soil analysis in comparable communities in Virginia found that even mafic depressions are strongly acidic. Seymour (2011) also found this, but found differences in soil texture, cation exchange capacity, calcium, magnesium, and other cations. These four types may be recognized as variants, but at present do not appear marked enough to warrant defining as subtypes.

Additional variation occurs in canopy dominance. Examples dominated by *Quercus lyrata* or by *Quercus bicolor* may be recognized as additional variants divided from the wet mafic variant, and the one example dominated by *Quercus michauxii* may be recognized as a variant divided from the dry mafic variant. It appears that all examples with different canopy dominants occur on mafic substrate. While *Quercus phellos* is usually present in them, it generally is distinctly subordinate.

UPLAND POOL (TYPIC PIEDMONT SUBTYPE) G1

Synonyms: *Cephalanthus occidentalis - (Leucothoe racemosa) / Carex joorii* Shrubland (CEGL004075). *Carex joorii* Pools (Seymour 2011).
Ecological Systems: Piedmont Upland Depression Swamp (CES202.336).

Concept: Type covers depression wetlands not associated with rivers or streams, holding water long enough through the growing season to present development of a substantial tree canopy. Trees are limited to the edge of the basin. Subtype covers the most typical and widespread Piedmont examples, which lack the distinctive Coastal Plain flora of the Pleasant Grove and Roberdo subtypes.

Distinguishing Features: Upland Pools are distinguished from Upland Depression Swamp Forests by the lack of a well-developed tree canopy. Some trees may be present, scattered in the pool or forming an

edge zone within the wetland. The pool may also be partly shaded by trees from adjacent forests, but should have sufficient light to allow shade-intolerant plants to survive.

The Typic Piedmont Subtype is distinguished from the Pleasant Grove and Roberdo subtypes by the absence of the characteristic Coastal Plain species that distinguish them - *Nyssa biflora, Cyrilla racemiflora,* and *Smilax walteri*. It is distinguished from the Mountain Subtype by the absence of the characteristic Blue Ridge components of the flora, as well as occurrence in the eastern or central Piedmont.

Comments: Seymour (2011) noted that, while *Carex joorii* usually strongly dominated the herb layer, the absence of other species was more characteristic than the presence of *Carex joorii*. She found this to be the most distinctive of the five Piedmont depression wetland types she identified; however the single plots for the Pleasant Grove and Roberdo subtypes were removed as outliers.

UPLAND POOL (PLEASANT GROVE SUBTYPE) G1
Synonyms: *Nyssa biflora / Cephalanthus occidentalis - Leucothoe racemosa* Forest (CEGL004550).
Ecological Systems: Piedmont Upland Depression Swamp (CES202.336).

Concept: Subtype covers the distinctive example with strong concentric zonation, *Nyssa biflora*-dominated edge zone, and high Coastal Plain affinities to the flora. This subtype is currently known only from Pleasant Grove Bog in Uwharrie National Forest, but discovery of additional examples in the eastern Piedmont is possible.

Distinguishing Features: The Pleasant Grove Subtype is distinguished by the presence of substantial concentric zonation, with *Nyssa biflora* dominating the edge, and by overall vegetation of deciduous wetland species more typical of the Coastal Plain.

UPLAND POOL (ROBERDO SUBTYPE) G1?
Synonyms: *Leucothoe racemosa - Vaccinium fuscatum - Smilax walteri* Shrubland (CEGL004533).
Ecological Systems: Piedmont Upland Depression Swamp (CES202.336).

Concept: Subtype covers the distinctive example with a more “pocosin-like” character, with a substantial component of evergreen Coastal Plain shrubs and greenbriers.

Distinguishing Features: The Roberdo Subtype is distinguished by the substantial presence of evergreen shrubs such as *Cyrilla racemiflora,* and of *Smilax*.

UPLAND POOL (MOUNTAIN SUBTYPE) G1Q
Synonyms: *Scirpus cyperinus - Dulichium arundinaceum / Sphagnum* spp. Herbaceous Vegetation (CEGL004134).
Ecological Systems: Piedmont Upland Depression Swamp (CES202.336).

Concept: Type covers depression wetlands not associated with rivers or streams, holding water long enough through the growing season to prevent development of a substantial tree canopy. Subtype covers the rare examples known in the Blue Ridge.

Distinguishing Features: Upland Pools are distinguished from Upland Depression Swamps by lack of a well-developed tree canopy. The pool may be partly shaded by trees from adjacent forests, but should have sufficient light to allow shade-intolerant plants to survive. The Mountain Subtype has some plants more typical of lowlands, such as *Dulichium arundinaceum,* but lacks *Cephalanthus occidentalis* and does not have as well-developed a Coastal Plain flora as Piedmont examples have.

Coastal Plain Nonalluvial Wetland Forests

NONRIVERINE WET HARDWOOD FOREST (OAK FLAT SUBTYPE) G2

Synonyms: *Quercus michauxii - Quercus pagoda / Clethra alnifolia - Leucothoe axillaris* Forest (CEGL007449).

Ecological Systems: Southern Atlantic Coastal Plain Nonriverine Swamp and Wet Hardwood Forest (CES203.304).

Concept: Type covers wetland forests of nonalluvial mineral soil flats not underlain by limestone, dominated by combinations of wetland oaks and other wetland hardwoods. Subtype covers the more mesic (though still wet) examples, containing *Quercus michauxii, Quercus pagoda, Liquidambar styraciflua,* or other species but not dominated by *Nyssa biflora* and *Quercus laurifolia.*

Distinguishing Features: The Nonriverine Wet Hardwood Forest type is distinguished by the dominance or substantial presence of bottomland oaks in sites remote from rivers and not subject to overland flooding. The dominance of the shrub layer by *Leucothoe axillaris* or *Clethra alnifolia* also distinguishes them from Brownwater Bottomland Hardwoods and most Blackwater Bottomland Hardwoods. The canopy composition also distinguishes them from Blackwater Bottomland Hardwoods. Nonriverine Wet Hardwood Forests are distinguished from Nonriverine Swamp Forests, which may occur in similar settings and are sometimes associated, by the presence of oaks or *Liquidambar*, the lack of *Taxodium*, and except in the Oak—Gum Slough Subtype, the absence of *Nyssa*. Disturbed examples of either may become strongly dominated by *Pinus taeda, Acer rubrum,* or *Liquidambar styraciflua,* and may be distinguishable only by undergrowth.

The Oak Flat Subtype is distinguished by a canopy containing *Quercus michauxii, Quercus pagoda*, or a mixture of oaks rather than dominated by *Quercus laurifolia* and *Nyssa biflora*.

Comments: A few examples contain other species of wetland oaks. Though these communities can become strongly dominated by *Liquidambar* if they are clearcut, it is possible that some naturally *Liquidambar*-dominated examples occur.

NONRIVERINE WET HARDWOOD FOREST (OAK-GUM SLOUGH SUBTYPE) G2G3

Synonyms: *Quercus laurifolia - Nyssa biflora / Clethra alnifolia - Leucothoe axillaris* Forest (CEGL007447).

Ecological Systems: Southern Atlantic Coastal Plain Nonriverine Swamp and Wet Hardwood Forest (CES203.304).

Concept: Subtype covers the wetter examples, usually in swales or incipient drainage systems, dominated by *Quercus laurifolia*, often with abundant *Nyssa biflora*. These examples are transitional to Nonriverine Swamp Forest.

Distinguishing Features: The Oak-Gum Slough Subtype is distinguished by the dominance of *Quercus laurifolia* and *Nyssa biflora*, usually with only minor amounts of *Quercus michauxii* or *Quercus pagoda*.

Comments: There are fewer records for this subtype than for the Oak Flat Subtype. It may, however, be overlooked. It is generally associated with the Oak Flat Subtype and is less extensive.

Quercus pagoda - Quercus michauxii - Quercus alba / Arundinaria gigantea ssp. *tecta - Sabal minor / Chasmanthium laxum* Forest (CEGL007849) is a similar community of South Carolina and Georgia. *Quercus phellos - Nyssa biflora / Panicum hemitomon - Carex* spp. *- Woodwardia virginica* Forest (CEGL004104) is a more pond-like community of South Carolina.

WET MARL FOREST G1

Synonyms: *Carya cordiformis - Quercus pagoda - Quercus shumardii - Carya myristiciformis / Sabal minor - Cornus asperifolia* Forest (CEGL007316).
Ecological Systems: Southern Atlantic Coastal Plain Nonriverine Swamp and Wet Hardwood Forest (CES203.304).

Concept: Perched wetland forest of nonalluvial flats shallowly underlain by limestone, dominated by calciphilic and rich-site wetland hardwood forest species, particularly *Carya myristiciformis*.

Distinguishing Features: Wet Marl Forests may be distinguished from Nonriverine Wet Hardwood Forests by the limestone-derived, calcareous soils and the strong presence of calciphilic plant species such as *Carya myristiciformis, Tilia americana var. caroliniana,* and *Cornus asperifolia,* along with an abundance of other species of rich sites such as *Carya cordiformis, Quercus shumardii, Acer floridanum, Acer negundo, Cercis canadensis,* and *Sabal minor*. Wet Marl Forests are distinguished from Coastal Plain Marl Outcrop and Basic Mesic Forest by their occurrence on poorly drained flats and by the abundance of wetland species. The only example known to remain is at Rocky Point Marl Forest.

Comments: This type is endemic to North Carolina. Although South Carolina has a community type called Marl Forest, it is an upland community more akin to our Basic Mesic Forest.

NONRIVERINE SWAMP FOREST (CYPRESS-GUM SUBTYPE) G2G3

Synonyms: *Taxodium distichum - Nyssa biflora / Berchemia scandens - Toxicodendron radicans / Woodwardia areolata* Forest (CEGL004429).
Ecological Systems: Southern Atlantic Coastal Plain Nonriverine Swamp and Wet Hardwood Forest (CES203.304).

Concept: Type covers the wettest, saturated to shallowly flooded, nonriverine wetlands, with canopies dominated by combinations of *Nyssa biflora, Taxodium distichum,* and *Acer rubrum*. Subtype covers the wettest examples, with canopies of *Taxodium distichum, Nyssa biflora, Nyssa aquatica,* and *Fraxinus*

spp. Ground water input as well as poor drainage may be responsible for the wetness of this subtype, and minerals in ground water may give it some of its distinctive character. This subtype is most like riverine swamps in flora and vegetation structure.

Distinguishing Features: Nonriverine Swamp Forests are distinguished from Cypress-Gum Swamps and Tidal Cypress-Gum Swamps by occurring on wet flats or basins away from the influence of rivers.

The Cypress-Gum Subtype is distinguished by strong dominance by *Taxodium distichum* or *Nyssa* spp. In known examples this is associated with composition more similar to river swamps and a smaller component of pocosin shrubs than in other subtypes.

Comments: This subtype is the rarest. It should probably be ranked G2.

Acer rubrum var. *trilobum - (Nyssa biflora) / Clethra alnifolia - (Persea palustris)* Forest (CEGL007445) is a successional version of all Nonriverine Swamp Forests.

NONRIVERINE SWAMP FOREST (MIXED SUBTYPE) G2G3

Synonyms: *Pinus taeda - Chamaecyparis thyoides - Acer rubrum - Nyssa biflora / Lyonia lucida - Clethra alnifolia* Forest (CEGL007558).
Ecological Systems: Southern Atlantic Coastal Plain Nonriverine Swamp and Wet Hardwood Forest (CES203.304).

Concept: Subtype covers examples with moderate to deep organic soil, dominated by a mixture of hardwoods and conifers that includes *Pinus taeda, Chamaecyparis thyoides*, or *Pinus serotina*, as well as the typical dominants.

Distinguishing Features: The Mixed Subtype is distinguished from other subtypes by having *Pinus taeda* or *Chamaecyparis thyoides* as substantial components, in addition to *Nyssa, Taxodium*, and *Acer*. This subtype often resembles Pond Pine Woodland and Peatland Atlantic White Cedar Forest in the lower strata, but differs in the canopy. Peatland Atlantic White Cedar Forests that have been logged and have not regenerated well are indistinguishable from poor quality examples of this subtype.

Comments: Much of this subtype occurs on deep organic soils that appear similar to those of pocosins. What causes the difference in community is not entirely clear. Intermittent mineral input by wind tides and differences in fire regime have both been suggested. This subtype often occurs with embedded patches of Peatland Atlantic White Cedar Forest, sometimes also Bay Forest and Pond Pine Woodland. It is possible that these communities exist as a long-term shifting mosaic with current condition determined by fire history.

Heavily logged examples may return as the successional *Acer rubrum* var. *trilobum - (Nyssa biflora) / Clethra alnifolia - (Persea palustris)* Forest (CEGL007445) or as a secondary bay forest (*Magnolia virginiana - Persea palustris / Lyonia lucida* Forest (CEGL007049)).

NONRIVERINE SWAMP FOREST (POPLAR-PAWPAW SUBTYPE) G2
Synonyms: *Nyssa biflora - Acer rubrum var. trilobum - Liriodendron tulipifera / Magnolia virginiana - Asimina triloba / Clethra alnifolia* Forest (CEGL004428).
Ecological Systems: Southern Atlantic Coastal Plain Nonriverine Swamp and Wet Hardwood Forest (CES203.304).

Concept: Subtype covers examples on shallow organic or mucky mineral soil, with slightly richer vegetation that contains substantial amounts of *Liriodendron tulipifera* in the canopy and/or *Asimina triloba* in the understory. These species are generally not dominant, but are abundant and indicate a somewhat richer and less wet site.

Distinguishing Features: The Poplar-Pawpaw Subtype is distinguished from all other subtypes by having *Liriodendron tulipifera* and *Asimina triloba* as significant components of the canopy and the shrub layer, respectively.

Comments: The naturalness of this subtype is somewhat controversial. The mixture of drier site species with wetter site species suggests possible changing hydroperiod. However, other aspects of the examples suggest they are naturally distinct from other subtypes and may be no more altered from natural condition than many examples of other subtypes.

NONRIVERINE SWAMP FOREST (SWEETGUM SUBTYPE) G2?
Synonyms: *Nyssa biflora - Liquidambar styraciflua - Acer rubrum var. trilobum / Clethra alnifolia* Forest (CEGL004679).
Ecological Systems: Southern Atlantic Coastal Plain Nonriverine Swamp and Wet Hardwood Forest (CES203.304).

Concept: Subtype covers examples with mineral soil, containing substantial amounts of *Liquidambar styraciflua* in the canopy.

Distinguishing Features: The Sweetgum Subtype is distinguished from other subtypes by the presence of *Liquidambar styraciflua* in either the canopy or understory, reflecting a more mineral soil, with only shallow or no organic matter. *Liquidambar* serves as an indicator, but may not dominate. Nonriverine Wet Hardwood Forests may also contain abundant *Liquidambar*, but also contain oaks.

Comments: The *Liquidambar* is probably increased in all examples as a result of past logging, but serves as an indicator of mineral soil. We previously recognized a Sweetgum variant of Nonriverine Wet Hardwood Forest. This has been dropped, but some examples have been reinterpreted as this wetter community.

Pinus taeda - Acer rubrum - Liquidambar styraciflua / Arundinaria gigantea ssp. *tecta* Forest (CEGL004649) is apparently a successional community that may be an altered version of this but may also be an altered version of other community types.

PEATLAND ATLANTIC WHITE CEDAR FOREST G2
Synonyms: *Chamaecyparis thyoides / Persea palustris / Lyonia lucida - Ilex coriacea* Forest (CEGL006146).
Ecological Systems: Southern Atlantic Coastal Plain Nonriverine Swamp and Wet Hardwood Forest (CES203.304).

Concept: The type covers forests dominated by *Chamaecyparis thyoides* in peatland, Carolina bay, and high river terrace environments. Tree and shrub species of Nonriverine Swamp Forests, many also shared with pocosins, may be present and are sometimes abundant.

Distinguishing Features: Peatland Atlantic White Cedar Forest is distinguished from Streamhead Atlantic White Cedar Forest by occurrence on flats or in shallow depressions fed by sheet flow and rain water, in contrast to seepage-fed drainages in sandhill terrain. There is normally a difference in associated plants, with Liriodendron tulipifera in particular usually present only in streamheads.

Comments: Peatland Atlantic White Cedar Forests usually contain a minority of other tree species, and variants can be recognized based on them. The primary variation ranges from associated species characteristic of Nonriverine Swamp Forest (*Nyssa biflora, Acer rubrum, Pinus taeda, Taxodium distichum*) to those characteristic of Pond Pine Woodland (*Pinus serotina, Gordonia lasianthus*). These differences are not strong, and some examples have both sets of associated trees.

Peatland Atlantic White Cedar Forest was formerly placed in the pocosin group. Although some examples are associated with pocosins, most are associated with Nonriverine Swamp Forests.

Peatland Atlantic White Cedar Forests often occur as patches in a matrix or mosaic with Nonriverine Swamp Forest, sometimes also with Bay Forest or Pond Pine Woodland. These communities may exist as a long-term shifting mosaic driven by fire history. *Chamaecyparis* does not generally survive fire, but apparently needs fires of a particular type to regenerate. It naturally occurs as even-aged stands regenerated after stand-killing fires that are intense enough to remove competing trees and shrubs but not severe enough to destroy the seed bank in the soil. However, many stands are established on top of piles of fallen logs from previous stands.

Peatland Pocosins

LOW POCOSIN (GALLBERRY-FETTERBUSH SUBTYPE) G2
Synonyms: *Ilex glabra - Lyonia lucida - Zenobia pulverulenta* Shrubland (CEGL003944).
Ecological Systems: Atlantic Coastal Plain Peatland Pocosin and Canebrake(CES203.267).

Concept: Type covers pocosin shrublands with prevailing natural shrub height less than 1.5 meters tall due to the low fertility and wetness produced by deep peat. They common are in the centers of domed peatlands, but may also occur in Carolina bays or some smaller peat-filled basins. Subtype covers more northern and inland examples in which *Cyrilla racemiflora* is absent or only a minor component. *Lyonia lucida, Ilex glabra,* and *Zenobia pulverulenta* generally dominate.

Distinguishing Features: Low Pocosins are distinguished from other pocosin communities by the persistent low stature of the shrubs (less the 1.5 meters tall). Most Low Pocosins do contain patches of taller shrubs and scattered, stunted *Pinus serotina,* but these are a minor component. The transition to

High Pocosin sometimes occurs as an increase in abundance of tall shrub patches so that the average vegetation height increases, but more often occurs with a gradual increase in prevailing shrub height. In general, Low Pocosins can be distinguished from even recently burned High Pocosins by the smaller stature of the pines. Low Pocosins are distinguished from Pocosin Openings by strong dominance of erect shrubs, with only a minor component of *Chamaedaphne calyculata* and of herbs.

The Gallberry-Fetterbush Subtype is distinguished from the Titi Subtype by the absence of *Cyrilla racemiflora* and corresponding geographic location. *Cyrilla racemiflora* may be present in nearby Pond Pine Woodland communities or even in scattered tall shrub patches, but is scarce or absent within the Low Pocosin itself.

Comments: Low Pocosins often contain small openings dominated by herbs and *Chamaedaphne calyculata*. In the 3rd Approximation these were treated as part of the Low Pocosin. In the 4th Approximation they are treated as a separate community, albeit one that is often intermixed in small patches.

LOW POCOSIN (TITI SUBTYPE) G2G3
Synonyms: *Cyrilla racemiflora - Zenobia pulverulenta* Shrubland (CEGL003943).
Ecological Systems: Atlantic Coastal Plain Peatland Pocosin and Canebrake(CES203.267).

Concept:. Subtype covers more southern examples in which *Cyrilla racemiflora* is a major component along with *Zenobia pulverulenta, Lyonia lucida,* and *Ilex glabra*.

Distinguishing Features: The Gallberry-Fetterbush Subtype is distinguished from the Titi Subtype by the absence of *Cyrilla racemiflora* and corresponding geographic location.

POCOSIN OPENING (SEDGE-FERN SUBTYPE) G1G2
Synonyms: *Chamaedaphne calyculata / Carex striata var. striata - Woodwardia virginica* Dwarf-shrubland (CEGL004163).
Ecological Systems: Atlantic Coastal Plain Peatland Pocosin and Canebrake(CES203.267).

Concept: Type covers patches of herbaceous or dwarf shrub dominance within Low Pocosin or occasionally High Pocosin. Individual patches are usually small but sometimes abundantly intermixed with Low Pocosin shrub vegetation. Subtype covers the common openings, dominated by the species listed but lacking abundant *Vaccinium macrocarpon* or *Sarracenia* spp.

Distinguishing Features: Pocosin Openings are distinguished from Low Pocosins by the predominance of *Chamaedaphne calyculata, Woodwardia virginica, Carex striata,* and *Sphagnum* over *Zenobia* and other taller shrubs. The Sedge-Fern Subtype is distinguished by a lack of significant amounts of *Vaccinium macrocarpon* or *Sarracenia* spp.

Comments: These communities usually occur in small patches in a matrix of shrubby Low Pocosin communities. They were included within the range of Low Pocosin in the 3rd Approximation, but are treated as a separate kind of community here. Pocosin Openings are widely believed to be created by hot fire. Over time they succeed to shrubby vegetation, but they may persist for some decades. However,

recent large pocosin fires, with a range of intensity and amount of peat consumption, have apparently failed to created substantial amounts of the subtype. Thus, this idea may warrant questioning.

POCOSIN OPENING (PITCHER PLANT SUBTYPE) G1
Synonyms: *Chamaedaphne calyculata / Carex striata var. striata - Sarracenia (flava, purpurea, rubra ssp. rubra)* Dwarf-shrubland (CEGL004164).
Ecological Systems: Atlantic Coastal Plain Peatland Pocosin and Canebrake(CES203.267).

Concept: Subtype covers the rare examples which have some combination of *Sarracenia* spp. as a dominant or codominant.

Distinguishing Features: The Pitcher Plant Subtype is distinguished by having greater than 25 percent cover by *Sarracenia* spp. There are numerous apparent references to large pitcher plant-dominated pocosins in past site reports from aerial surveys and pocosin exploration. More recent examination of the same pocosins does not reveal extensive pitcher plant dominance. Only small patches of this subtype are known. This discrepancy may indicate a difference in interpretation of pitcher plant dominance, or may indicate a widespread decline in this subtype. Extensive wild fires in pocosins do not appear to have created new substantial areas of this subtype in areas where they previously were reported nor in new areas.

POCOSIN OPENING (CRANBERRY SUBTYPE) G1
Synonyms: *Chamaedaphne calyculata - Vaccinium macrocarpon / Carex striata var. striata - Woodwardia areolata* Dwarf-shrubland (CEGL004165).
Ecological Systems: Atlantic Coastal Plain Peatland Pocosin and Canebrake(CES203.267).

Concept: Subtype covers the rare examples which have *Vaccinium macrocarpon* as a significant component.

Distinguishing Features: The Cranberry Subtype is distinguished by having appreciable cover of *Vaccinium macrocarpon*. It is known only as a well-developed example on in the Dare County Pocosin.

HIGH POCOSIN (EVERGREEN SUBTYPE) G3
Synonyms: *Pinus serotina / Lyonia lucida - Ilex glabra - (Cyrilla racemiflora)* Shrubland (CEGL003846).
Ecological Systems: Atlantic Coastal Plain Peatland Pocosin and Canebrake(CES203.267).

Concept: Type covers pocosin communities of persistent intermediate shrub stature and lacking a well-developed tree canopy. Subtype covers the common examples dominated strongly by evergreen shrubs, generally *Lyonia lucida, Ilex glabra,* or *Cyrilla racemiflora*.

Distinguishing Features: High Pocosins are distinguished from other peatland pocosins by having dense shrub layers persistently greater than 1.5 meters tall (except immediately after fire) but lacking a well-developed tree canopy (cover less than 25 percent). They are distinguished from Streamhead Pocosins by not occurring in seepage-fed drainages in sandhill terrain. They lack *Liriodendron tulipifera,*

Toxicodendron vernix, and other characteristic streamhead species and may have *Gordonia lasianthus* as a component. They are distinguished from the Pocosin Shrub Subtype of Natural Lake Shoreline by lacking hydrology affect by a lake.

The Evergreen Subtype is distinguished from the Deciduous Subtype by having only a minor amount of deciduous shrubs such as *Zenobia pulverulenta* and *Vaccinium* spp.

Comments: Similar vegetation occurs in southern Virginia on small peat bodies along tidal rivers and is treated as this community. This is not known to occur in NC in such sites.

HIGH POCOSIN (DECIDUOUS SUBTYPE) G2?
Synonyms: *Pinus serotina / Zenobia pulverulenta - Cyrilla racemiflora - Lyonia lucida* Wooded Shrubland (CEGL004458).
Ecological Systems: Atlantic Coastal Plain Peatland Pocosin and Canebrake(CES203.267).

Concept: Subtype covers the uncommon examples with a significant deciduous shrub component, usually *Zenobia pulverulenta* but sometimes *Vaccinium* spp. or other species.

Distinguishing Features: The Deciduous Subtype is distinguished from the Evergreen Subtype by having more than a minor amount of deciduous shrubs such as *Zenobia pulverulenta* and *Vaccinium* spp.

POND PINE WOODLAND (TYPIC SUBTYPE) G3
Synonyms: *Pinus serotina - Gordonia lasianthus / Lyonia lucida* Woodland (CEGL003671). Ecological Systems: Atlantic Coastal Plain Peatland Pocosin and Canebrake (CES203.267).

Concept: Type covers pocosin communities of shallow peats or mucky mineral soils, with a well-developed, though usually open, canopy of *Pinus serotina*, with or without *Gordonia lasianthus*. They occur on the edges of large domed peatlands, in peat-filled Carolina bays, and in swales in aeolian sand areas. Subtype covers all examples except those at the northern end of the range, where *Cyrilla racemiflora* is absent. Subtype includes the previously recognized subtypes containing *Gordonia lasianthus* and those otherwise similar examples without it.

Distinguishing Features: The Pond Pine Woodland type is distinguished from High Pocosin by the presence of a significant tree canopy (greater than 25 percent cover except shortly after fires). It is distinguished from Streamhead Pocosin by not occurring in seepage-fed drainages in sandhill terrain and in lacking *Liriodendron tulipifera* and other species typical of streamheads. It is most readily distinguished from Small Depression Pocosin by occurring in contiguous patches larger than 5 acres, but also lacks appreciable amounts of species more typical of basins, such as *Vaccinium* spp. It is distinguished from the Pond Pine Subtype of Estuarine Fringe Pine Forest by having a shrub layer dominated by typical pocosin shrubs rather than *Morella cerifera*.

The Typic Subtype is distinguished from the Canebrake Subtype/Phase by having broadleaf shrubs exceeding *Arundinaria* in cover. It is distinguished from the Northern Subtype by more southern location and generally by having *Cyrilla racemiflora* as a significant component.

Comments: Two subtypes distinguished provisionally in early drafts of this guide, the Shrub Subtype and Loblolly Bay Subtype, have been merged here. This distinction, still recognized in the NVC, does not appear to be useful as defined. *Gordonia lasianthus* abundance varies widely in Pond Pine Woodlands, from complete absence to codominance in the canopy. Abundant canopy *Gordonia* is often interpreted as being a result of long fire suppression. It may thus represent a condition grade rather than a natural community type. However, large *Gordonia* are quite resilient to fire, and it is unclear how much of them it is appropriate to have in the canopy. The presence or complete absence of *Gordonia* does not appear to correlate with any other aspect of the communities. *Pinus serotina / Cyrilla racemiflora - Lyonia lucida - Ilex glabra* Woodland (CEGL003670) is the association lacking *Gordonia*.

POND PINE WOODLAND (NORTHERN SUBTYPE) G2?

Synonyms: *Pinus serotina / Ilex glabra / Woodwardia virginica* Woodland (CEGL004652). Ecological Systems: Atlantic Coastal Plain Peatland Pocosin and Canebrake(CES203.267).

Concept: Subtype covers examples at the northern end of the range of Pond Pine Woodland, in which *Cyrilla racemiflora* is absent and *Acer rubrum* and *Clethra alnifolia* become important components.

Comments: The range of this subtype is not well known. It has been thought to occur only in the Great Dismal Swamp in North Carolina and Virginia and a few Virginia sites along the North Landing River. However, some parts of Dare Bombing Range (e.g. near Lake Worth) appear to have a similar depauperate *Ilex glabra*-dominated composition. The natural character of this subtype is also unclear. The frequent presence of *Acer rubrum* may be a result of fire suppression, but the presence of *Clethra alnifolia* suggests less acidic or more fertile soils.

POND PINE WOODLAND (CANEBRAKE SUBTYPE) G1

Synonyms: *Pinus serotina / Arundinaria gigantea ssp. tecta* Woodland (CEGL004433). Ecological Systems: Atlantic Coastal Plain Peatland Pocosin and Canebrake (CES203.267).

Concept: Subtype covers examples with a shrub layer dominated by *Arundinaria tecta*, resulting from more frequent fire than that occurring in other Pond Pine Woodlands.

Distinguishing Features: The Canebrake Subtype is distinguished from other subtypes by having a shrub layer with greater cover of *Arundinaria* than of broadleaf shrubs.

Comments: The ecological relationship of this subtype to the other subtypes is unclear. Canebrakes in general apparently were abundant in early settlement times, but it is unclear how extensive peatland canebrakes were. Canebrakes succeed relatively quickly to broadleaf shrubs in the absence of fire under present circumstances, but may have been more stable if cane was well established and shrubs were scarce in a community. It is unclear if cane would have persisted in some parts of the landscape where fire was more frequent, or whether canebrakes and shrubby peatlands would have alternated as a shifting mosaic. It is also not entirely clear if the Pond Pine Woodlands with cane represent a persistent natural community occurring under different circumstances than those of the open canebrakes, if they are both part of a shifting mosaic, or if they are possibly an artifact of modern fire suppression.

Pinus serotina / Arundinaria gigantea ssp. tecta Wooded Shrubland (CEGL003851) is another NVC

association, but this distinction between woodland and wooded shrubland appears too finely divided, especially given the rapid changes in structure that can accompany fires or succession following fire.

PEATLAND CANEBRAKE G1

Synonyms: *Arundinaria gigantea ssp. tecta* Shrubland (CEGL003843). Atlantic Coastal Plain Peatland Pocosin and Canebrake(CES203.267).
Ecological Systems: Southern Atlantic Coastal Plain Nonriverine Swamp and Wet Hardwood Forest(CES203.304). Atlantic Coastal Plain Peatland Pocosin and Canebrake (CES203.267).

Concept: Treeless or sparsely treed vegetation dominated by *Arundinaria tecta* (less than 25 percent tree cover) in peatland and nonriverine wetland settings.

Distinguishing Features: Peatland Canebrakes are distinguished from all other peatland and nonriverine wetland communities by the dominance of *Arundinaria tecta* combined with tree cover less than 10 percent. Examples with more trees are included in the Canebrake Subtype of Pond Pine Woodland. They are distinguished from the Streamhead Canebrake type by occurring in flat or basin peatlands or nonriverine wetlands where rainfall and sheetflow, rather than seepage, is the main source of water.

Comments: No substantial extant examples are known to remain, though small patches are present within Pond Pine Woodland. Where the sites were not destroyed, the Peatland Canebrakes have apparently succeeded to Pond Pine Woodland or possibly Nonriverine Swamp Forest. Peatland Canebrakes could probably be restored by increasing fire frequency in remnants of Pond Pine Woodland with *Arundinaria*.

The ecological relationship of this type to the subtypes of Pond Pine Woodland is unclear. Canebrakes in general were apparently abundant in early settlement times, but it is unclear how extensive peatland canebrakes were. Canebrakes succeed relatively quickly to broadleaf shrubs in the absence of fire under present circumstances, but may have been more stable if cane was well established and shrubs were scarce in a community. It is unclear if cane would have persisted in some parts of the landscape where fire was more frequent, or whether canebrakes and shrubby peatlands would have alternated as a shifting mosaic.

BAY FOREST G4

Synonyms: *Gordonia lasianthus - Magnolia virginiana - Persea palustris / Sphagnum* spp. Forest (CEGL007044).
Ecological Systems: Atlantic Coastal Plain Peatland Pocosin and Canebrake (CES203.267).

Concept: Covers natural peatland forests and woodlands dominated by *Gordonia lasianthus*, alone or in combination with other evergreen hardwoods.

Distinguishing Features: Bay Forest is distinguished from Pond Pine Woodland, Peatland Atlantic White Cedar Forest, High Pocosin, and other pocosin communities by canopy dominance of *Gordonia lasianthus* alone or in combination with *Magnolia virginiana* or *Persea palustris*. Minority amounts of species from other peatland communities may be present.

Comments: *Magnolia virginiana - Persea palustris / Lyonia lucida* Forest (CEGL007049) is an association that is apparently a secondary bay forest, created by removal of the canopy from a Peatland Atlantic White Cedar Forest, Nonriverine Swamp Forest, or Pond Pine Woodland. *Gordonia lasianthus* is not usually a significant tree of these communities.

Bay Forests are generally thought to represent the final stage of succession in Pond Pine Woodlands in the absence of fire, because *Pinus serotina* cannot regenerate in dense unburned vegetation. However, *Gordonia* is quite resilient to fire when large, and readily sprouts after fire when killed. Some fires in Pond Pine Woodland have resulted in death of pond pines and capture of the site by bays, effectively creating a Bay Forest through fire rather than through absence of fire.

Streamhead Pocosins

STREAMHEAD POCOSIN GNR

Synonyms: *Pinus serotina - (Liriodendron tulipifera) / Lyonia lucida - Clethra alnifolia - Ilex glabra* Woodland (CEGL004435).
Ecological Systems: Atlantic Coastal Plain Streamhead Seepage Swamp, Pocosin and Baygall (CES203.252).

Concept: Type covers pocosin vegetation in mucky, seepage-fed drainages in the Sandhills Region and rarely in similar terrain with sandy uplands and seepage-fed streams.

Distinguishing Features: Streamhead Pocosins are distinguished from other pocosin communities by their occurrence in drainages in sandhill terrain, with flowing or seepage water, rather than on peat domes or in depressions fed mainly by rain water. *Liriodendron tulipifera* is often, but not always, a component of this type and is never present in other pocosin types. *Clethra alnifolia, Toxicodendron vernix,* and *Oxydendrum arboreum* are often present in this type and seldom present in other types of pocosins. Streamhead Pocosins are distinguished from Streamhead Atlantic White Cedar Forest and Sandhill Streamhead Swamp by canopy predominance of *Pinus serotina*. Streamhead Pocosins that have repeatedly burned through have boggy herbaceous vegetation. In places with long absence of fire, vegetation resembling Streamhead Pocosin spreads uphill into Sandhill Seep sites and even into less wet areas.

Comments: The ecological relationship between the different communities of Sandhills streamheads is not entirely clear. While there is a general trend from Streamhead Pocosin upstream to Sandhills Streamhead Swamp downstream, Streamhead Atlantic White Cedar Forest, Streamhead Canebrake, and Coastal Plain Semipermanent Impoundment may alternate along the length of a given drainage. It is not clear if these communities occur as a shifting mosaic, or whether their location is determined by fixed variations in seepage, fire penetration, and suitability to impoundment.

STREAMHEAD ATLANTIC WHITE CEDAR FOREST G1

Synonyms: *Chamaecyparis thyoides - (Liriodendron tulipifera) / Lyonia lucida* Forest (CEGL007563).
Ecological Systems: Atlantic Coastal Plain Streamhead Seepage Swamp, Pocosin and Baygall (CES203.252).

Concept: Type covers forests dominated by *Chamaecyparis thyoides* in mucky, seepage-fed drainages in

the Sandhills Region and rarely in similar terrain with sandy uplands and seepage-fed streams.

Distinguishing Features: Streamhead Atlantic White Cedar Forests are distinguished from Streamhead Pocosin and Sandhill Streamhead Swamp by having canopies with over 50 percent *Chamaecyparis thyoides* cover. They are distinguished from Peatland Atlantic White Cedar Forests by occurring in mucky, seepage-fed drainages in sandhill terrain. *Liriodendron tulipifera* is often, but not always, present.

STREAMHEAD CANEBRAKE G1

Synonyms: *Arundinaria gigantea ssp. tecta* Shrubland (CEGL003843) (not distinguished from Peatland Canebrake in NVC). Atlantic Coastal Plain Streamhead Seepage Swamp, Pocosin and Baygall (CES203.252).

Concept: Treeless or sparsely treed vegetation dominated by *Arundinaria tecta*, generally with less than 25 percent cover of either trees or shrubs, in seepage-fed drainages. Most of this rare community type is in the Sandhills Region , but it might occur in sand dune areas elsewhere in the Coastal Plain.

Distinguishing Features: Streamhead Canebrakes are distinguished from other communities of seepage-fed streamheads by the dominance of *Arundinaria tecta* combined with low cover of trees and other shrub s (less than 25 percent). They are distinguished from Peatland Canebrakes by occurring in streamheads rather than in flat or domed peatlands.

Comments: The NVC does not distinguish between Streamhead and Peatland Canebrakes, but given the substantial environmental difference and distinction between other communities in these environments, they should be considered distinct.

The natural dynamics of Streamhead Canebrakes are not well known. They now occur only in landscapes that have had frequent fire for some decades, such as on Fort Bragg. At least some of those present now appear to have been created in the last few decades by hot fires that removed an established tree canopy. We can presume that they once were more abundant when fire was widespread, and that many have been invaded by shrubs and become Streamhead Pocosins. However, even in frequently burned landscapes, they are small parts of streamhead systems, and give way to Streamhead Pocosin or Sandhill Streamhead Swamp communities. It is not clear if they form a shifting mosaic driven by fire history, or if they are tied to subtly distinct sites within these landscapes.

Wet Pine Savannas

WET PIEDMONT LONGLEAF PINE FOREST G1

Synonyms: *Pinus palustris - Pinus taeda - Pinus serotina / Chasmanthium laxum - Panicum virgatum* Piedmont Woodland (CEGL003663).
Ecological Systems: Southeastern Interior Longleaf Pine Woodland (CES202.319).

Concept: Type covers seepage fed or perched wetland woodlands or forests of the eastern Piedmont (primarily the Uwharries and areas adjacent to the Sandhills) in which *Pinus palustris* naturally dominates or codominates. *Pinus palustris* may be scarce in examples where past logging and fire suppression have removed it and allowed other pines and hardwoods to expand.

Distinguishing Features: Wet Piedmont Longleaf Pine Forest is distinguished from all other Piedmont wetland communities by having a component of *Pinus palustris* or evidence that it once dominated. In degraded examples the canopy may be dominated by *Pinus taeda* and *Pinus serotina* with only scattered *Pinus palustris*. It is distinguished from Dry Piedmont Longleaf Pine Forest by its overall mesic to wet flora, with appreciable amounts of facultative wetland species such as *Panicum virgatum* or *Chasmanthium laxum*, and often some more exclusively wetland species such as *Osmunda (Osmundastrum) cinnamomeum*. It is distinguished from most longleaf pine communities of the adjacent Coastal Plain by lacking *Aristida stricta*, as well as by its Piedmont location. Northern Wet Pine Savanna also lacks *Aristida stricta*, but has a more depauperate and northern flora that still contains a number of Coastal Plain species absent in the Piedmont.

Comments: Hillside Seepage Bogs are often associated with Dry Piedmont Longleaf Pine Forest. It is possible that *Pinus palustris* once occurred in them, potentially blurring the distinction between them and Wet Piedmont Longleaf Pine Forest. However, Hillside Seepage Bogs contain a more specialized wetland flora.

WET PINE FLATWOODS (TYPIC SUBTYPE) G3

Synonyms: Wet Pine Flatwoods (Wet Spodosol Variant); *Pinus palustris / Ilex glabra / Aristida stricta* Woodland (CEGL003648). Wet Sandy Pine Savanna of earlier 4th approximation guide drafts.
Ecological Systems: Central Atlantic Coastal Plain Wet Longleaf Pine Savanna and Flatwoods (CES203.265).

Concept: Type covers seasonally wet open grassy longleaf pine or pond pine communities on coarse sandy Spodosols, less wet than the Sandy Pine Savanna type, typically low in species richness. This type may possibly have more shrub cover then the various Pine Savanna communities under natural conditions, but still is naturally more dominated by grasses than by shrubs. Subtype covers the common examples of the Coastal Plain in which *Kalmia buxifolia (Leiophyllum buxifolium)* is not a major component. Instead, *Gaylussacia frondosa, Ilex glabra, Hypericum reductum, Arundinaria tecta, Rhododendron atlanticum*, or other wetland shrubs are present with low to high cover. *Aristida stricta* dominates a dense but low-diversity herb layer, sometimes with codominant *Pteridium aquilinum*.

Distinguishing Features: Wet Pine Flatwoods are distinguished from both Sandy Pine Savannas and Wet Loamy Pine Savannas by the absence of plant species typical of richer or wetter sites, such as *Sporobolus pinetorum, Ctenium aromaticum, Muhlenbergia expansa, Sporobolus teretifolius*, and *Sarracenia flava.* They are distinguished from Mesic Pine Savanna by coarse sandy soil and by a low-diversity herbaceous flora that largely lacks legumes. They are distinguished from Xeric Sandhill Scrub and Pine/Scrub Oak Sandhill by a lack of scrub oaks and lack of non-wetland herbs. While it has been suggested that these communities of sandy soils naturally have more shrub cover than wetter or more fertile savannas, the amount of shrubs cannot be used to distinguish them. Virtually all examples of all the longleaf pine communities have more shrubs than under natural conditions, because of past periods of fire suppression. Amounts of shrub and herb cover are an indication of community condition rather than community type. Similarly, the abundance of *Aristida stricta* cannot be used to distinguish among these community types, as it may dominate in most. The distinctive species of Pine Savanna types may dominate, but may be present only in smaller amounts, and may be scarce in fire-suppressed examples.

The Typic Subtype is distinguished by the absence or scarcity of *Kalmia buxifolia (Leiophyllum buxifolium).*

Comments: Wet Pine Flatwoods represents the marginally wet portion of the moisture gradient on coarse sandy soils. The moisture gradient on these soils appears to be compressed compared to that of loamy soils. While loamy or clayey soils sometimes have a distinctive mesic savanna community that develops between the oak-rich sandhill communities and the wet savannas, there is no apparent mesic segment of the moisture gradient on coarse sandy soils. Wet Pine Flatwoods often grade directly into Xeric Sandhill Scrub. The lack of moisture-holding capacity in the sand, which leads to dry conditions whenever the water table is not high, presumably is the reason, but the low fertility of these soils may also be involved. The seasonal high water table is presumably the reason for exclusion of scrub oaks and the preponderance of wetland shrubs and trees in Wet Pine Flatwoods when fire is suppressed for long periods. However, Wet Pine Flatwoods are often not considered jurisdictional wetlands because their low-diversity vegetation is dominated by facultative plants of widespread moisture tolerance and lacks obligate wetland species.

Naming conventions for this community type have been problematic. These communities are closely related to the suite of communities that are called Pine Savannas, sharing frequent fire, and dominance by longleaf pine and wiregrass. However, while most wet longleaf pine communities are known for their high fine-scale plant species richness, this type tends to have low species richness. In some other usages, the term "flatwoods" implies more shrub cover than "savanna". However, all of the wet longleaf pine communities become shrubby if they are not burned frequently, so shrub abundance is a poor indicator of community type among longleaf pine communities. Nevertheless, there is some indication that these marginally wet sandy soils retain more shrub cover naturally under conditions of frequent fire than do those of finer textured soils (Glitzenstein 200?). In earlier drafts of the 4th Approximation, I named it as a kind of Pine Savanna. But there is a confusing array of Pine Savanna names even without it, so I have returned to the 3rd Approximation name of Wet Pine Flatwoods.

This type is the most common remaining longleaf pine community type of the outer Coastal Plain, but it is rare globally. It occurs only in North Carolina and northern South Carolina.

WET PINE FLATWOODS (SAND MYRTLE SUBTYPE) G2?

Synonyms: Wet Pine Flatwoods (Leiophyllum Variant); *Pinus palustris / Leiophyllum buxifolium / Aristida stricta* Woodland (CEGL003649). Wet Sandy Pine Savanna of earlier 4th approximation guide drafts.

Ecological Systems: Central Atlantic Coastal Plain Wet Longleaf Pine Savanna and Flatwoods (CES203.265).

Concept: Subtype covers the rare examples of the Coastal Plain in which *Kalmia buxifolia (Leiophyllum buxifolium*) is a significant component.

Distinguishing Features: The Sand Myrtle Subtype is readily distinguished from all other longleaf pine communities by the presence of significant numbers of *Kalmia buxifolia*. All of the shrub species of the Typic Subype may also be present.

Comments: *Kalmia buxifolia* has an unusual distribution and range of ecology, occurring in high

elevation rock outcrop communities in the mountains, outcrops on a few lower Piedmont monadnocks, in a few dry sites in the Sandhills region, and in this rare community subtype of the outer Coastal :Plain. This subtype occurs only in Brunswick and Pender County, with a disjunct occurrence in eastern Carteret County. It probably is better ranked G1 than G2.

WET PINE FLATWOODS (DEPRESSION SUBTYPE) G1G2Q
Synonyms: *Hypericum reductum* / *Aristida stricta* Dwarf-shrubland (CEGL003954).
Ecological Systems: Central Atlantic Coastal Plain Wet Longleaf Pine Savanna and Flatwoods (CES203.265).

Concept: Subtype covers small, marginally wet, sandy limesink depression and swales in dry sandhills, where *Aristida stricta* and *Hypericum reductum* dominate. Trees are absent in the few known examples, but *Pinus palustris* might potentially be present.

Distinguishing Features: The Depression Subtype is distinguished by occurrence in small, closed basins, in combination with the dominance of *Hypericum reductum* and *Aristida stricta*. Local areas in the Typic Subtype may be dominated by these species, but generally trees and other shrubs will be present.

Comments: This community has been called a vernal pool, but the dominance of *Aristida stricta* suggests that standing water is absent or is only of very short duration. The composition ties the community to the Wet Pine Flatwoods type. It is unclear if it is distinct enough to recognize as a separate subtype. It may simply be the Typic Subtype, depauperate because the occurrences are small and isolated. However, it is possible that ponded water is the reason for its depauperate flora and lack of trees.

SANDY PINE SAVANNA (TYPIC SUBTYPE) G3
Synonyms: Pine Savanna (Wet Spodosol Variant); *Pinus palustris - Pinus serotina / Ctenium aromaticum - Muhlenbergia expansa - Carphephorus odoratissimus* Woodland (CEGL003658).
Ecological Systems: Central Atlantic Coastal Plain Wet Longleaf Pine Savanna and Flatwoods (CES203.265).

Concept: Type covers very wet pine/wiregrass savannas of sandy soils, typically high in species richness but with flora consisting mostly of the more widespread savanna species. *Pinus palustris* or *Pinus serotina, Aristida stricta, Sporobolus pinetorum, Ctenium aromaticum,* or other grasses, or *Pleea tenuifolia* typically dominate. Subtype covers the typical examples of most parts of the Coastal Plain, having herb layers dominated by grasses, in which *Pleea tenuifolia* is not dominant or codominant (though it often is present).

Distinguishing Features: Sandy Pine Savannas are distinguished from Wet Pine Flatwoods by a more diverse herb layer that includes species indicative of greater wetness. Species in Sandy Pine Savanna but not in Wet Pine Flatwoods include *Sporobolus pinetorum, Ctenium aromaticum, Andropogon glomeratus, Andropogon glaucopsis, Osmundastrum (Osmunda) cinnamomeum, Woodwardia virginica, Polygala lutea, Sarracenia flava,* and *Dionaea muscipula.* All plant species of Wet Pine Flatwoods may also occur in Sandy Pine Savanna, including *Aristida stricta, Rhexia alifanus, Xyris caroliniana,* all of the shrub species, and *Pinus palustris* and *Pinus serotina*. Though Wet Pine Flatwoods may naturally

have more shrub cover under frequent fire, the amount of shrubs is usually artificially high in both types and is not a good distinguishing feature. Sandy Pine Savanna and Wet Pine Flatwoods can be hard to distinguish in fire-suppressed examples where indicator herbs have become sparse, and may be impossible if no herbs remain.

Sandy Pine Savannas are distinguished from Wet Loamy Pine Savanna and Very Wet Loamy Pine Savanna by the soil texture and fertility and by corresponding differences in vegetation. They are typically dominated by *Aristida stricta* or *Pleea tenuifolia*, in combination with *Sporobolus pinetorum* or less frequently, *Ctenium aromaticum*. Other characteristic herbs include *Andropogon* sp., *Osmundastrum cinnamomeum, Carphephorus* spp., *Rhexia alifanus, Polygala lutea, Dionaea muscipula, Xyris caroliniana, Zigadenus densus,*, and *Drosera* spp. They are perhaps best distinguished by the absence or scarcity of a suite of herbs generally confined to the loamy savannas, such as *Eupatorium rotundifolium, Bigelowia nudata, Chaptalia tomentosa, Cirsium virginianum, Helianthus heterophyllus, Helianthus angustifolius, Lysimachia loomisii, Polygala ramosa, Eryngium integrifolium, Eryngium yuccifolium, Sporobolus teretifolius,* and most *Rhynchospora* species.

The Typic Subtype is distinguished from the Rush Featherling Subtype by not having *Pleea tenuifolia* dominant, though the species sometimes is present.

SANDY PINE SAVANNA (RUSH FEATHERLING SUBTYPE) G1

Synonyms: Pine Savanna (Pleea Flat Variant); *Pinus palustris - Pinus serotina / Pleea tenuifolia - Aristida stricta* Woodland (CEGL003661).
Ecological Systems: Central Atlantic Coastal Plain Wet Longleaf Pine Savanna and Flatwoods (CES203.265).

Concept: Subtype covers the rare examples in the southern outer Coastal Plain, in which *Pleea tenuifolia* is dominant or codominant in the herb layer. Examples are known only from Brunswick and Pender counties. The *Pleea* plants form tall hummocks which give the ground much more relief than in other savannas. The strong dominance of *Pleea* often leads to low species richness in this subtype.

Distinguishing Features: The Rush Featherling Subtype is distinguished by the dominance of *Pleea tenuifolia* in the herb layer. This species may be present in other Pine Savanna communities but is not dominant.

Comments: The reason for the distinctive dominance and the rarity of this subtype is not clear, especially given that *Pleea* has a larger range. However, its widespread and repeating occurrence within its range suggests that it is natural.

WET LOAMY PINE SAVANNA G1

Synonyms: Pine Savanna (Wet Ultisol Variant); *Pinus palustris - Pinus serotina / Ctenium aromaticum - Muhlenbergia expansa - Rhynchospora latifolia* Woodland (CEGL003660); Ecological Systems: Central Atlantic Coastal Plain Wet Longleaf Pine Savanna and Flatwoods (CES203.265).

Concept: Type covers longleaf pine or pond pine savanna that are wet but less wet than the Very Wet Loamy Pine Savanna type, on soils other than coarse sands (sandy loam, loam, or soils with a clayey B

horizon). These communities are typically very high in fine-scale species richness, sharing all of the species of Sandy Pine Savanna and having an additional suite of herbaceous species. *Pinus palustris* or *Pinus serotina, Ctenium aromaticum, Sporobolus pinetorum, Muhlenbergia expansa,* or *Rhynchospora* spp. typically dominate or codominate with *Aristida stricta*.

Distinguishing Features: Wet Loamy Pine Savannas are distinguished from Sandy Pine Savannas by a suite of herbaceous species that only occur on the finer textured soils, including *Eupatorium rotundifolium, Bigelowia nudata, Chaptalia tomentosa, Cirsium virginianum, Helianthus heterophyllus, Helianthus angustifolius, Lysimachia loomisii, Eryngium integrifolium, Polygala ramosa, Eryngium integrifolium,* and most *Rhynchospora* species. Wet Loamy Pine Savannas are distinguished from Very Wet Loamy Pine Savannas by the lack or scarcity of a suite of herbaceous species of wetter or richer sites. These include *Sporobolus teretifolius, Eryngium yuccifolium, Zigadenus densus, Carex lutea, Thalictrum cooleyi,* and *Allium* sp. 1.

Wet Loamy Pine Savannas are distinguished from Mesic Pine Savannas by an abundant suite of wetland herbaceous plants and an almost complete lack of leguminous herbs.

Comments: *Pinus palustris - Pinus serotina / Sporobolus pinetorum - (Aristida stricta) - Eryngium integrifolium* Woodland (CEGL004501) is another association that corresponds to this subtype. Given the high species richness and variability of dominance over short distances, this distinction does not appear useful.

This type is conceived as occupying a segment of the moisture gradient that is marginally to moderately wet, between mesic and very wet. This is the same portion of the moisture gradient occupied on coarse sandy soils by Wet Pine Flatwoods. The difference in character and vegetation between the two is related to soil fertility, but may also be related to moisture dynamics. Coarse sandy soils have little inherent moisture-holding capacity, and likely go from saturated to very dry in a short time as the water table drops. Finer-textured soils retain more moisture and therefore are more hospitable for plants.

VERY WET LOAMY PINE SAVANNA G1

Synonyms: *Pinus palustris - Pinus serotina / Magnolia virginiana / Sporobolus teretifolius - Carex striata* Woodland (CEGL004500). Pine Savanna (Very Wet Clay Variant) (3rd Approximation). Ecological Systems: Central Atlantic Coastal Plain Wet Longleaf Pine Savanna and Flatwoods (CES203.265).

Concept: Type covers rare longleaf pine or pond pine savannas of the wettest loamy or silty soils, often with local inclusions high in calcium and pH. They are typically very high in species richness. They share most plant species of the Wet Loamy Pine Savanna but have some reduced in importance, and they also have a distinctive suite of additional species. *Pinus serotina* and *Ctenium aromaticum, Sporobolus teretifolius, Muhlenbergia expansa, Rhynchospora* spp., or *Carex striata* typically dominate. *Aristida stricta* and *Sporobolus pinetorum* are generally absent or scarce, and *Pinus palustris* is often scarce or appears to have difficultly regenerating after logging.

Distinguishing Features: Very Wet Loamy Pine Savannas are distinguished from all other pine savannas and flatwoods by a suite of herbs that includes *Sporobolus teretifolius, Eryngium yuccifolium, Zigadenus densus, Carex lutea, Thalictrum cooleyi,* and *Allium* sp., 1. *Taxodium ascendens* and *Liriodendron*

tulipifera are generally present, at least in small numbers. Additional species of very wet, boggy sites, such as *Eriocaulon decangulare* are also more likely present than in other pine savanna types.

Comments: The environmental factors responsible for the occurrence of Very Wet Loamy Pine Savannas are not entirely clear. Their flora suggests they are wetter than the Wet Loamy Pine Savannas, but most Wet Loamy Pine Savannas grade to pocosin communities without Very Wet Loamy Pine Savannas intervening. These communities are very rare, with a limited and patchy geographic range. They often, maybe always, have inclusions where soils are high in calcium and have a higher pH (5.5 to 7.2), but the majority of their soil is similar to other pine savannas (pH 3.8-4.1). This type was called the Very Wet Clay Variant of Pine Savanna in the 3rd approximation, but soil samples in CVS plots consisted mostly of silt. Clay content was never higher than 10 percent, and was not generally higher than in other loamy savannas.

Pinus palustris - Pinus serotina / Sporobolus pinetorum - Ctenium aromaticum - Eriocaulon decangulare var. decangulare Woodland (CEGL004502) is another NVC association that appears to be equivalent to this type. It is not clear that a distinction within this type can be recognized consistent, nor that it is of value to make one.

NORTHERN WET PINE SAVANNA G2

Synonyms: *Pinus palustris - (Pinus serotina) / Ilex glabra - Gaylussacia frondosa - (Kalmia carolina)* Woodland (CEGL003647). Wet Pine Flatwoods (Northern Variant).
Ecological Systems Central Atlantic Coastal Plain Wet Longleaf Pine Savanna and Flatwoods (CES203.265).

Concept: Type covers wet longleaf pine savannas and flatwoods north of the range of wiregrass.

Distinguishing Features: Northern Wet Pine Savanna is distinguished from all other Pine Savanna types by its occurrence north of the natural range of *Aristida stricta*. *Schizachyrium scoparium* is probably the natural dominant, but all examples degraded by fire suppression, so that the natural character of these communities is poorly understood. It is not clear if they are more closely related to Wet Pine Flatwoods or to Wet Loamy Pine Savanna or Sandy Savanna, or if equivalents of all three types once existed.

SANDHILL SEEP (WET SUBTYPE) G3?

Synonyms: *Gaylussacia frondosa - Clethra alnifolia - Arundinaria gigantea* ssp. *tecta / Aristida stricta - Pteridium aquilinum* var. *pseudocaudatum* Herbaceous Vegetation (CEGL004468).
Ecological Systems Atlantic Coastal Plain Sandhill Seep (CES203.253).

Concept: Type covers sloping, seepage-fed herbaceous or shrub-herb wetlands of the Sandhills region or similar sandhill terrain elsewhere in the Coastal Plain. They are generally small areas on slopes or slope bases, and may occur as isolated seeps or as broad to narrow ecotonal communities between Pine/Scrub Oak Sandhill and Streamhead Pocosin communities. In the Sandhills region, they often occur where a clay layer forces water to the surface.

Subtype covers the less wet examples, which are seasonally rather than permanently saturated and have sandy soils with little muck. Their flora contains *Aristida stricta* and other species typical of the wetter

end of its moisture tolerance, but lacks most species tolerant of organic soils. These may occur alone or as an outer zone around the Very Wet Subtype.

Distinguishing Features: Sandhill Seeps are distinguished from Streamhead Pocosins by occurring on mineral soils with a slope and by having a significant persistent component of herbs. The amount of shrub biomass varies with fire history, but the natural state includes abundant herbs. Streamhead Pocosins may have weedy herbs immediately after hot fires but the persistent herb component is limited to a few wetland fern species. Sandhill Seeps are floristically related to Wet Loamy Pine Savannas, but are distinguished by some floristic differences and more readily by their occurrence on sloping seepage-fed sites.

The Wet Subtype is distinguished from the Very Wet Subtype by a flora that includes *Aristida stricta* and other herbs of seasonally saturated mineral soil wetlands but that lacks more water-tolerant species and species of organic soils. Species typical of the Wet Subtype include *Pteridium aquilinum, Rhexia alifanus, Polygala lutea, Xyris caroliniana, Lachnocaulon anceps, Muhlenbergia expansa, Sporobolus pinetorum, Oxypolis ternata*. *Lespedeza* spp., *Gaylussacia frondosa,* and *Symplocos tinctoria.* Species typical of the Very Wet Subtype include *Osmundastrum (Osmunda) cinnamomeum, Sarracenia* spp., *Xyris* species other than *X. caroliniana, Eriocaulon decangulare, Cladium mariscoides, Drosera capillaris, Solidago patula* var. *strictula, Lilium pyrophilum, Cyrilla racemiflora, Lyonia lucida, Ilex coriacea,* and *Toxicodendron vernix. Ctenium aromaticum, Calamovilfa brevipilis, Andropogon glomeratus, Clethra alnifolia, Ilex glabra,* and *Arundinaria tecta* are characteristic of both subtypes.

Comments: A separate sandhill-pocosin ecotone community has been discussed at times, and was included in an earlier draft of the 4th approximation guide. *(Pinus palustris, Pinus serotina) / Ctenium aromaticum - Muhlenbergia expansa - Calamovilfa brevipilis* Woodland (CEGL003659) is an association created for it in the NVC. This community does not appear to be distinct from Sandhill Seep, and it has been dropped from the 4th approximation. Ecotonal occurrences of this subtype appear to be the most common, but many are too small to distinguish as distinct occurrences. These ecotonal communities are particularly subject to shrub invasion with inadequate fire, and are largely lost amid the expanding shrubs of adjacent Streamhead Pocosins in most places. It is somewhat unclear how extensive well-developed ecotonal seeps would be with a more natural fire frequency, but they would be much more abundant than they have become at present.

Sandhill Seeps, this subtype especially, share much flora with several Pine Savanna communities of the outer Coastal Plain. Species more typical of Sandhill Seeps include *Oxydendrum arboreum, Calamovilfa brevipilis, Chasmanthium laxum, Doellingeria sericocarpoides (= Aster sericocarpoides), Glyceria obtusa,* and *Hexastylis sorriei*. Species more prevalent or exclusive in Outer Coastal Plain savannas and flatwoods communities than in this one include *Lysimachia loomisii, Pinguicula caerulea, Pinguicula caerulea, Pinguicula pumila, Dionaea muscipula, Pyxidanthera barbulata, Arnoglossum ovatum, Cirsium horridulum, Carphephorus odoratissimus, Pterocaulon pycnostachyum, Helianthus heterophyllus, Balduina uniflora, Coreopsis falcata, Helenium pinnatifidum, Helenium vernale, Amphicarpum purshii, Paspalum praecox, Anthaenantia rufa, Andropogon glaucopsis, Rhynchospora latifolia, Pleea tenuifolia, Lilium catesbaei* ssp. *catesbaei, Platanthera nivea, Platanthera integra, Sarracenia minor, Polygala brevifolia,* and *Polygala hookeri.*

SANDHILL SEEP (VERY WET SUBTYPE) G2?
Synonyms: *Clethra alnifolia - Toxicodendron vernix / Aristida stricta - Osmunda cinnamomea - Sarracenia* spp. Shrub Herbaceous Vegetation (CEGL004467). Sandhill Seep (Bog Subtype) (earlier drafts of the 4th approximation guide).
Ecological Systems Atlantic Coastal Plain Sandhill Seep (CES203.253).

Concept: Subtype covers the typical wetter examples with substantial flora shared with Pine Savannas. These generally occur as an inner zone surrounded by the Wet Subtype.

Distinguishing Features: The Very Wet Subtype is distinguished from the Wet Subtype by a more water-tolerant flora and generally by muck accumulation in the soil. *Aristida stricta* and *Pinus palustris* are lacking in this subtype. Species typical of the Wet Subtype include *Pteridium aquilinum, Rhexia alifanus, Polygala lutea, Lachnocaulon anceps, Muhlenbergia expansa, Sporobolus pinetorum, Oxypolis ternata*. *Lespedeza* spp., *Gaylussacia frondosa,* and *Symplocos tinctoria.* Species typical of the Very Wet Subtype include *Osmundastrum (Osmunda) cinnamomeum,, Sarracenia* spp., *Xyris* species other than *X. caroliniana, Eriocaulon decangulare, Cladium mariscoides, Drosera capillaris, Solidago patula* var. *strictula, Lilium pyrophilum, Cyrilla racemiflora, Lyonia lucida, Ilex coriacea,* and *Toxicodendron vernix. Ctenium aromaticum, Calamovilfa brevipilis, Xyris chapmanii, Xyris platylepis, Lobelia batsonii, Clethra alnifolia, Ilex glabra,* and *Arundinaria tecta* are characteristic of both subtypes.

Comments: This subtype encompasses a range in wetness and composition. Splitting it into additional subtypes may be warranted, but the variation in vegetation with management and over time makes determining lasting character difficult. Three variants are recognized: 1. Typic variant, best fitting the description. 2. Bog variant, for lower slope and slope base examples that are wetter and have more organic accumulation. 3. Twig-rush variant, a possibly unique variant dominated by *Cladium mariscoides* and occurring over a nearly flat-lying surficial clay bed. There appears to be an interaction between these communities and impoundments in adjacent stream bottoms. Most of the Bog Variant, the wettest, most boggy examples of this subtype, occur adjacent to existing or former beaver ponds. This may indicate a reduced ground water gradient that increases wetness upslope. Where the impoundment is abandoned and has developed into a mire, plants of the Sandhill Seeps often extend out into the pond bed and mix with species of the mire. This is recognized as the Bog Variant of Coastal Plain Semipermanent Impoundment (Sandhills Mire Subtype), and may warrant recognition as a distinct subtype.

Coastal Plain Depression Communities

SMALL DEPRESSION POCOSIN (TYPIC SUBTYPE) G2G3
Synonyms: *Pinus serotina / Cyrilla racemiflora - Lyonia lucida - Vaccinium fuscatum* Woodland (CEGL004434).
Ecological Systems: Southern Atlantic Coastal Plain Depression Pondshore (CES203.262).

Concept: Type covers communities filling small depression wetlands which naturally have dense shrub layers of typical pocosin shrubs or *Vaccinium* spp., and which have either an open canopy of pocosin species or no canopy. Subtype covers typical pocosin-like examples, with dense shrub layers dominated by combinations of *Cyrilla racemiflora, Lyonia lucida, Ilex glabra, Ilex coriacea,* or *Zenobia pulverulenta,* with or without a minority of *Vaccinium* spp. A canopy of *Pinus serotina* or occasionally *Pinus taeda, Acer rubrum,* or *Gordonia lasianthus* is usually present.

Distinguishing Features: The Small Depression Pocosin type is distinguished from other depressional wetlands by the presence of a dense shrub layer that fills all or a substantial part of the basin. It is distinguished from other pocosin communities by occurring in small depressions (less than 5 acres in size and often with shallowly ponded water in wet seasons). It is distinguished from the Small Depression Shrub Border type by filling most of the basin and by the absence of pond species such as *Ilex myrtifolia, Ilex cassine, Litsea aestivalis,* and various herbs of open ponds. Most characteristic pocosin species may be present, including *Pinus serotina, Magnolia virginiana, Persea palustris, Cyrilla racemiflora, Lyonia lucida, Ilex coriacea, Ilex glabra, Clethra alnifolia,* and *Smilax laurifolia*. The Typic Subtype is distinguished from the Blueberry Subtype by the dominance of characteristic pocosin species, with only a small minority presence of *Vaccinium* spp. Swamp trees such as *Taxodium ascendens* and *Nyssa biflora* may be present in small numbers.

SMALL DEPRESSION POCOSIN (BLUEBERRY SUBTYPE) G3?
Synonyms: *Vaccinium formosum - Vaccinium fuscatum / Sphagnum cuspidatum* Shrubland (CEGL003907).
Ecological Systems: Southern Atlantic Coastal Plain Depression Pondshore (CES203.262).

Concept: The Blueberry Subtype covers densely shrubby depressional wetlands that are dominated by *Vaccinium formosum* and/or *Vaccinium fuscatum*. It is quite rare, and it is unclear what drives its occurrence and distinction from the other subtype.

Distinguishing Features: The Blueberry Subtype is distinguished by the dominance of *Vaccinium fuscatum* and *Vaccinium formosum* over more typical pocosin shrubs.

SMALL DEPRESSION SHRUB BORDER G3?
Synonyms: *Cyrilla racemiflora - Lyonia lucida* Shrubland (CEGL003844). Small Depression Pond (3rd Approximation).
Ecological Systems: Southern Atlantic Coastal Plain Depression Pondshore (CES203.262).

Concept: Type covers relatively narrow shrub thickets on the rims of Small Depression Pond, Small Depression Drawdown Meadow, and Vernal Pool communities. These communities are narrow enough to be strongly subject to edge effects from both sides. They contain a mix of pocosin species, such as *Cyrilla racemiflora, Lyonia lucida,* and *Smilax laurifolia*, along with some characteristic pond species such as *Ilex myrtifolia, Ilex cassine, Litsea aestivalis,* and *Cephalanthus occidentalis*. Trees may be present but are generally sparse and have little effect on the shrubs because of open edges. They may include *Pinus serotina,* but more often will be *Nyssa biflora, Acer rubrum, Magnolia virginiana,* and *Persea palustris*. Herbaceous species of the adjacent open wetland are usually present.

Distinguishing Features: This type is distinguished from all other communities by the combination of shrub dominance and occurrence in a narrow zone on the edge of other open depressional wetlands. Small Depression Pocosins may contain some of the same species, but will fill most or all of the basins they occur in and will not contain an appreciable amount of *Ilex myrtifolia, Ilex cassine, Litsea aestivalis,* or *Cephalanthus occidentalis*. The Natural Lake Shoreline type may share some species, but generally has a limited shrub layer. It occurs on larger bodies of water where wave action is important.

Comments: The natural dynamics and character of these communities are driven by a combination of seasonal but variable flooding and by intrusion of fire from the adjacent uplands, which are almost always longleaf pine communities. With fire suppression, shrub borders expand and shrubs become taller and denser, while the return of fire narrows them and confines them to wetter areas. Natural fires in the summer, fall, and in dry springs, would burn all the way through them and through the adjacent herbaceous wetland communities, top-killing the shrubs and possibly trees. The natural frequency of burning was presumably less frequent than in the uplands, but more frequent than at present. Prescribed fire programs that are confined to the winter or to mild conditions may never burn through these communities, allowing them to expand both into the upland edge and into the open pond communities. Some people believe that shrub border communities are entirely an artifact of inadequate fire. It is likely that some have developed in places where they did not naturally occur. These can be expected to consist solely of the more mobile species, or of species present nearby. However, those with characteristic pond species that are not widespread, such as *Litsea aestivalis*, almost certainly are natural, though perhaps altered in structure.

COASTAL PLAIN DEPRESSION SWAMP (MIXED SUBTYPE) G3

Synonyms: *Taxodium ascendens / (Nyssa biflora) / Leucothoe racemosa - Lyonia lucida - Morella cerifera* Depression Forest (CEGL007420). Nonriverine Swamp Forest (3rd Approximation). Ecological Systems: Southern Atlantic Coastal Plain Depression Pondshore (CES203.262).

Concept: The Small Depression Swamp type covers communities of depressional wetlands in which there is a well-developed, closed or nearly closed tree canopy of *Taxodium ascendens* or *Nyssa biflora* but not a dense graminoid-dominated herb layer. They may or may not have a well-developed shrub layer. They are associated with deeper flooding than Small Depression Pocosins or Nonriverine Swamp Forests. The Mixed Subtype covers examples that have shrub layers containing a mix of characteristic pocosin and swamp species. They are generally less deeply flooded than the Cypress Dome Subtype. They may occur throughout the NC Coastal Plain, but are most common in the southern part.

Distinguishing Features: The Small Depression Swamp type is distinguished from other Coastal Plain depressional wetlands by the occurrence of a well-developed canopy of *Taxodium ascendens* or *Nyssa biflora* in a depressional wetland, without a well-developed herb layer. The shrub layer may range from open to dense. The type is distinguished from other *Taxodium*- and *Nyssa*-dominated swamps, such as Nonriverine Swamp Forest, by occurring in relatively deep closed basins, generally Carolina bays or limesinks, and therefore having deep flooding with non-flowing water. Oxbow Lakes may also be deeply flooded cypress or gum forests in depressions, but are subject to periodic river flooding and generally contain exclusively floodplain species such as *Fraxinus caroliniana*.

The Mixed Subtype is distinguished from the Pocosin Subtype by the shrub layer having a significant component of species not characteristic of pocosins, such as *Cephalanthus occidentalis, Morella cerifera, Eubotrys racemosa*, *Itea virginica*, *Leucothoe axillaris,* and *Arundinaria tecta,* with only subordinate amounts of *Cyrilla racemiflora, Lyonia lucida, Ilex glabra, Ilex coriacea,* or *Zenobia pulverulenta*. It is distinguished from the Cypress Dome Subtype by lacking *Ilex myrtifolia* and by having other shrubs present.

Comments: This type is one of the least well understood of the Coastal Plain wetlands, and the

relationship among the subtypes is somewhat uncertain. It is unclear if all examples are natural; some may represent artificial succession of Cypress Savannas or Small Depression Ponds in response to water table drawdown or fire suppression.

Nifong (1998) recognized several associations within the vegetational variation covered by this subtype: *Nyssa biflora - Taxodium ascendens / Liquidambar styraciflua / Ilex amelanchier* (9.1.1); *Nyssa biflora - Taxodium ascendens / Decodon verticillatus / (Smilax laurifolia) / Utricularia purpurea* (8.0.3); *Taxodium ascendens / Nyssa biflora - Acer rubrum / (Leucothoe racemosa - Vaccinium* spp. *- Zenobia pulverulenta) / Sphagnum* Bog (8.0.6).

Nyssa biflora / Itea virginica - Cephalanthus occidentalis Depression Forest (CEGL007434) is another depression swamp association attributed to North Carolina. It may be a deeper or less acid swamp. No examples that would fit it well are known.

COASTAL PLAIN DEPRESSION SWAMP (POCOSIN SUBTYPE) G2

Synonyms: *Taxodium ascendens / Cyrilla racemiflora - Zenobia pulverulenta* Woodland (CEGL003734).

Ecological Systems: Atlantic Coastal Plain Clay-Based Carolina Bay Wetland (CES203.245). Southern Atlantic Coastal Plain Depression Pondshore (CES203.262).

Concept: Subtype covers examples, generally in Carolina bays, with a dense shrub layer strongly dominated by the characteristic pocosin shrubs, mainly *Cyrilla racemiflora, Lyonia lucida, Ilex glabra,* and *Zenobia pulverulenta*, often along with *Ilex amelanchier, Vaccinium formosum*, and *Vaccinium fuscatum*. It is thus like a Small Depression Pocosin but with a well-developed swamp canopy.

Distinguishing Features: The Pocosin Subtype is distinguished by the dense pocosin-like shrub layer beneath a swamp canopy. *Morella cerifera, Eubotrys racemosa, Itea virginica,* and *Leucothoe axillaris* are absent or scarce.

Comments: Nifong (1998) recognized several associations within the vegetational variation covered by this subtype: *Taxodium ascendens / Lyonia lucida / Carex striata - Woodwardia virginica / Sphagnum* Bog (8.0.1); *Nyssa biflora / Chamaedaphne calyculata / Carex striata / Sphagnum* spp. Bog (8.0.2); *Taxodium ascendens / Nyssa biflora - Acer rubrum / Zenobia pulverulenta - Lyonia lucida - Cyrilla racemiflora / Woodwardia virginica* Bog (8.0.6); *Taxodium ascendens / Lyonia lucida - Leucothoe racemosa / (Leucobryum* sp.) Bog? (8.0.8).

COASTAL PLAIN DEPRESSION SWAMP (CYPRESS DOME SUBTYPE) G3

Synonyms: *Taxodium ascendens / Ilex myrtifolia* Depression Forest (CEGL007418). Small Depression Pond (3rd Approximation).

Ecological Systems: Southern Atlantic Coastal Plain Depression Pondshore (CES203.262). Southern Atlantic Coastal Plain Depression Pondshore (CES203.262).

Concept: The Cypress Dome Subtype covers examples in deep, steep-sided basins with poorly developed shrub layers. This is a more southern community that reaches its northern range limit in southeasternmost North Carolina. Farther south it occurs in a variety of settings, but in North Carolina it

is confined to a few steep-sided limesinks.

Distinguishing Features: The Cypress Dome Subtype is distinguished from the Mixed Subtype and Pocosin Subtype by deeper water and the scarcity of shrubs of the other subtypes, at least beyond the edge. *Ilex myrtifolia* is usually the predominant shrub. Some aquatic plants such as *Nymphaea odorata* may be present.

VERNAL POOL (TYPIC SUBTYPE) G2?

Synonyms: *Panicum virgatum - Andropogon (capillipes, glaucopsis) - Aristida palustris* Herbaceous Vegetation (CEGL004100). Small Depression Pond (3rd Approximation - outer zone).
Ecological Systems: Southern Atlantic Coastal Plain Depression Pondshore (CES203.262).

Concept: Type covers herb-dominated depressional wetlands with reliably short hydroperiods, which contain wetland plants absent in surrounding communities but lack indicators of deeper water and longer hydroperiod. These communities generally completely fill shallow depressions. Depauperate assemblages of the same plants may occur on the upper edges of some deeper ponds, but only expanses that cover a significant part of a basin or that cover a substantial area in a larger basin should be considered this type. The Typic Subtype covers most examples in North Carolina, all those that don't meet the criteria for the specialized Sphagnum Subtype. There may be a need for further breakdown of this group, but the basis for doing so is unclear at present.

Distinguishing Features: The Vernal Pool type is distinguished from other depressional wetlands by the absence of plants associated with longer hydroperiods and the presence of plants intolerant of long inundation. *Panicum hemitomon, Rhynchospora tracyi, Rhynchospora inundata, Rhynchospora careyana, Leersia hexandra, Coelorachis rugosa, Diodia virginiana, Rhexia aristosa,* and *Juncus repens* are generally absent. (These species may become scarce in wetter communities during drought.) *Centella erecta, Panicum verrucosum, Lachnanthes caroliana, Eleocharis tricostata,* and *Panicum rigidulum* may be present in small numbers, in wet microsites, or during unusually wet periods. Typical plants include *Panicum virgatum, Saccharum giganteum, Carex glaucescens, Aristida virgata, Woodwardia virginica, Aristida palustris, Schizachyrium scoparium,* and any of several *Andropogon* species. Trees may include a mixture of *Pinus taeda, Pinus palustris, Nyssa biflora, Acer rubrum,* or may be absent altogether.

VERNAL POOL (SPHAGNUM SUBTYPE) G2?

Synonyms: *Sphagnum cuspidatum* Nonvascular Vegetation (CEGL004384).
Ecological Systems: Southern Atlantic Coastal Plain Depression Pondshore (CES203.262).

Concept: Subtype covers depauperate examples strongly dominated by *Sphagnum* spp., with only sparse vascular plants. It is not clear how closely related these communities are to the Typic Subtype.

Distinguishing Features: These communities are distinguished from all others by the strong dominance of *Sphagnum* spp. and near absence of vascular plants in a shallow depressional wetland.

Comments: The ecological nature of this subtype is poorly known. A few examples are known with almost no vegetation other than *Sphagnum*. But *Sphagnum* can also cover other Vernal Pool and Small

Depression Drawdown Meadow communities at times, apparently temporarily. These can be recognized by emergent live or dead plants of the Typic Subtype.

CYPRESS SAVANNA (TYPIC SUBTYPE) G2G3

Synonyms: *Taxodium ascendens / Panicum hemitomon - Polygala cymosa* Woodland (CEGL003733). Cypress Savanna (Typic and Depression Meadow variants) (3rd Approximation) (in part). Small Depression Drawdown Meadow/Savanna (Typic Cypress Savanna Subtype) (earlier 4th approximation guide drafts).
Ecological Systems: Atlantic Coastal Plain Clay-Based Carolina Bay Wetland (CES203.245).

Concept: Type covers wetlands of flat-bottomed depressions, typically clay-based Carolina bays, with dense, diverse herbaceous layers. A canopy of *Taxodium ascendens* is usually present. They are intermediate in wetness between Vernal Pools and the center of Small Depression Pond communities, and so are probably similar in hydroperiod to Small Depression Drawdown Meadows. Water may stand much of the growing season, but in all but the wettest years will dry up. The hydroperiod is too short to support floating or emergent aquatic plants on a long-term basis, and too wet to support trees other than *Taxodium ascendens* and *Nyssa biflora* on a long-term basis (but other trees may invade temporarily).

Subtype covers examples with diverse herb layers of species typical of mineral soils. Boggy species such as *Woodwardia virginica* and *Carex striata* may be present but are not strongly dominant. These communities typically support a mixture of plants that emerge when water goes down and those that grow in the water, but the vegetation may vary drastically from year to year.

Distinguishing Features: The Cypress Savanna type is distinguished from the Vernal Pool type by the absence of less flood-tolerant plants such as *Panicum virgatum* and *Schizachyrium scoparium*. Other more upland species, such as *Andropogon virginicus, Andropogon capillipes, Andropogon glaucopsis, Eupatorium compositifolium, Eupatorium album*, and *Pinus taeda* may invade during droughts but will not persist for long periods. Cypress Savanna is distinguished from most subtypes of Small Depression Pond by lacking plants indicative of longer term inundation. Plants will include some of the more broadly tolerant emergent species, such as *Panicum hemitomon* and *Leersia hexandra*, but will lack true aquatics and the more restricted emergents such as *Eleocharis equisetoides, Rhynchospora tracyi*, and *Rhynchospora inundata*.

The Small Depression Drawdown Meadow type may share some plants with Cypress Savanna communities, but overall flora will differ. Plants that are characteristic of Cypress Savanna and uncommon in Small Depression Drawdown Meadow include *Coelorachis rugosa, Eriocaulon compressum, Saccharum giganteum, Diodia virginiana,* and *Hypericum cistifolium*. Plants characteristic of the Small Depression Drawdown Meadows and not of Cypress Savannas include *Centella erecta, Lachnanthes caroliniana, Panicum tenerum, Juncus abortivus,* and *Proserpinaca pectinata*. Some plant species, such as *Dichanthelium erectifolium, Dichanthelium wrightianum, Polygala cymosa, Rhexia aristosa, Pluchea rosea, Scleria reticularis, Eupatorium leucolepis*, and *Panicum verrucosum*, may be frequent in either subtype. Distinguishing these communities is made more difficult by the fact that dominant plants and aspect dominants may very drastically from year to year, depending on rainfall.

The Typic Subtype is distinguished from the Acid Subtype by a diverse and characteristic herbaceous flora that is not dominated by boggy species. The herb layer may include *Woodwardia virginica, Carex*

striata, Sphagnum, and other boggy species, but these will not dominate as they do in the Acid Subtype. An open canopy of *Taxodium ascendens* is usually present unless removed by past disturbance, but some examples have no clear sign of having once had trees.

Comments: The 3rd Approximation recognized Typic and Depression Meadow variants of Cypress Savanna, based largely on the presence or absence of a *Taxodium* canopy or evidence of one in the recent past. Nifong (1998) found only minor floristic differences between the two, and believed that those lacking canopy had once had one that had been eliminated by cutting and lack of seed source. The distinction may be retained at the variant level because of differing opinions about this, but cannot be supported at the subtype level. This subtype includes most of subclass 9.2, Cypress-Gum Pond and 9.3 Drawdown Savanna/Meadow of Nifong (1998).

CYPRESS SAVANNA (ACID SUBTYPE) G2?

Synonyms: *Taxodium ascendens / Woodwardia virginica* Woodland (CEGL004441). Cypress Savanna (3rd Approximation). Small Depression Drawdown Meadow/Savannas (Acid Cypress Savanna subtype) (earlier 4th approximation guide drafts).
Ecological Systems: Atlantic Coastal Plain Clay-Based Carolina Bay Wetland (CES203.245).

Concept: Subtype covers examples with vegetation that is dominated by acid-loving or boggy plants, generally relatively low in species richness.

Distinguishing Features: The Acid Subtype is distinguished by vegetation dominated by acid-loving plants. There is usually an open canopy of *Taxodium ascendens* or sometimes *Nyssa biflora*. *Woodwardia virginica, Carex striata, Lachnanthes caroliniana,* and *Sphagnum* spp. are prominent in the herb layer. The less acid-tolerant species characteristic of the Typic Subtype may be present only in small numbers and low diversity. Shrubs may include both pond and pocosin species, but the shrub layer will not be dense and pocosin-like.

The Acid Subtype is distinguished from the Small Depression Pond (Boggy Pool Subtype) by occurring is broad, flat basins, by the presence of a well-developed *Taxodium* or *Nyssa* canopy, and by a greater species richness. It is distinguished from the Coastal Plain Depression Swamp (Mixed Subtype) by a more open canopy, well developed herb layer, and absence of a dense shrub layer. It is distinguished from Small Depression Pocosin by lacking a dense shrub layer.

Comments: This subtype includes the *Taxodium ascendens / Pinus taeda - Acer rubrum - Liquidambar styraciflua / Lindera / Smilax glauca / Carex glaucescens* Swamp (9.1.3); *Taxodium ascendens / (Nyssa biflora)* Swamp (9.1.4) of Nifong (1998).

SMALL DEPRESSION DRAWDOWN MEADOW (TYPIC SUBTYPE) G2?

Synonyms: *Dichanthelium wrightianum - Dichanthelium erectifolium* Herbaceous Vegetation (CEGL004105), Small Depression Pond (3rd Approximation). Small Depression Drawdown Meadow/Savanna (Pond Margin Subtype) (earlier 4th approximation guide drafts).
Ecological Systems: Southern Atlantic Coastal Plain Depression Pondshore (CES203.262).

Concept: Type covers herbaceous communities of seasonally-flooded, mineral soil depressions with

fairly long hydroperiods, most often outer zones of open water or marshy ponds. It occurs in limesink depressions and occasionally in inland dune swales or other natural depressions, but generally not in clay-based Carolina bays. These communities have longer hydroperiods than Vernal Pools and shorter than Small Depression Pond communities. Subtype covers the typical examples with diverse herbaceous flora.

Distinguishing Features: The Small Depression Drawdown Meadow type is distinguished from the Vernal Pool type by having a longer hydroperiod, with standing water or saturated soil persisting well into the growing season. Flora intolerant of longer flooding, such as *Panicum virgatum, Saccharum giganteum, Carex glaucescens, Aristida virgata, Woodwardia virginica, Aristida palustris, Schizachyrium scoparium*, and any of several *Andropogon* species, are absent, are confined to the shallowest edges, or invade only for short periods during drought. *Panicum hemitomon, Rhynchospora tracyi, Rhynchospora inundata, Rhynchospora careyana, Leersia hexandra, Coelorachis rugosa, Diodia virginiana, Rhexia aristosa, Juncus repens, Centella erecta, Panicum verrucosum, Lachnanthes caroliana, Eleocharis tricostata, Panicum rigidulum,* or plants tolerant of even wetter conditions are generally present. (These species may become scarce in wetter communities during drought.)

Small Depression Drawdown Meadows are distinguished from Cypress Savannas by occurring in different kinds of basins and being floristically distinct. Cypress Savannas occur in flat-bottomed basins, while this subtype generally occurs in more sloping basins, usually in association with wetter subtypes. Plants that are characteristic of Cypress Savanna and uncommon in Small Depression Ponds include *Coelorachis rugosa, Eriocaulon compressum, Saccharum giganteum, Diodia virginiana,* and *Hypericum cistifolium*. Plants characteristic of Small Depression Drawdown Meadows and not of Cypress Savannas include *Centella erecta, Lachnanthes caroliniana, Panicum tenerum, Juncus abortivus*, and *Proserpinaca pectinata*. Some plant species, such as *Dichanthelium erectifolium, Dichanthelium wrightianum, Polygala cymosa, Rhexia aristosa, Pluchea rosea, Scleria reticularis, Eupatorium leucolepis,* and *Panicum verrucosum,* may be frequent in either subtype.

Small Depression Drawdown Meadows are distinguished from Small Depression Pond communities, which they usually adjoin, by a diverse flora that is not tolerant of longer flooding, and by the presence of mineral soil. Wetter environments in ponds tend to have a least some muck accumulation in the soil, which is visible even during dry periods. The vegetation generally consists of small to medium size graminoids and abundant forbs, in contrast to the large emergent graminoids or floating aquatic plants of wetter Small Depression Pond communities. An open canopy of *Taxodium ascendens, Nyssa biflora*, or *Acer rubrum* may be present in either. During unusually wet periods, Small Depression Drawdown Meadows may remain flooded; the less flood-tolerant plants may not be visible and rhizomatous marsh graminoids may expand and become dominant. However, these communities will still lack the more flood-tolerant plants that are slower to invade and will lack a mucky soil. It will generally help to know whether water levels are higher or lower than usual and to interpret communities in light of this.

The Typic Subtype is distinguished from the Boggy Pool Subtype by having a diverse flora that is not confined to the most acid-tolerant species such as *Woodwardia virginica* and *Carex striata. Sphagnum* is generally scarce or absent.

SMALL DEPRESSION DRAWDOWN MEADOW (BOGGY POOL SUBTYPE) G2
Synonyms: *Woodwardia virginica / Sphagnum cuspidatum* Herbaceous Vegetation (CEGL004475), Small Depression Pond (3rd Approximation).
Ecological Systems: Southern Atlantic Coastal Plain Depression Pondshore (CES203.262).

Concept: This subtype covers examples with vegetation dominated by the most acid-tolerant, boggy species, and generally having abundant *Sphagnum*. Trees and shrubs are usually absent or sparse.

Distinguishing Features: The Boggy Pool Subtype is distinguished from the Typic Subtype by having a low-diversity flora dominated by the most acid-tolerant species, such as *Woodwardia virginica, Carex striata,* and *Sphagnum* spp. Species characteristic of the Typic Subtype will be present only in small numbers and with low diversity, and will mostly consist of the more broadly tolerant species such as *Andropogon* spp., *Saccharum giganteum*, and *Panicum hemitomon*.

The Boggy Pool Subtype is distinguished from the Acid Subtype of Cypress Savanna by occurrence in smaller, more steeply sloping basins, by the absence of trees, and generally by more extensive coverage of *Sphagnum*.

Comments: *Carex striata* var. *brevis* Herbaceous Vegetation (CEGL004120) is an association described for New Jersey to Virginia and attributed to North Carolina and South Carolina. It might fit within this subtype's concept, or that of the Cypress Savanna (Acid Subtype). Given the close association of *Carex striata* with *Woodwardia virginica,* it does not appear that such a distinction is warranted here. No distinctive examples are known in North Carolina.

Most of the sites for these communities occur in sandy terrain. They function as water table windows, often with substantial seasonal fluctuations in water levels. The absence of organic accumulation in the soils of drawdown meadows may be due to periodic burning as well as to seasonal drying.

SMALL DEPRESSION POND (TYPIC MARSH SUBTYPE) G3?
Synonyms: *Panicum hemitomon - Eleocharis equisetoides - Rhynchospora inundata* Herbaceous Vegetation (CEGL004127). Includes the Boggy Marsh Subtype and Maidencane Subtype of earlier 4th approximation drafts.
Ecological Systems: Southern Atlantic Coastal Plain Depression Pondshore (CES203.262).

Concept: Type covers the wettest portions of all mainland Coastal Plain small depressions, with permanent flooding or with hydroperiods lasting most of the growing season. They may occur in limesink depressions, the wettest clay-based Carolina bays, and occasionally in deep inland dune swales or other natural basins. This concept differs somewhat from the 3rd Approximation, where the Small Depression Pond type covered all zones in basins that contained permanent or near permanent water in their center. As now defined, it will often occur in association with one or two drier zonal community types such as Small Depression Drawdown Meadow and Small Depression Shrub Border. Subtype covers examples with *Panicum hemitomon* or other large or small graminoids dominant, which do not fit the characteristics of the Cutgrass Prairie Subtype.

Distinguishing Features: The Small Depression Pond type is distinguished from Small Depression Drawdown Meadows by vegetation and soils characteristic of a hydroperiod lasting most, if not all, of

the growing season. They tend to have soils with at least some muck accumulation. They tend to be dominated either by floating-leaf plants or by large emergent graminoids, though smaller water-tolerant graminoids may dominate. Small Depression Drawdown Meadows tend to have smaller graminoids and abundant forbs. The Small Depression Pond type is distinguished from Natural Lake Shoreline by occurring in small, shallow depressions, where wave action is not significant, and where emergent or floating vegetation is generally able to occur all the way across.

Small Depression Ponds are closely related to Interdune Ponds, but are distinguished by occurring in coastal fringe or inland locations, not on barrier islands, nor in association with maritime communities and salt spray. Upland Pool communities of the Piedmont and Blue Ridge may be closely related, including containing some Coastal Plain flora, but are easily distinguished by their location in those provinces and by their distinctive vegetation.

This subtype is distinguished from the Open Lily Pond Subtype by the dominance of emergent plants. It is distinguished from the Cutgrass Prairie Subtype by the absence or scarcity of *Leersia hexandra*.

Comment: *Rhynchospora filifolia - Juncus abortivus* Herbaceous Vegetation (CEGL004131) and *Eleocharis (elongata, equisetoides) - Rhynchospora tracyi* Semipermanently Flooded Herbaceous Vegetation (CEGL004960) are additional small depression pond associations that has been attributed to North Carolina. Nifong (1998) also recognized a depauperate *Panicum hemitomon* association, which was not recognized in NVC. All of these are treated as variation within this subtype. The fine-scale spatial variability and temporal variation in vegetation makes it very difficult to distinguish appropriate natural divisions of these communities with one-time plot studies or observations. While this subtype, as defined, is fairly broad and heterogeneous, it is unclear that these associations represent an appropriate subdivision that meets the criteria for community subtypes. Nifong (1998) also recognized an *Eleocharis quadrangulata - Rhynchospora inundata - Rhynchospora* sp. 1 / *Sphagnum* Marsh association, which is not represented in NVC. It needs clarification of its concept and character, but may warrant recognition as a distinct subtype.

SMALL DEPRESSION POND (CUTGRASS PRAIRIE SUBTYPE) G2G3
Synonyms: *Leersia hexandra - (Panicum verrucosum, Scleria reticularis)* Herbaceous Vegetation [Provisional] (CEGL004047).
Ecological Systems: Southern Atlantic Coastal Plain Depression Pondshore (CES203.262).

Concept: Subtype covers examples, typically in small, flat Carolina bays or other depressions with loamy soils and a hydroperiod slightly shorter than other marsh subtypes, in which the vegetation is dominated by or has a substantial component of *Leersia hexandra*. Vegetation varies dramatically in response to rainfall cycles. In wetter periods *Leersia hexandra* dominates more strongly, while in drier times *Panicum verrucosum* and *Scleria reticularis* are also abundant. In long droughts *Panicum hemitomon* and various woody species may invade. This subtype should generally not be classified in the same depression as other emergent subtypes.

Distinguishing Features: The Cutgrass Prairie Subtype is distinguished by the dominance or codominance of *Leersia hexandra* during wet periods and a continued substantial presence of it during droughts.

Comments: This subtype includes the *Leersia* Prairie (2.0.1), *Leersia/Panicum verrucosum* Prairie (2.0.2), *Pinus taeda/Panicum hemitomon/Leersia* "successional prairie" (2.0.3) of Nifong (1998). Nifong (1998) emphasized the successional relationships between the three of his associations that are included in this subtype, suggesting that they are different phases that can occur in the same site at different times in normal climatic cycles.

SMALL DEPRESSION POND (OPEN LILY POND SUBTYPE) G3?
Synonyms: *Nymphaea odorata - Nuphar advena - (Nymphoides aquatica, Xyris smalliana)* Herbaceous Vegetation (CEGL004326). Nymphaea Pond (3.0.1) (Nifong 1998).
Ecological Systems: Southern Atlantic Coastal Plain Depression Pondshore (CES203.262).

Concept: Subtype covers the deepest examples, dominated by floating or submersed aquatic plants.

Distinguishing Features: The Open Lily Pond Subtype covers examples or zones dominated in the long term either by floating aquatic plants such as *Nymphoides aquatica, Nymphaea odorata, Nuphar advena* (= *Nuphar lutea ssp. advena), Lemna* spp., etc., by permanently submersed aquatic plants such as *Utricularia* spp., or by open water lacking vascular plants. Rare drawdowns may occur, and may reveal *Juncus repens* mats or other bottom vegetation. This subtype largely lacks emergent marsh plants such as *Eleocharis equisetoides, Eleocharis elongata, Eleocharis melanocarpa, Rhynchospora tracyi, Rhynchospora inundata, Rhynchospora careyana, Panicum hemitomon, Leersia hexandra,* and *Panicum verrucosum*. Trees and shrubs are generally absent or sparse. These communities are often surrounded by Small Depression Drawdown Meadow or Small Depression Shrub Border communities, or by other subtypes of Small Depression Pond in drier parts of the basin.

The Open Lily Pond Subtype is dominated by floating-leaved aquatic plants without a large component of emergents. It may occur with other subtypes that are dominated by emergents. This subtype should not be classified unless it covers a major part of the basin or covers a large area in a larger basin.

FLOATING BOG G1?
Synonyms: *Rhynchospora alba* Saturated Herbaceous Vegetation (CEGL004463).
Ecological Systems: Southern Atlantic Coastal Plain Depression Pondshore (CES203.262).

Concept: Type covers the rare communities developed on floating vegetation mats in deep water. They may occur in limesink depressions, or in natural or artificial impoundments. Vegetation usually includes a mixture of species shared with northern quaking bogs and pocosins. Characteristic species are *Rhynchospora alba, Dulichium arundinaceum, Triadenum virginicum, Eleocharis baldwinii, Sarracenia rubra, Sarracenia flava, Chamaedaphne calyculata*, and *Sphagnum cuspidatum*.

Distinguishing Features: Floating Bogs are distinguished by their substrate, which is floating organic mats over water. The few examples known are in very different settings, including a limesink pond, a naturally blocked creek embayment, and an old mill pond impounded in a pocosin.

Natural Lake Communities

NATURAL LAKE SHORELINE SWAMP (SWEETGUM SUBTYPE) G1

Synonyms: *Liquidambar styraciflua / Persea palustris* Forest (CEGL004481).
Ecological Systems: Southeastern Coastal Plain Natural Lakeshore (CES203.044).

Concept: Type covers tree-dominated vegetated wetland vegetation on the shores of medium to large permanent natural lakes. It extends inland to where the effect of lake hydrology on vegetation is replaced by the hydrology of the surrounding area, either upland or wetland. Subtype covers examples on peatland lakes, dominated or codominated by *Liquidambar styraciflua*, with an acid-tolerant flora, such as occur at Great Lake and Catfish Lake.

Distinguishing Features: The Natural Lake Shoreline Swamp type is distinguished from other forested wetlands by occurrence along a large to medium permanent lake. It is distinguished from the Small Depression Pond type by the permanence of the lake and presence of wave action, as well as generally by distinctive vegetation. The Sweetgum Subtype is distinguished by the strong dominance of *Liquidambar styraciflua* and by an overall flora of relatively few species of acid-tolerant plants. The Sweetgum Subtype is distinguished from Nonriverine Swamp Forest (Sweetgum Subtype) by lake hydrology and by vegetational differences.

NATURAL LAKE SHORELINE SWAMP (RICH SUBTYPE) G1?

Synonyms: *Taxodium distichum - Liquidambar styraciflua - Platanus occidentalis / Asimina triloba* Forest (CEGL004424).
Ecological Systems: Southeastern Coastal Plain Natural Lakeshore (CES203.044).

Concept: Subtype covers the very rare examples with richer flora, generally containing abundant Liquidambar styraciflua but also a diversity of other species, including a number in all strata indicative of richer soils.

Distinguishing Features: The Rich Subtype is distinguished by a relatively diverse flora with a number of species of richer, less acidic wetlands, many of them shared with brownwater river floodplain communities. These include *Platanus occidentalis*, *Fraxinus pennsylvanica*, *Quercus michauxii*, and *Asimina triloba*. This subtype is known only from the north shore of Lake Phelps and, more marginally developed, the north shore of Pungo Lake.

NATURAL LAKE SHORELINE SWAMP (CYPRESS SUBTYPE) G3

Synonyms: *Taxodium distichum - Taxodium ascendens / Panicum hemitomon* Woodland (CEGL004466).
Ecological Systems: Southeastern Coastal Plain Natural Lakeshore (CES203.044).

Concept: Subtype covers wetter examples dominated by *Taxodium distichum* or *Taxodium ascendens*, usually with an open woodland or savanna canopy. The couple examples with canopy of *Nyssa biflora* or *Chamaecyparis thyoides* are also tentatively placed in this subtype.

Distinguishing Features: The Cypress Subtype is distinguished from the Lake Waccamaw Subtype and Rich Subtype by having limited species richness, with few herbs present. It is distinguished from Nonriverine Swamp Forest by having lake hydrology, with more permanent water and wave action.

NATURAL LAKE SHORELINE SWAMP (LAKE WACCAMAW SUBTYPE) G1

Synonyms: *Taxodium distichum - Taxodium ascendens / Panicum hemitomon - Sclerolepis uniflora* Woodland (CEGL004465).
Ecological Systems: Southeastern Coastal Plain Natural Lakeshore (CES203.044).

Concept: Subtype covers the one known example on a lake with somewhat calcareous waters – Lake Waccamaw. The vegetation resembles that of the Cypress Subtype but has a distinctive and richer flora.

Distinguishing Features: This subtype is distinguished by the presence of numerous plant species not found in other subtypes, including *Sclerolepis uniflora*, *Cladium mariscoides*, and *Boltonia asteroides*. The presence of the endemic animals of Lake Waccamaw at seasonal high water levels also makes it distinctive.

NATURAL LAKE SHORELINE MARSH (TYPIC SUBTYPE) G1

Synonyms: *Panicum hemitomon - Juncus* spp. Coastal Plain Lakeshore Herbaceous Vegetation (CEGL004307). Southeastern Coastal Plain Natural Lakeshore (CES203.044).

Concept: Type covers the rare herb-dominated wetlands on the shores of medium to large Coastal Plain lakes. Subtype covers all examples other than the Lake Waccamaw Pond-Lily Subtype.

Distinguishing Features: This type is distinguished from all others by the combination of lake hydrology and herbaceous dominance. It is distinguished from Small Depression Pond communities by the permanent flooding and size of the lake, with attendant wave action and presence of fish-dominated lake fauna at high water. It is distinguished from the Natural Lake Shoreline Swamp type by having extensive herbaceous vegetation without more than scattered cypress trees. However, *Panicum hemitomon* beds of lower diversity are often present in openings between the cypress trees in the Cypress Subtype of Natural Lake Shoreline Swamp.

NATURAL LAKE SHORELINE MARSH (LAKE WACCAMAW POND-LILY SUBTYPE) G1

Synonyms: *Nuphar sagittifolia - Eriocaulon aquaticum* Lakeshore Herbaceous Vegetation (CEGL004297).
Ecological Systems: Southeastern Coastal Plain Natural Lakeshore (CES203.044).

Concept: Subtype covers examples dominated by *Nuphar sagittifolia*, known only from Lake Waccamaw.

Distinguishing Features: The Lake Waccamaw Pond-Lily Subtype is distinguished by the dominance of *Nuphar sagittifolia*.

Maritime Wetlands

MARITIME WET GRASSLAND (SOUTHERN HAIRGRASS SUBTYPE) G2

Synonyms: *Muhlenbergia filipes - Spartina patens - Eustachys petraea* Herbaceous Vegetation (CEGL004051).
Ecological Systems: Northern Atlantic Coastal Plain Dune and Swale (CES203.264)? Southern Atlantic Coastal Plain Dune and Maritime Grassland (CES203.273).

Concept: Type covers interdune swales and low sand flats on barrier islands, with seasonally to permanently saturated soils or shallow flooding but no regular salt water flooding (though overwash may occur during severe storms). Vegetation is dominated by any of several grasses or sedges, but not by species of the Dune Grass community. Subtype covers the typical examples of the Outer Banks, where *Spartina patens* or *Muhlenbergia filipes* dominate.

Distinguishing Features: Maritime Wet Grasslands are distinguished from Maritime Dry Grasslands by the presence of wetland species, such as *Muhlenbergia filipes*, *Andropogon glomeratus, Schoenoplectus pungens (= Scirpus pungens),* or *Fimbristylis castanea*. They are distinguished from Brackish Marshes by the presence of salt-intolerant species such as *Muhlenbergia sericea (= filipes), Panicum virgatum, Andropogon glomeratus*, and *Eustachys petraea*. They are distinguished from Interdune Marsh by the vegetation, which is generally dominated by small or medium size graminoids rather than coarse graminoids. *Spartina patens, Muhlenbergia sericeas, Panicum virgatum, Andropogon* spp., and smaller *Juncus* spp. generally dominate in Maritime Wet Grasslands and are absent in Interdune Marshes.

The Southern Hairgrass Subtype is the most common subtype in North Carolina (though still rare), and represents all examples other than those with *Panicum virgatum* as a major component.

Comments: This type, as currently defined, is extremely variable and probably warrants division into more subtypes based on biogeography, wetness, or stage of primary succession. However, the appropriate division is unclear. The potential for rapid temporal changes in vegetation and substantial differences in seasonal aspect complicate sorting out the variation. Analysis of Carolina Vegetation Survey and NatureServe plot data may clarify the variation. One potentially well-marked variant contains *Juncus dichotomus* or *Juncus scirpoides* as dominants or codominants.

MARITIME WET GRASSLAND (SWITCHGRASS SUBTYPE) G?

Synonyms: *(Morella cerifera*) - *Panicum virgatum - Spartina patens* Herbaceous Vegetation (CEGL004129).
Ecological Systems: Northern Atlantic Coastal Plain Dune and Swale (CES203.264).

Concept: Subtype covers swales and flats where *Panicum virgatum* is dominant or codominant, expected to occur in the northern part of our coast.

Distinguishing Features: The Switchgrass Subtype is distinguished by the dominance or codominance of *Panicum virgatum*. *Spartina patens* is a minor component.

Comments: The NVC association was described from Assateague Island and represents a northern type that probably ranges into North Carolina. An apparent example is known on Currituck Banks.

INTERDUNE MARSH G2 as defined here

Synonyms: Interdune Pond (3rd Approximation). *Typha domingensis - Setaria magna* Herbaceous Vegetation (CEGL004138). *Leptochloa fusca* ssp. *fascicularis - Sesuvium maritimum* Herbaceous Vegetation (CEGL004125). *Fimbristylis castanea - Schoenoplectus pungens* Seasonally Flooded Herbaceous Vegetation (CEGL003790). All of these associations are more broadly defined.
Ecological Systems: Central Atlantic Coastal Plain Maritime Forest (CES203.261). Northern Atlantic Coastal Plain Dune and Swale (CES203.264). Southern Atlantic Coastal Plain Dune and Maritime Grassland (CES203.273).

Concept: Type covers all barrier island dune swale ponds that are dominated by emergent herbaceous vegetation. They may occur as extensive marshes, or as broad marsh edge zones around open water ponds. They are extremely variable in vegetation from site to site and at different times within a single site. These communities were treated as part of the Interdune Pond type of the 3rd approximation.

Distinguishing Features: This type is distinguished by the occurrence of marshy vegetation in barrier island depressions that are permanently to semipermanently flooded. It is distinguished from the various subtypes of Maritime Wet Grassland, which also have dense herbaceous vegetation in dune swales, by having longer hydroperiods, deeper water, and vegetation indicative of wetter conditions. Interdune Marsh communities are usually dominated by large graminoids, such as *Typha* spp., *Schoenoplectus* spp., *Fimbristylis* spp., *Cladium jamaicense*, or *Zizania aquatica*. One example has a zone dominated by *Leptochloa fascicularis* var. *maritima*. In contrast, Maritime Wet Grasslands may have small patches dominated by *Schoenoplectus, Fimbristylis,* or *Juncus roemerianus* but are substantially dominated by *Spartina patens*, smaller *Juncus* spp. or other smaller graminoids or forbs, generally in a much more diverse mix. Interdune Marsh sites may be flooded by sea water during extreme events such as major storms but are otherwise fresh water. Dune swales that are regularly penetrated by water from normal spring tides or wind tides are Brackish or Tidal Freshwater Marsh communities rather than this type. They may share some of the above species but typically resemble one of the tidal marsh subtypes. If examining dune swales shortly after a major storm, distinguishing Interdune Marsh from tidal marshes may be difficult until equilibrium conditions return.

Comments: This community type is extremely variable in vegetation, within sites, among sites, and at different times within a site. Temporal variation follows unusually dry or wet periods or storm events that cause sea water penetration. Examples may vary in the long term because of different susceptibility to sea water penetration and drawdown. Since barrier islands are dynamic and geologically young, these communities may also change gradually due to primary succession. Where Interdune Marshes occur in complexes of swales, as at Buxton Woods, different basins may have different vegetation. The NVC associations listed above represent several particular vegetation types of individual marshes, but represent only two of the several occurrences of this community and do not characterize the vegetation of the other examples. It may be appropriate to recognize subtypes after further research.

Most ponds on barrier islands appear to be formed as dune swales, but some may also form by cutting off tidal creeks or inlets by sand movement. Ponds may potentially be destroyed by erosion which breaches the separation from tide water, or by sand movement that buries them. However, most known ponds appear to be long-lived.

Schoenoplectus pungens - Fimbristylis (castanea, caroliniana) Herbaceous Vegetation (CEGL004117) is an association of the Chesapeake Bay region, which appears to be a northern equivalent.

INTERDUNE POND G1 as defined here
Synonyms: No true NVC equivalent. *Lemna* spp. Permanently Flooded Herbaceous Vegetation (CEGL003059) is a very broadly defined association that would cover some examples at some times.
Ecological Systems: Central Atlantic Coastal Plain Maritime Forest (CES203.261). Northern Atlantic Coastal Plain Dune and Swale (CES203.264). Southern Atlantic Coastal Plain Dune and Maritime Grassland (CES203.273).

Concept: Type covers open water pond communities in the deepest, most permanently flooded interdune swales of barrier islands. Marshy ponds, included in this type in the 3rd approximation, are treated as the Interdune Marsh type here. In these ponds, long term rooted vegetation is confined to edge zones. Otherwise, open water, submersed aquatic plants, or floating aquatic plants predominate. Annual plants such as *Cyperus* spp. may establish during rare periods of drawdown.

Distinguishing Features: This type is distinguished by permanent or semipermanent open water in a barrier island setting. Floating aquatic plants such as *Lemna* spp. may or may not be present, as may submersed aquatic plants such as *Potamogeton* spp. *Nyssa biflora, Cephalanthus occidentalis, Salix nigra, Decodon verticillatus* and other plants may occur in the edge. Opportunistic plants may potentially establish in the pond bed in periods of extreme drawdown

MARITIME SWAMP FOREST (TYPIC SUBTYPE) G2
Synonyms: *Acer rubrum - Nyssa biflora - (Liquidambar styraciflua, Fraxinus* sp.) Maritime Swamp Forest (CEGL004082).
Ecological Systems: Central Atlantic Coastal Plain Maritime Forest (CES203.261).

Concept: Type covers non-tidal forested wetlands of barrier island dune swales. Subtype covers most examples, dominated by hardwood species. Canopy dominants are quite variable among the few examples.

Distinguishing Features: Maritime Shrub Swamps are distinguished from other barrier island wetlands by dominance by tree species of (at least potentially) large stature. The Typic Subtype is dominated by combinations of *Nyssa, Fraxinus, Liquidambar, Acer,* or *Quercus nigra*, rather than *Taxodium* or *Salix*.

MARITIME SWAMP FOREST (CYPRESS SUBTYPE) G1
Synonyms: *Taxodium distichum / Cephalanthus occidentalis / Boehmeria cylindrica - Ceratophyllum muricatum* Maritime Swamp Forest (CEGL004079).
Ecological Systems: Central Atlantic Coastal Plain Maritime Forest (CES203.261).

Concept: Subtype covers the rare examples dominated by *Taxodium*. It occurs in North Carolina only at Southern Shores and possibly in Kitty Hawk Woods .

Distinguishing Features: Subtype is distinguished by the dominance of *Taxodium* in a non-tidal barrier island setting.

MARITIME SHRUB SWAMP (DOGWOOD SUBTYPE) G1
Synonyms: *Cornus foemina / Berchemia scandens* Forest (CEGL007384).
Ecological Systems: Central Atlantic Coastal Plain Maritime Forest (CES203.261).

Concept: Type covers freshwater depressional wetlands of barrier island dune swales, dominated by shrubs or small trees. Subtype covers examples dominated *Cornus foemina*. *Persea palustris* may also be present, though not dominant, and a supercanopy of *Pinus taeda* may locally be present. It is known only in Buxton Woods.

Distinguishing Features: The Dogwood Subtype is readily distinguished from all other communities by the combination of barrier island dune swale setting and dominance by *Cornus foemina*.

MARITIME SHRUB SWAMP (RED BAY SUBTYPE) G1
Synonyms: *Persea palustris / Morella cerifera* Maritime Forest (CEGL004635).
Ecological Systems: Central Atlantic Coastal Plain Maritime Forest (CES203.261).

Concept: Subtype covers examples dominated by *Persea palustris*, with *Cornus foemina* scarce or absent. It is currently known only in Nags Head Woods and on Hatteras Island.

Distinguishing Features: The Red Bay Subtype is distinguished from all other communities by the combination of barrier island wet dune swale setting and dominance by *Persea palustris* without *Cornus* as a codominant.

MARITIME SHRUB SWAMP (WILLOW SUBTYPE) G2?
Synonyms: *Salix caroliniana / Sacciolepis striata - Boehmeria cylindrica* Woodland (CEGL004222).
Ecological Systems: Central Atlantic Coastal Plain Maritime Forest (CES203.261).

Concept: Subtype covers examples dominated by *Salix caroliniana*.

Distinguishing Features: The Willow Subtype is readily distinguished from all other communities by the combination of barrier island dune swale setting and dominance by *Salix caroliniana*.

Comments: This subtype is not well understood. Only a couple of small examples are known. Willows are generally more pioneer species, but this subtype does not appear to represent an earlier stage of primary or secondary succession.

Salix nigra Seasonally Flooded Forest (CEGL006348) is a maritime swamp of Virginia and may be found in North Carolina.

ESTUARINE FRINGE PINE FOREST (LOBLOLLY PINE SUBTYPE) G3
Synonyms: *Pinus taeda / Morella cerifera / Osmunda regalis var. spectabilis* Forest (CEGL006137).
Ecological Systems: Attributed to Central Atlantic Coastal Plain Maritime Forest (CES203.261), somewhat problematically.

Concept: Type covers strongly pine-dominated forests and woodlands adjacent to sounds or marshes, which have lower strata indicative of estuarine influence rather than consisting of typical pocosin shrubs. Subtype covers examples with *Pinus taeda*-dominated canopies.

Distinguishing Features: Estuarine Fringe Pine Forests are distinguished from Pond Pine Woodland and Nonriverine Swamp Forest by having a shrub layer dominated or codominated by *Morella cerifera*. Typical pocosin shrubs such as *Lyonia lucida* and *Cyrilla racemiflora* are absent or at least sparse, though *Ilex glabra* may be abundant. *Osmunda regalis* or *Woodwardia areolata* are generally the dominant herb, though *Woodwardia virginica* may be present. Other species shared with Tidal Freshwater Marshes or not typical of pocosins are usually present.

The Loblolly Pine Subtype is distinguished from the rarer Pond Pine Subtype by the canopy dominant.

Comments: The dynamics and ecological relationships of this community are not well understood. They occur in association with brackish estuaries, but are not tidally flooded. Penetration of brackish water likely occurs in major storms, but not with regular high lunar or wind tides. This subtype appears to be stable, likely regenerating after storm disturbance. It may be one of the few forest community types in North Carolina that is maintained by catastrophic disturbances. The NVC association synonymized to this subtype appears to be a broader concept, including barrier island and marsh island sites in states to the north.

ESTUARINE FRINGE PINE FOREST (POND PINE SUBTYPE) G2?
Synonyms: *Pinus serotina / Morella cerifera / Osmunda regalis var. spectabilis* Woodland (CEGL003669). Pond Pine Woodland (3rd Approximation).
Ecological Systems: Attributed to Atlantic Coastal Plain Peatland Pocosin and Canebrake (CES203.267), somewhat problematically.

Concept: Subtype covers examples with *Pinus serotina*-dominated canopies.

Distinguishing Features: The Pond Pine Subtype is distinguished from the more common Loblolly Pine Subtype by the canopy dominant.

Comments: This subtype was formerly treated within Pond Pine Woodland. However, despite the canopy, it appears to be more ecologically similar to *Pinus taeda*-dominated examples than to most Pond Pine Woodlands. Nevertheless, it is unclear how closely related the two subtypes are. The Loblolly Pine Subtype appears to be stable, having occupied sites for many years. All well-known examples of the Pond Pine Subtype appear to be transitional communities, developing from true Pond Pine Woodland communities as rising sea level brings occasional storm flooding and salt influence. It is unlikely that *Pinus serotina* can regenerate in these circumstances. However, at present rates of sea level rise, it apparently can persist for years and can occupy sizeable areas. This subtype might conceivably succeed to the Loblolly Pine Subtype in time, but it is more likely that continued sea level rise will gradually convert it to a marsh.

A few examples are known where rising sea level affecting a Pond Pine Woodland has led to a boggy community with open *Pinus serotina* canopy but with an herb layer dominated by *Sphagnum*,

Woodwardia virginica, even with *Vaccinium macrocarpon*. More information is needed on these communities. This may merit recognition as a distinct subtype or even a community type, but may be too short-lived.

ESTUARINE BEACH FOREST G2
Synonyms: *Acer rubrum / Sambucus canadensis / Ampelopsis arborea - Sicyos angulatus* Forest (CEGL004698).
Ecological Systems: Southern Atlantic Coastal Plain Tidal Wooded Swamp (CES203.240).

Concept: Type covers communities of chronically disturbed shorelines of freshwater or oligohaline estuaries, with vegetation that is more open than Tidal Cypress–Gum Swamp, Estuarine Fringe Pine Forest, or Tidal Freshwater Marsh. These communities likely are not frequently flooded by tides, but are more influenced by storm waves.

Distinguishing Features: This type is distinguished by occurrence on a chronically disturbed estuarine shoreline, and having vegetation that is more indicative of severe disturbance than any other estuarine community type. This includes an open canopy or young trees, and species composition that includes many weedy or disturbance-loving species.

Comments: This type is very little studied. It is possible that several subtypes will eventually be recognized. The NVC association is defined from a single site, at the mouth of the Roanoke River, apparently the only one for which data have been reported. The vegetation of these sites is likely to be quite variable, reflecting the small size of the communities and the opportunistic establishment of plants. A broadly defined conceptual type appears to be the best approach, but subdivision by amount of salt influence may be appropriate.

Freshwater Tidal Wetlands

TIDAL FRESHWATER MARSH (GIANT CORDGRASS SUBTYPE) G4
Synonyms: *Spartina cynosuroides* Herbaceous Vegetation (CEGL004195). Atlantic Coastal Plain Embayed Region Tidal Freshwater Marsh (CES203.259).
Ecological Systems: Atlantic Coastal Plain Central Fresh and Oligohaline Tidal Marsh (CES203.376).

Concept: Type covers very wet herbaceous wetlands, permanently saturated and regularly or irregularly flooded by lunar or wind tides with fully fresh or oligohaline water. Vegetation is often strongly zoned or patchy, and may include tall graminoids or short broadleaf or graminoid plants. Subtype covers the common, though often narrow, zones dominated by *Spartina cynosuroides*, generally on the edges of oligohaline channels or next to open water. This subtype has a broad range of salt tolerance, and may occur from marginally brackish to fully fresh water.

Distinguishing Features: The Tidal Freshwater Marsh community type is distinguished from all Brackish Marsh and Salt Marsh by occurring in oligohaline to fresh water and having plants intolerant of brackish water. Even subtypes dominated by brackish water-tolerant species such as *Juncus roemerianus* have associated intolerant species associated with them. Tidal Freshwater Marshes are often invaded by shrubs or trees in the absence of fire, making the natural border with adjacent woody vegetation difficult to determine.

The Giant Cordgrass Subtype is distinguished from all other subtypes by the dominance of *Spartina cynosuroides*.

Comments: Tidal Freshwater Marsh has more subtypes than any other community type. Most occur as zones or as apparently random patches in a mosaic. Most are based on a single dominant species that spreads clonally, and it is not entirely clear that they represent anything other than the chance spread of clones. Other portions of marsh complexes have mixed vegetation that is intermediate between two or more of the subtypes. In particular, the Giant Cordgrass, Sawgrass, Threesquare, and Cattail subtypes tend to occur together. The Needlerush Subtype also is a major part of this mosaic in the Currituck Sound area. It is unclear if these represent stable mosaics or if the subtypes shift over time. With further study, it may be appropriate to lump these into a single subtype. However, the relative amounts of each vary, and some are absent from particular sites, suggesting some value in attempting to track each specifically. The other subtypes are more distinct and are associated with different kinds of sites.

Spartina cynosuroides - Panicum virgatum - Phyla lanceolata Herbaceous Vegetation (CEGL007741) is another association in NVC, described from southeast Virginia and attributed to North Carolina. It appears to be a narrowly defined association that overlaps the more broadly defined *Spartina cynosuroides* association. *Panicum virgatum* is present in North Carolina's examples but without high constancy. It doesn't appear to make sense to try to distinguish two associations in North Carolina, though it may be appropriate to divide the more broadly defined association into several, of which the Virginia association is one. The association synonymized to this subtype ranges from New Jersey to South Carolina.

Taxodium distichum / *Typha angustifolia* Woodland (CEGL004231) and several other tidal *Taxodium distichum* woodlands have been recognized in Virginia and attributed to North Carolina. These do not appear to be distinct enough to be appropriate as community elements. *Taxodium* groves may be present in most of the Tidal Freshwater Marsh subtypes.

TIDAL FRESHWATER MARSH (SAWGRASS SUBTYPE) G4?
Synonyms: *Cladium mariscus ssp. jamaicense* Tidal Herbaceous Vegetation (CEGL004178). Atlantic Coastal Plain Embayed Region Tidal Freshwater Marsh (CES203.259).
Ecological Systems: Atlantic Coastal Plain Central Fresh and Oligohaline Tidal Marsh (CES203.376).

Concept: Subtype covers the common zones in oligohaline areas, dominated by *Cladium jamaicense*, which may be in a narrow zone near channels or may cover large expanses.

Distinguishing Features: The Sawgrass Subtype is distinguished from all other subtypes by the dominance of *Cladium jamaicense*. It is one of the most salt-tolerant subtypes, and may extend into brackish water areas.

Comments: There are suggestions that, in the absence of fire, this subtype may expand at the expense of the shorter subtypes such as the Threesquare and Oligohaline Low Marsh Subtype. The association for this subtype ranges from Virginia to Louisiana.

TIDAL FRESHWATER MARSH (NEEDLERUSH SUBTYPE) G2G3

Synonyms: *Juncus roemerianus - Pontederia cordata* Herbaceous Vegetation (CEGL004660).
Ecological Systems: Atlantic Coastal Plain Embayed Region Tidal Freshwater Marsh (CES203.259). Atlantic Coastal Plain Central Fresh and Oligohaline Tidal Marsh (CES203.376).

Concept: Subtype covers the common zones dominated or codominated by *Juncus roemerianus* while having salt-intolerant species that are shared with other Tidal Freshwater Marsh subtypes but absent from Brackish Marshes. These zones are generally in the interior of oligohaline marshes.

Distinguishing Features: The Needlerush Subtype is distinguished from all other subtypes by the dominance or codominance of *Juncus roemerianus* in an oligohaline setting. It is distinguished from the Needlerush Subtype of Brackish Marsh by the presence of less salt-tolerant plants such as *Thelypteris palustris var. pubescens*, *Osmunda regalis*, *Sagittaria falcata*, *Eleocharis fallax*, *Pontederia cordata*, or by association with other Tidal Freshwater Marsh subtypes in areas of oligohaline to fresh water.

Comments: There are suggestions that in the absence of fire this subtype may expand at the expense of the shorter subtypes such as the Threesquare and Oligohaline Low Marsh Subtype. This subtype is rare, occurring only in the Embayed Region of northeast North Carolina and southeast Virginia. It was initially believed to represent a non-equilibrium community of Currituck Sound, where closure of inlets in the barrier islands led to conversion of salt water sound to fresh water in the 1800s. However, examples have since been found in other parts of the Embayed Region.

TIDAL FRESHWATER MARSH (THREESQUARE SUBTYPE) G2G3

Synonyms: *Schoenoplectus pungens* - (*Osmunda regalis* var. *spectabilis*) Herbaceous Vegetation (CEGL004189).
Ecological Systems: Atlantic Coastal Plain Embayed Region Tidal Freshwater Marsh (CES203.259). Atlantic Coastal Plain Central Fresh and Oligohaline Tidal Marsh (CES203.376).

Concept: Subtype covers the uncommon zones dominated or codominated by *Schoenoplectus pungens (= Scirpus pungens)* in association with other salt-intolerant plants. These zones generally occur in the interior of oligohaline marshes.

Distinguishing Features: The Threesquare Subtype is distinguished from all other subtypes by the dominance of *Schoenoplectus pungens (= Scirpus pungens)* or by the codominance of *Schoenoplectus* with species other than the dominants of other subtypes. It may grade particularly gradually into the Oligohaline Low Marsh Subtype.

Comments: As defined, this subtype is confined to North Carolina, though it is unclear why it should be confined there. It is known both from the wind tidal marshes of the Embayed Region and the lunar tidal freshwater marshes of southeastern North Carolina.

Schoenoplectus pungens Tidal Herbaceous Vegetation (CEGL004188) is a more northern, but also more brackish, association of more northern marshes.

TIDAL FRESHWATER MARSH (CATTAIL SUBTYPE) G?
Synonyms: *Typha angustifolia - Hibiscus moscheutos* Herbaceous Vegetation (CEGL004201).
Unnamed *Typha latifolia* tidal association.
Ecological Systems: Atlantic Coastal Plain Embayed Region Tidal Freshwater Marsh (CES203.259).
Atlantic Coastal Plain Central Fresh and Oligohaline Tidal Marsh (CES203.376).

Concept: Subtype covers zones dominated or codominated by *Typha latifolia, Typha angustifolia*, or *Typha domingensis*. These generally occur in the interior of oligohaline marshes.

Distinguishing Features: The Cattail Subtype is distinguished from all other subtypes by the dominance of *Typha,* or by the codominance of *Typha* with species other than the dominants of other subtypes.

Comments: The NVC describes this association as being a brackish marsh, but it occurs in North Carolina in oligohaline marshes. The NVC at present has no tidal *Typha latifolia* association, so oligohaline marshes dominated by it are included in this subtype. As defined, this is a wide-ranging association, occurring from Maine to North Carolina. It should be divided into associations of similar biogeographic scale to the other marsh associations.

TIDAL FRESHWATER MARSH (SOUTHERN WILD RICE SUBTYPE) G3G5
Synonyms: *Zizaniopsis miliacea* Tidal Herbaceous Vegetation (CEGL004705).
Ecological Systems: Atlantic Coastal Plain Embayed Region Tidal Freshwater Marsh (CES203.259).
Atlantic Coastal Plain Central Fresh and Oligohaline Tidal Marsh (CES203.376).

Concept: Subtype covers fringing marshes and marsh zones dominated by *Zizaniopsis miliacea*. These are generally associated with fully fresh water rather than oligohaline, and often occur on rivers near the upper reaches of tidal influence.

Distinguishing Features: The Southern Wild Rice Subtype is distinguished from all other subtypes by the dominance by *Zizaniopsis miliacea* or by the codominance of *Zizania* with species other than the dominants of other subtypes. It is distinguished from Interdune Ponds and other areas where *Zizaniopsis* may dominate by occurrence of lunar or wind tidal flooding or occurrence in association with other Tidal Freshwater Marsh or Tidal Swamp subtypes.

Comments: This subtype extends far up tidal rivers, occurring as disjunct patches on the shoreline of Tidal Swamps well upstream of most other Tidal Freshwater Marsh subtypes. It less often occurs in mosaics with other subtypes.

Alnus serrulata / (Zizania aquatica, Zizaniopsis miliacea) Shrubland (CEGL004627) is a shrubby tidal marsh association known from as near as the lower Waccamaw River in South Carolina, and might occur in North Carolina. It is unclear how distinct it is from this subtype.

TIDAL FRESHWATER MARSH (WILD RICE SUBTYPE) G4?
Synonyms: *Zizania aquatica* Tidal Herbaceous Vegetation (CEGL004202).
Ecological Systems: Atlantic Coastal Plain Embayed Region Tidal Freshwater Marsh (CES203.259).
Atlantic Coastal Plain Central Fresh and Oligohaline Tidal Marsh (CES203.376).

Concept: Subtype covers the rare (in NC) zones strongly dominated by *Zizania aquatica*. These are generally associated with fully fresh water rather than oligohaline.

Distinguishing Features: The Wild Rice Subtype is distinguished from all other subtypes by the dominance of *Zizania aquatica* or by the codominance of *Zizania* with species other than the dominants of other subtypes. It is distinguished from Interdune Ponds and other areas where *Zizania* may dominate by occurrence of lunar or wind tidal flooding or occurrence in association with other Tidal Freshwater Marsh subtypes.

Comments: The status of this subtype in North Carolina is very uncertain. *Zizania aquatica* is reported as present, and occasionally dominant, in marshes. But the difficulty distinguishing this species from *Zizaniopsis* calls for some caution in interpreting literature sources.

Alnus serrulata / (Zizania aquatica, Zizaniopsis miliacea) Shrubland (CEGL004627) is a shrubby tidal marsh association known from as near as the lower Waccamaw River in South Carolina, and might occur in North Carolina.

TIDAL FRESHWATER MARSH (OLIGOHALINE LOW MARSH SUBTYPE) G1
Synonyms: *Eleocharis fallax - Eleocharis rostellata - Schoenoplectus americanus - Sagittaria lancifolia* Herbaceous Vegetation (CEGL004628).
Ecological Systems: Atlantic Coastal Plain Embayed Region Tidal Freshwater Marsh (CES203.259). Atlantic Coastal Plain Central Fresh and Oligohaline Tidal Marsh (CES203.376)?

Concept: Subtype covers the interior zones of oligohaline marshes that are dominated by often-diverse mixtures of shorter herbs such as *Eleocharis fallax, Eleocharis rostellata, Sagittaria falcata,* or *Pontederia cordata*. As defined, it is a diverse and highly variable association.

Distinguishing Features: The Oligohaline Low Marsh Subtype is distinguished from other subtypes by the dominance of the species named above or by a mixture of short herbs with no clear dominants.

Comments: This subtype as defined is broad, and includes complex variation from site to site and within sites. It is the most diverse of the subtypes, often with a high species richness, and may harbor rare species. This subtype is particularly susceptible to invasion by *Phragmites australis*. It also tends to be replaced by taller graminoid subtypes in the absence of fire, and may have substantially declined since the advent of fire control.

TIDAL FRESHWATER MARSH (MIXED FRESHWATER SUBTYPE) G2?
Synonyms: *Carex stricta - Peltandra virginica - Sagittaria (lancifolia* ssp. *media, latifolia)* Tidal Herbaceous Vegetation (CEGL004314).
Ecological Systems: Atlantic Coastal Plain Embayed Region Tidal Freshwater Marsh (CES203.259). Atlantic Coastal Plain Central Fresh and Oligohaline Tidal Marsh (CES203.376).

Concept: Subtype covers diverse marshes of the most inland locations, where water is completely fresh, where broadleaf herbs are abundant and where species intolerant of oligohaline conditions are present.

Distinguishing Features: The Mixed Freshwater Subtype is distinguished by occurrence on more inland, freshwater tidal sites, and by the presence of species intolerant of oligohaline conditions. They include abundant *Peltandra virginica* and *Sagittaria* spp., and may include *Carex stricta, Spartina pectinata, Impatiens capensis, Apios americana, Zizania aquatica, Lilium superbum,* and *Bidens frondosa,* as well as small numbers of *Cornus foemina* or *Cephalanthus occidentalis.* They lack *Juncus roemerianus, Cladium jamaicense, Schoenoplectus pungens, Eleocharis fallax,* and *Eleocharis rostellata,* The Wild Rice Subtype, Southern Wild Rice Subtype, Broadleaf Pond-Lily Subtype, and Narrowleaf Pond-Lily Subtype also occur in freshwater rather than oligohaline situations, but are low-diversity communities dominated by the nominal species.

Comments: As defined, this subtype appears to be confined to North Carolina. Virginia has wind-tidal oligohaline marshes but lacks fully freshwater ones. Several lunar-tidal freshwater marsh associations occurring farther north in Virginia are fairly closely related to this subtype.

TIDAL FRESHWATER MARSH (SHORELINE LAWN SUBTYPE) G2
Synonyms: *Eriocaulon parkeri - Polygonum punctatum* Herbaceous Vegetation (CEGL006352).
Ecological Systems: Atlantic Coastal Plain Embayed Region Tidal Freshwater Marsh (CES203.259). Atlantic Coastal Plain Central Fresh and Oligohaline Tidal Marsh (CES203.376).

Concept: Subtype includes all short vegetation of the lower, wetter oligohaline marsh areas, usually along tidal channels but potentially in interior depressions connected to channels. They may be dominated by *Eriocaulon parkeri, Lilaeopsis chinensis, Lilaeopsis carolinensis,* or other species. As defined, it is a diverse and highly variable association that may warrant further division. It usually occurs as narrow fringes or small patches.

Distinguishing Features: The Shoreline Lawn Subtype may be distinguished from other subtypes by occurrence in lower, wetter area and dominance by very short, graminoid or phylloidial vegetation. Most marsh edges are very narrow bands. Only larger patches should be recorded as occurrences of this subtype.

Comments: This subtype was formerly synonymized with CEGL004303 *Eriocaulon parkeri.* That association was merged into the one named above.

TIDAL FRESHWATER MARSH (BROADLEAF PONDLILY SUBTYPE) G4G5
Synonyms: *Nuphar advena* Tidal Herbaceous Vegetation (CEGL004472).
Ecological Systems: Atlantic Coastal Plain Embayed Region Tidal Freshwater Marsh (CES203.259). Atlantic Coastal Plain Central Fresh and Oligohaline Tidal Marsh (CES203.376).

Concept: Subtype covers channel edges and pools in oligohaline to fresh marshes that are dominated by floating-leaved aquatic plants. The dominant plant is usually *Nuphar advena* (= *Nuphar lutea ssp. advena*), and often few or no other vascular plants are present.

Distinguishing Features: The Broadleaf Pondlily Subtype is distinguished from all other subtypes by the dominance of *Nuphar advena*. It is distinguished from Coastal Plain Semipermanent Impoundment,

Small Depression Pond, and other communities with floating-leaved plants by occurring in areas flooded by wind or lunar tides.

Comments: This community sometimes occurs in "pools" in marsh interiors, and sometimes along the edge of marsh patches. More often, it occurs on the edges of tidal rivers, where it may co-occur with the Southern Wild Rice Subtype and also may extend farther upstream than other marsh subtypes. The Broadleaf Pondlily and Narrowleaf Pondlily subtypes occupy different geographic ranges. *Nuphar advena* is a widespread species to the north.

TIDAL FRESHWATER MARSH (NARROWLEAF PONDLILY SUBTYPE) GNR
Synonyms: *Nuphar sagittifolia* Tidal Herbaceous Vegetation (CEGL006094).
Ecological Systems: Atlantic Coastal Plain Central Fresh and Oligohaline Tidal Marsh (CES203.376).

Concept: Subtype covers edges and pools in oligohaline to fresh marshes that are dominated by *Nuphar sagittifolia* (= *Nuphar lutea ssp. sagittifolia*).

Distinguishing Features: The Narrowleaf Pondlily Subtype is distinguished from all other subtypes by the dominance of *Nuphar sagittifolia*. It is distinguished from Coastal Plain Semipermanent Impoundment, Small Depression Pond, and other communities with floating-leaved plants by occurring in areas flooded by wind or lunar tides.

Comments: This community most often occurs on the edges of tidal rivers, where it may co-occur with the Southern Wild Rice Subtype and also may extend farther upstream than other marsh subtypes. The Broadleaf Pondlily and Narrowleaf Pondlily subtypes occupy different geographic ranges. This association was initially described for Virginia only. It has an unusual distribution, apparently present in a small area of Virginia and in southeastern North Carolina but not in northeastern North Carolina.

TIDAL FRESHWATER MARSH (SHRUB SUBTYPE) G4
Synonyms: *Morella cerifera* - *Rosa palustris* / *Thelypteris palustris* var. *pubescens* Shrubland (CEGL004656).
Ecological Systems: Atlantic Coastal Plain Embayed Region Tidal Freshwater Marsh (CES203.259).

Concept: Subtype covers transitional zones between Tidal Freshwater Marsh and Tidal Swamp or other forests, where the vegetation is naturally dominated by shrubs. Relict trees may be present in areas that have recently developed into Tidal Freshwater Marsh in response to rising sea level.

Distinguishing Features: Subtype is distinguished by dominance by shrubs in a freshwater tidal setting. *Morella cerifera* and *Rosa palustris* are the most common species, but *Persea palustris, Baccharis halimifolia, Salix caroliniana, Toxicodendron radicans* tangles, *Smilax walteri* tangles, and saplings of *Acer rubrum* var. *trilobum*, *Pinus taeda*, or other species may also be common.

Comments: This subtype is often extensive in the landward parts of large freshwater marsh complexes, and at the upstream extent of large freshwater marshes. It is usually the first subtype to develop when Tidal Swamp canopies are killed by rising sea level. Indeed, since its dominant species are the characteristic species of the lower strata of open Tidal Swamps, in a sense it appears fully formed.

Morella cerifera - Toxicodendron radicans / Spartina bakeri Shrubland (CEGL004789) is a more southern equivalent from South Carolina to Florida. *Morella cerifera - Baccharis halimifolia / Eleocharis fallax* Shrubland (CEGL006846) is a more northerly equivalent from Virginia, Maryland, and Delaware.

FRESHWATER MARSH POOL G3?

Synonyms: *Ceratophyllum demersum - Utricularia macrorhiza - Nymphaea odorata* Herbaceous Vegetation (CEGL004661).
Ecological Systems: Atlantic Coastal Plain Embayed Region Tidal Freshwater Marsh (CES203.259). Atlantic Coastal Plain Central Fresh and Oligohaline Tidal Marsh (CES203.376).

Concept: Type covers permanently flooded, submersed aquatic vegetation of pools and calm edges of Tidal Freshwater Marshes and freshwater sounds. As defined, this is a broad type that may need division into subtypes.

Distinguishing Features: Freshwater Marsh Pools may be distinguished by dominance by submersed aquatic vegetation in association with Tidal Freshwater Marshes. The means for distinguishing from other submersed estuarine vegetation of the sounds is not clear.

TIDAL SWAMP (CYPRESS–GUM SUBTYPE) G?

Synonyms: *Nyssa biflora - (Taxodium distichum, Nyssa aquatica) / Morella cerifera - Rosa palustris* Tidal Forest (CEGL004484).
Ecological Systems: Southern Atlantic Coastal Plain Tidal Wooded Swamp (CES203.240).

Concept: Type covers forested wetlands significantly influenced by regular or irregular tidal fluctuations, occurring in lower reaches of rivers and creeks, and adjacent to freshwater estuaries. Subtype covers the most common examples, dominated by some combination of *Nyssa biflora, Nyssa aquatica,* and *Taxodium distichum*.

Distinguishing Features: Tidal Swamp is distinguished by vegetation that is distinct from comparable non-tidal swamps. This includes a blurring of blackwater-brownwater distinctions (i.e., brownwater species appearing adjacent to rivers that are blackwater farther upstream, or vice versa); presence of species indicative of tidal influence (e.g. *Morella cerifera*, various herbs shared with Tidal Freshwater Marsh); evidence of increased wetness, in the form of stressed trees, increased mortality, canopy thinning, and plants indicative of permanent saturation. Some of the vegetational differences from nonriverine and riverine swamps may result from permanent saturation and increasing wetness from rising sea level, rather than from tidal flooding itself. Evidence of tidal fluctuations may be taken as distinguishing this type if there is substantial fluctuation. Because tidal influence attenuates up rivers, the transition from Cypress—Gum Swamp to Tidal Swamp is gradual, and it may be that some tidal fluctuation could be detectable upstream of where the vegetation is affected.

Tidal Swamps are distinguished from Nonriverine Swamp Forest, which may have a very similar canopy, by the shrub layer. Nonriverine Swamp Forests have acid-tolerant species such as *Ilex glabra* and *Lyonia lucida, Smilax laurifolia,* and *Woodwardia virginica,* and lack *Morella cerifera*. On the

broad organic deposits along drowned wind tidal rivers in the Embayed Region, such as the Alligator, Chowan, and Northwest, Tidal Swamps sometimes give way to Nonriverine Swamp Forest away from the river, but in other places have oval patches of Nonriverine Swamp Forest on slightly raised areas embedded within the Tidal Swamp.

The Cypress–Gum Subtype is distinguished by dominance by combinations of *Nyssa biflora, Nyssa aquatica, Taxodium distichum,* and *Acer rubrum.*

Comments: There is much variation within this type, which may warrant recognition of different subtypes. In particular, the distinction between tidal swamps on brownwater and blackwater rivers, might be ecologically significant, as might the distinction between regular lunar tidal flooding and irregular wind tidal flooding. However, floristic analysis of North Carolina's examples shows no recognizable pattern correlating with these environmental differences.

Nyssa biflora - Nyssa aquatica - Taxodium distichum / Saururus cernuus Forest (CEGL004696) is a problematic association attributed to Virginia and North Carolina. It appears to overlap substantially in concept with the one named above and is probably not distinct. Milo Pyne and Gary Fleming (pers. comm. Jan. 2009) agree that it can be dropped (or lumped with this). *Pinus taeda - Nyssa biflora - Taxodium distichum* / *Morella cerifera* / *Osmunda regalis* var. *spectabilis* Forest (CEGL004651) is an association defined in southeast Virginia. It has pronounced hummock-and-hollow topography, coarse fibric peat, and little *Nyssa aquatica*. While these characteristics are present in some North Carolina examples of this type, no distinct community of this sort has been found.

Taxodium distichum / *Typha angustifolia* Woodland (CEGL004231) and several other tidal *Taxodium distichum* woodlands have been recognized and attributed to North Carolina. These do not appear to be distinct enough to be appropriate as community elements. Some appear to be ecotonal or transitional to Tidal Freshwater Marsh.

TIDAL SWAMP (MIXED SUBTYPE) G1G2

Synonyms: *Fraxinus pennsylvanica - (Ulmus americana) - Pinus taeda / Morella cerifera - Juniperus virginiana var. silicicola* Tidal Forest (CEGL004483).
Ecological Systems: Southern Atlantic Coastal Plain Tidal Wooded Swamp (CES203.240).

Concept: Subtype covers examples dominated by *Fraxinus pennsylvanica* or *Ulmus americana,* sometimes with *Pinus taeda,* possibly by other *Fraxinus* species.

Distinguishing Features: Subtype is distinguished by the canopy dominants. Because these species don't tend to occur in adjacent related communities, this subtype should be much easier to distinguish from other types than is the Cypress–Gum Subtype. However, confusion may occur with low levee forests farther inland. This subtype is distinguished from Brownwater Levee Forest by the presence of species in the lower strata that are indicative of tidal influence, increased wetness, and increased light levels. *Morella cerifera* and *Juniperus virginiana* are both good indicators, as are a number of herbs shared with Tidal Freshwater Marsh.

Comments: *Fraxinus pennsylvanica / Cornus foemina / Carex bromoides* Forest (CEGL007742) has been described from the Northwest River in Virginia. It is called a riverine community rather than tidal,

but it sounds like it is very similar to this type. If something like it occurred in North Carolina, it would be included in this subtype.

TIDAL RED CEDAR FOREST G1
Synonyms: *Juniperus virginiana var. silicicola / Morella cerifera / Kosteletzkya virginica - Bacopa monnieri* Woodland (CEGL007166).
Ecological Systems: Southern Atlantic Coastal Plain Tidal Wooded Swamp (CES203.240).

Concept: Open woodlands of *Juniperus* with marsh species beneath, occurring adjacent to brackish or salt tidal waters or marshes and at least partially flooded by them. An irregular ground surface allows the trees to root above normal tide levels, while brackish marsh species occur beneath them.

Distinguishing Features: Tidal Red Cedar Forest is distinguished from Marsh Hammock by being lower and wetter, with tidal waters regularly penetrating at least the lower microsites. Marsh Hammock communities may have some marsh flora present, but it is more incidental, occurring in sandy or dry soils.

Comments: Examples occurring on organic and on mineral soils may be worthy of recognition as separate subtypes.

Estuarine Communities

SALT MARSH (CAROLINIAN SUBTYPE) G5
Synonyms: *Spartina alterniflora* Carolinian Zone Herbaceous Vegetation (CEGL004191). Ecological Systems: Southern Atlantic Coastal Plain Salt and Brackish Tidal Marsh (CES203.270). Atlantic Coastal Plain Embayed Region Tidal Salt and Brackish Marsh (CES203.260).

Concept: Type covers marshes regularly flooded by sea water at full salinity, dominated by *Spartina alterniflora*. Subtype covers examples of the Carolinian Faunal Zone, from Cape Hatteras southward, which differ in the composition of their fauna and algal flora.

Distinguishing Features: The Salt Marsh type is distinguished from most other marshes by the dominance of *Spartina alterniflora*. It is distinguished from the Smooth Cordgrass subtype of Brackish Marsh, which does contain *Spartina alterniflora*, by having tidal waters at or near full sea water salinity and by lacking *Lilaeopsis chinensis* and other less salt-tolerant species. Associated plants in Salt Marshes are limited to just a few species, such as *Salicornia* spp. and *Distichlis spicata*. The Carolinian Subtype is believed to differ from the Virginian Subtype in composition of the associated algal and animal communities but the differences are not well determined. It is suggested that the alga *Ascophyllum nodosum* may be characteristic of the Acadian Zone and absent in the Carolinian Zone. At present, the two subtypes should be distinguished by geographic location.

Comments: Ranges from North Carolina to Florida.

SALT MARSH (VIRGINIAN SUBTYPE) G5
Synonyms: *Spartina alterniflora* / (*Ascophyllum nodosum*) Acadian/Virginian Zone Herbaceous Vegetation (CEGL004192).
Ecological Systems: Atlantic Coastal Plain Embayed Region Tidal Salt and Brackish Marsh (CES203.260).

Concept: Subtype covers examples of the Virginian Zone, from Cape Hatteras northward, which differ in the composition of their fauna and algal flora.

Distinguishing Features: The Virginiana Subtype is believed to differ from the Carolinian Subtype in the composition of the animal communities and algae. It has been suggested that the alga *Ascophyllum nodosum* is characteristic of the Virginian Zone and not the Caroliniana Zone. At present, the two subtypes should be distinguished by geographic location.

Comments: Ranges from North Carolina to Nova Scotia.

BRACKISH MARSH (SALT MEADOW CORDGRASS SUBTYPE) G4G5
Synonyms: *Spartina patens - Distichlis spicata - (Juncus roemerianus)* Herbaceous Vegetation (CEGL004197).
Ecological Systems: Southern Atlantic Coastal Plain Salt and Brackish Tidal Marsh (CES203.270). Atlantic Coastal Plain Embayed Region Tidal Salt and Brackish Marsh (CES203.260).

Concept: Type covers marshes that are salt influenced but to a lesser degree than Salt Marshes, due to regular or irregular flooding by brackish water or by irregular flooding by salt water mitigated by freshwater input. It includes marshes of estuarine areas at some distance from oceanic inlets, where the water is brackish, and also higher zones of Salt Marshes in areas with salt water.

Subtype covers examples dominated or codominated by *Spartina patens*. They most often occur as higher zones of Salt Marshes and are flooded with full strength salt water at less than daily intervals.

Distinguishing Features: Brackish Marshes are distinguished from Salt Marshes by having vegetation dominated by *Spartina patens*, *Juncus roemerianus*, or by having *Spartina alterniflora* in combination with less salt-tolerant species such as *Lilaeopsis chinensis*. They are distinguished from Tidal Freshwater Marsh subtypes by lacking salt-intolerant species. The Salt Meadow Cordgrass Subtype is distinguished from the other subtypes of Brackish Marsh by dominance of *Spartina patens*. It is distinguished from Maritime Dry Grassland and Maritime Wet Grassland, which may also be dominated by *Spartina patens*, by the absence of upland species and salt-intolerant species such as *Rhynchospora colorata* and *Muhlenbergia sericea*. It also usually may be distinguished by the presence of some plant species shared with Salt Marshes, such as *Distichlis spicata* and *Borrichia frutescens*, which are absent in maritime grasslands.

BRACKISH MARSH (NEEDLERUSH SUBTYPE) G5
Synonyms: *Juncus roemerianus* Herbaceous Vegetation (CEGL004186).
Ecological Systems: Southern Atlantic Coastal Plain Salt and Brackish Tidal Marsh (CES203.270). Atlantic Coastal Plain Embayed Region Tidal Salt and Brackish Marsh (CES203.260).

Concept: Subtype covers examples dominated by *Juncus roemerianus*, often with few or no other vascular plant species present. This common subtype may occur either as an upper zone of Salt Marshes, in the headwaters of tidal creeks upstream from Salt Marshes, or in vast expanses in the brackish sounds. In the sounds, it may be influenced by wind tides or lunar tides.

Distinguishing Features: The Needlerush Subtype is distinguished from other subtypes by the dominance of *Juncus roemerianus*. It is distinguished from the Needlerush Subtype of Tidal Freshwater Marsh by the absence of less salt-tolerant plant species such as *Thelypteris palustris, Osmunda regalis, Sagittaria lancifolia,* and *Pontederia cordata*.

BRACKISH MARSH (SMOOTH CORDGRASS SUBTYPE) G?
Synonyms: *Spartina alterniflora - Lilaeopsis chinensis* Herbaceous Vegetation (CEGL004193).
Ecological Systems: Southern Atlantic Coastal Plain Salt and Brackish Tidal Marsh (CES203.270). Atlantic Coastal Plain Embayed Region Tidal Salt and Brackish Marsh (CES203.260).

Concept: Subtype covers examples of regularly flooded brackish to oligohaline tidal rivers, dominated or codominated by *Spartina alterniflora,* and having plants intolerant of sea water salinity. This subtype is little known, but is present on the Brunswick River and possibly the estuarine Cape Fear River.

Distinguishing Features: The little-known Smooth Cordgrass Subtype is distinguished from other Brackish Marsh subtypes by the presence of *Spartina alterniflora* and by occurrence in regularly flooded brackish areas. The presence of *Lilaeopsis chinensis* and other plant species intolerant of full sea water salinity distinguishes this subtype from Salt Marsh.

BRACKISH MARSH (TRANSITIONAL SUBTYPE) GNR (likely G4 or G5)
Synonyms: *Panicum virgatum - Spartina patens* Herbaceous Vegetation (CEGL006150).
Ecological Systems: North Atlantic Coastal Plain Brackish Tidal Marsh (CES203.894).

Concept: Subtype is currently broadly defined to cover the varied vegetation of the irregularly flooded inland transition zones of Brackish Marsh and Salt Marsh communities.

Distinguishing Features: This subtype is distinguished by herbaceous dominated vegetation not attributable to the other subtypes but influenced by irregular salt or brackish tidal flooding. It occurs adjacent to other Brackish Marsh or Salt Marsh communities, and represents the transition zone of diminishing tidal influence, where vegetation of inland communities is not able to persist. It may be closely related to Salt Shrub, but is distinguished by scarcity of shrubs. Where salt shrub is absent, the transition to scrub or forest vegetation is generally clear. The transition to Maritime Wet Grassland on barrier islands may be ambiguous, as these communities share some species. However, presence of species not tolerant of frequent salt water flooding, such as *Rhynchospora colorata, Centella erecta,* and *Muhlenbergia sericea* should distinguish Maritime Wet Grassland.

Comments: These communities are seldom described or sampled, and are not well known. Further revision may well be needed as data accumulate. *Panicum virgatum - (Cladium mariscus ssp. jamaicense, Juncus roemerianus)* Herbaceous Vegetation (CEGL004962*)* is a Gulf Coast equivalent

community. *Schoenoplectus americanus - Spartina patens* Herbaceous Vegetation (CEGL006612) is another transitional association, questionably attributed to North Carolina. It is reported to occur between low marsh and high marsh, rather than at the edge of high marsh. It is unclear if it occurs in North Carolina, nor whether it would be distinguishable from this subtype if it did.

TIDAL MUD FLAT GNR

Synonyms: *Isoetes riparia* Tidal Herbaceous Vegetation (CEGL006058).
Ecological Systems: Southern Atlantic Coastal Plain Salt and Brackish Tidal Marsh (CES203.270).
Atlantic Coastal Plain Embayed Region Tidal Salt and Brackish Marsh (CES203.260).

Concept: Type covers sparse vegetated tidal mud flats. While *Isoetes riparia* may dominate, other sparsely vegetated tidal mud flat vegetation should be placed here as well. The range and vegetation of this type are not well known.

Distinguishing Features: The Tidal Mud Flat type is distinguished from other tidal communities by predominance of small plants other than the characteristic dominants of the various marsh types. Vegetation is usually sparse.

Comments: Several subtypes are likely to be distinguished with further study. *Sagittaria subulata - Limosella australis* Tidal Herbaceous Vegetation (CEGL004473) is a northern equivalent of this type that ranges into Virginia.

SALT FLAT G5

Synonyms: *Salicornia* (*virginica, bigelovii, maritima*) - *Spartina alterniflora* Herbaceous Vegetation (CEGL004308).
Ecological Systems: Southern Atlantic Coastal Plain Salt and Brackish Tidal Marsh (CES203.270).
Atlantic Coastal Plain Embayed Region Tidal Salt and Brackish Marsh (CES203.260).

Concept: Type covers salt panne areas, where salt water is concentrated by evaporation between tides. Sparse to moderately dense vegetation is dominated by plants tolerant of hypersaline conditions, such as *Salicornia virginica, Sarcocornia pacifica, Distichlis spicata*.

Distinguishing Features: Salt Flats are distinguished from Salt Marshes and all other communities by the predominance of the above species.

SALT SHRUB (HIGH SUBTYPE) G5

Synonyms: *Baccharis halimifolia - Iva frutescens / Panicum virgatum* Shrubland (CEGL003921).
Baccharis halimifolia - Iva frutescens - Morella cerifera - (*Ilex vomitoria*) Shrubland (CEGL003920).
Ecological Systems: Southern Atlantic Coastal Plain Salt and Brackish Tidal Marsh (CES203.270).
Atlantic Coastal Plain Embayed Region Tidal Salt and Brackish Marsh (CES203.260).

Concept: Type covers areas on high edges of salt marshes, infrequently flooded with salt water and dominated by the most salt-tolerant shrubs. Subtype covers higher, less frequently flooded examples dominated by *Baccharis halimifolia, Iva frutescens,* and *Morella cerifera. Spartina patens* is sometimes

an important component.

Distinguishing Features: Salt Shrub is distinguished from all other community types by having vegetation dominated or codominated by *Baccharis halimifolia, Iva frutescens,* or *Borrichia frutescens*. When it has a substantial amount of *Morella cerifera,* it is distinguishable from Maritime Shrub by the codominance of one of these species. The High Subtype is distinguished from the Low Subtype by the predominance of *Baccharis halimifolia* or *Iva frutescens* over *Borrichia frutescens.*

Comments: It is unclear how the two synonymized NVC associations relate and whether they are that distinctive. *Iva frutescens* / *Spartina patens* Shrubland (CEGL006848) is a northeastern association attributed to North and South Carolina. It also appears to be redundant with the above associations, at least in North Carolina.

SALT SHRUB (LOW SUBTYPE) G4

Synonyms: *Borrichia frutescens* / (*Spartina patens, Juncus roemerianus)* Shrubland (CEGL003924).
Ecological Systems: Southern Atlantic Coastal Plain Salt and Brackish Tidal Marsh (CES203.270). Atlantic Coastal Plain Embayed Region Tidal Salt and Brackish Marsh (CES203.260).

Concept: Subtype covers lower-lying, more frequently flooded examples dominated by *Borrichia frutescens,* often with a substantial component of *Juncus roemerianus*, *Spartina patens,* or *Distichlis spicata*.

Distinguishing Features: The Low Subtype is distinguished from the High Subtype by having *Borrichia frutescens* as the dominant shrub, with *Baccharis halimifolia* and *Iva frutescens* scarce and/or confined to higher microsites.

UPPER BEACH (NORTHERN SUBTYPE) G4G5

Synonyms: *Cakile edentula* ssp. *edentula* - *Chamaesyce polygonifolia* Sparse Vegetation (CEGL004400).
Ecological Systems: Central Atlantic Coastal Plain Sandy Beach (CES203.064).

Concept: Type covers the sparsely vegetated areas between the unvegetated intertidal beach and the foredunes. Subtype covers more northerly examples where *Cakile edentula* (*Cakile edentula* ssp. *edentula*) dominates.

Distinguishing Features: Upper Beaches are distinguished from Dune Grass by the absence of significant cover of *Uniola paniculata* or of plants of other coastal communities. Its seaward edge is the portion of the beach where all vascular plants are absent. The Northern Subtype is distinguished by being dominated by *Cakile edentula* ssp. *edentula* rather than *Cakile edentula* ssp. *harperi* (= *Cakile harperi*).

Comments: The two subtypes are included provisionally. They reflect a distinction recognized in NVC, and believed to correlate well with biogeography. However, the ranges of the two species (or subspecies) of *Cakile* appear to overlap substantially in North Carolina. It is not clear how the two subtypes interact in the range of overlap. This subtype ranges from North Carolina northward to Maine.

The communities covered by the Sand Flat type were included in this type in earlier drafts of the 4th approximation, as well as in the 3rd approximation, but are distinguished here.

UPPER BEACH (SOUTHERN SUBTYPE) G3
Synonyms: *Cakile edentula* ssp. *harperi* Sparse Vegetation (CEGL004401).
Ecological Systems: Southern Atlantic Coastal Plain Southern Beach (CES203.535).

Concept: Subtype covers more southerly examples, where *Cakile harperi* (*Cakile edentula* ssp. *harperi*) dominates.

Distinguishing Features: The Southern Subtype is distinguished by the dominance by *Cakile harperi* rather than *Cakile edentula s.s.*

Comments: This subtype ranges from North Carolina to Georgia or Florida.

SAND FLAT G3
Synonyms: *Sesuvium portulacastrum* - *Atriplex* spp. - *Suaeda* spp. Sparse Vegetation (CEGL004406).
Ecological Systems: Central Atlantic Coastal Plain Sandy Beach (CES203.064).

Concept: Type covers sparsely vegetated communities of the extensive low-lying sand flats on the accreting ends of barrier islands.

Distinguishing Features: Sand Flat communities are distinguished by occurrence on accreting sand flats and by sparse vegetation containing *Sesuvium*, *Atriplex*, and *Suaeda*. Incipient dunes dominated by *Uniola paniculata* may be present, but substantial areas should be regarded as inclusions of Dune Grass.

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4th Approximation names not matching 3rd Approximation names

Most changes in the 4th Approximation are simple additions of subtypes, without any change in concept at the type level. There are some minor changes in names that should be readily recognizable. This table lists 3rd Approximation names where these are not apparent. In many cases, these are newly recognized communities that were not explicitly covered in the 3rd Approximation, and the equivalent is a poorly fitting concept. Are few newly discovered communities are so distinctive that no 3rd Approximation type is reasonably equivalent.

4th Approximation name	3rd Approximation equivalent
High Elevation Birch Boulderfield	Boulderfield Forest
Cape Fear Valley Mixed Bluff Forest	no equivalent – newly discovered
Low Mountain Pine Forest (Shortleaf Pine Subtype)	Pine—Oak/Heath
Low Mountain Pine Forest (Montane Pine Subtype)	Pine—Oak/Heath
Southern Mountain Pine—Oak Forest	Montane Oak—Hickory Forest
Southern Mountain Pine—Oak Woodland	Pine—Oak/Heath
Calcareous Oak—Walnut Forest	Mesic Mixed Hardwood Forest (Montane Calcareous Subtype)
Montane Grape Opening	no equivalent – newly discovered
Mixed Moisture Hardpan Forest	Dry Oak—Hickory Forest, Dry-Mesic Oak—Hickory Forest
Swamp Island Evergreen Forest	Coastal Fringe Evergreen Forest
Montane Cliff (Acidic Subtype)	Montane Acidic Cliff
Montane Cliff (Mafic Subtype)	Montane Mafic Cliff
Montane Cliff (Calcareous Subtype)	Montane Calcareous Cliff
Talus Vineland	High Elevation Rocky Summit, Montane Acidic Cliff
Piedmont Cliff (Acidic Subtype)	Piedmont/Coastal Plain Acidic Cliff
Piedmont Cliff (Basic Subtype)	Piedmont Mafic Cliff, Piedmont Calcareous Cliff
Coastal Plain Cliff	Piedmont/Coastal Plain Acidic Cliff
Granitic Flatrock Border Woodland	Granitic Flatrock
Low Elevation Acidic Glade	Low Elevation Rocky Summit, Low Elevation Granitic Dome
Low Elevation Basic Glade	Low Elevation Rocky Summit, Low Elevation Granitic Dome
Montane Red Cedar—Hardwood Woodland	no equivalent – but adopted before 4th Approximation
Granitic Dome Basic Woodland	Montane Oak—Hickory Forest, Basic Oak—Hickory Forest
Acidic Shale Slope Woodland	no equivalent – but adopted as “Dry Rocky Slope” before 4th Approximation
Calcareous Shale Slope Woodland	no equivalent – but adopted as “Dry Rocky Slope” before 4th Approximation
Piedmont Acidic Glade	Low Elevation Rocky Summit
Piedmont Basic Glade	Low Elevation Rocky Summit
Xeric Piedmont Slope Woodland	Dry Oak—Hickory Forest

Live Dune Barren	Dune Grass
Stable Dune Barren	Maritime Dry Grassland
Maritime Vine Tangle	Maritime Dry Grassland
Calcareous Coastal Fringe Forest	no equivalent – but adopted before 4th Approximation
Marsh Hammock	Maritime Evergreen Forest
Coastal Fringe Shell Woodland	no equivalent – but adopted as Calcareous Coastal Fringe Forest before 4th Approximation
Dry Piedmont Longleaf Pine Forest	Piedmont Longleaf Pine Forest
Sand Barren	Xeric Sandhill Scrub
Mesic Pine Savanna	Mesic Pine Flatwoods
Brownwater Levee Forest	Coastal Plain Levee Forest (Brownwater Subtype)
Blackwater Levee/Bar Forest	Coastal Plain Levee Forest (Blackwater Subtype)
Brownwater Bottomland Hardwoods	Coastal Plain Bottomland Hardwoods (Brownwater Subtype)
Blackwater Bottomland Hardwoods	Coastal Plain Bottomland Hardwoods (Blackwater Subtype)
Cypress—Gum Swamp (Intermediate Subtype)	Cypress—Gum Swamp (Blackwater Subtype)
Sandhill Streamhead Swamp	Coastal Plain Small Stream Swamp (Blackwater Subtype)
Riverine Floating Mat	no equivalent
Montane Floodplain Slough Forest	Montane Alluvial Forest
Piedmont Alluvial Forest	Piedmont/Low Mountain Alluvial Forest
Piedmont/Mountain Levee Forest	Piedmont Levee Forest
Piedmont/Mountain Swamp Forest	Piedmont Swamp Forest
Piedmont/Mountain Bottomland Forest	Piedmont Bottomland Forest
Piedmont/Mountain Canebrake	no equivalent
French Broad Valley Bog	Southern Appalachian Bog (Southern Subtype)
Low Mountain Seepage Bog	Southern Appalachian Bog (Southern Subtype)
High Elevation Boggy Seep	High Elevation Seep
Rich Montane Seep	High Elevation Seep, Low Elevation Seep
Piedmont Boggy Streamhead	no equivalent -- but adopted before 4th Approximation
Coastal Plain Seepage Bank	no equivalent
Pocosin Opening	Low Pocosin
Peatland Canebrake	Pond Pine Woodland
Streamhead Canebrake	Streamhead Pocosin
Wet Piedmont Longleaf Pine Forest	Piedmont Longleaf Pine Forest
Sandy Pine Savanna	Pine Savanna
Wet Loamy Pine Savanna	Pine Savanna
Very Wet Loamy Pine Savanna	Pine Savanna
Northern Wet Pine Savanna	Pine Savanna
Small Depression Shrub Border	Small Depression Pond, Cypress Savanna
Coastal Plain Depression Swamp	Nonriverine Swamp Forest
Small Depression Drawdown Meadow	Small Depression Pond
Floating Bog	no equivalent
Interdune Marsh	Interdune Pond

Estuarine Fringe Pine Forest (Loblolly Pine Subtype)	Estuarine Fringe Loblolly Pine Forest
Estuarine Fringe Pine Forest (Pond Pine Subtype)	Pond Pine Woodland
Estuarine Beach Forest	no equivalent
Freshwater Marsh Pool	Tidal Freshwater Marsh
Tidal Red Cedar Forest	no equivalent - but added before 4th Approximation
Tidal Mud Flat	no equivalent
Sand Flat	Upper Beach

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