PIEDMONT AND MOUNTAIN FLOODPLAINS

Contents

PIEDMONT AND MOUNTAIN FLOODPLAINS THEME

Concept: Piedmont and Mountain Floodplain communities occur on alluvial soils or in areas that are presently or recently influenced by overbank flooding by rivers or streams. They include bars and scoured areas along the channel that are too recently deposited or too frequently disturbed to support forests but which have lower stature or sparser vegetation. Characteristic vegetation distinguishes Piedmont and Mountain Floodplains even where flooding is rare or has been eliminated by dams, stream incision, or other alterations.

Distinguishing Features: Piedmont and Mountain Floodplain communities are distinguished by occurring in stream or river floodplains, influenced by overbank flooding. A suite of characteristic alluvial species (e.g., *Platanus occidentalis, Betula nigra, Xanthorhiza simplicissima, Chasmanthium latifolium,* and *Elymus hystrix*) indicates this environment, and at least several members should be present to distinguish floodplain communities from upland communities or other wetlands such as Mountain Bogs and Fens. Most examples also have combinations of plant species not found in either Mountain Cove Forests or Mountain Oak Forests, such as a mixture of upland and wetland species. Most floodplains have alluvial soils, though sometimes in bodies too small to map, but areas that show signs of scouring or movement of material by water during common flood conditions (e.g., 5-year floods) should also be included.

Within this theme, communities are distinguished first by being forested or open. Nonforested communities include canebrakes, beaver ponds, pools, stream bars, and shore areas kept open by more intense flood disturbance. Forested communities are distinguished by geographic region and the related floristic differences, and by floodplain size. The mountain communities occur in the Blue Ridge but also in the mountainous foothill areas where gradients tend to be steeper and where the flora of the Mountain Region is present. The Piedmont communities occur in the rest of the Piedmont Region, extending through the Fall Zone. They are separated from the Coastal Plain Floodplains theme where floodplains are bordered by Coastal Plain sedimentary formations and are no longer confined by harder igneous and metamorphic rock of the Piedmont. Floodplains tend to abruptly widen and gradients decrease at this point.

Larger floodplains have depositional landforms that are large enough to form separate natural communities – natural levees, lower backswamps and sloughs, and bottomland ridges and terraces. Smaller floodplains may have such landforms but the scale is too small to form separate communities, often just the size of a few trees; they are treated as a single community that fills the floodplain. As noted by Matthews, et al. (2011), the distinction is the size of the floodplain, not the size of the river. Large rivers in gorges or confined to narrow floodplains by hard rock lack large depositional landforms and have mixed vegetation. In the soft Triassic sedimentary rocks, moderate-size creeks can form large floodplains with well-developed depositional landforms. These Triassic basin floodplains can share characteristics with Coastal Plain floodplains, but their flora remains more related to the Piedmont.

Sites: Piedmont and Mountain Floodplain communities generally occur in distinct valley bottoms, where stream erosion and alluvial deposition have created a more level surface than in the adjacent uplands. At least some semblance of a bottom is often present along even small intermittent streams but, especially in the Mountains, slopes may adjoin a channel without any recognizable

floodplain or floodplain community. Narrow bands of floodplain vegetation may occur on steeper slopes at the base of bluffs or upland slopes next to rivers. Larger floodplains may have distinct raised natural levees along the river, but sometimes the rapid deposition, coarse sediment deposits, and increased floodwater currents associated with levees occur on the riverbank without a distinct raised area. Large floodplains sometimes have substantial microrelief, with wet sloughs or backswamp basins and ridges creating different environments. Some have broad terraces that are flatter, are well above the river, but still have alluvial soils that flood in the largest floods and that support floodplain communities.

Soils: Soils include several series of alluvial soils, usually Incepticols and Entisols, but sometimes Ultisols on the older terraces.

Hydrology: Piedmont and Mountain Floodplains generally flood for relatively short periods, due to the high gradient of the rivers, and floodwaters usually have significant current. Only places where water flow is trapped by basins or beaver dams retain surface water much of the year. Nevertheless, variations in wetness are enough to create differences in communities. When not flooded, soil drainage can vary substantially; areas near the river channel may be well drained, while interior areas may be well drained or poorly drained.

Rivers usually have a single channel, which may meander or be fairly straight. Islands and multiple channels occur but are not common. River channels appear to be quite stable, and course changes appear rare, though undercutting of banks can topple trees. However, bars within the channel may be reworked fairly frequently. Overflow channels parallel to the river are sometimes present.

Vegetation: Piedmont and Mountain Floodplain vegetation is extremely variable. The forest communities share a large pool of species in all strata, and species group less clearly than those in the Coastal Plain Floodplains theme. There is a set of wetter communities that have fewer tree species, but their characteristic species, such as *Fraxinus pennsylvanica*, *Ulmus americana*, and *Acer rubrum*, also occur in many other floodplain communities. A suite of species, such as *Platanus occidentalis, Betula nigra*, and *Acer negundo*, as well as *Chasmanthium latifolium*, are indicative of natural levees, but they can also occur in more mixed forests in other settings. Many species occur primarily in floodplains but can be found in uplands where soils are basic. *Lindera benzoin, Juglans nigra, Aesculus sylvatica, Phryma leptostachya, Elymus virginicus*, and *Elymus hystrix* are a small sample of this suite of species. Nonnative species are present more often than not. Several exotic species frequently occur in the same site, and they fairly often dominate the herb or shrub layer. Much more than in the Coastal Plain, upland species are an abundant part of the mix in most Piedmont and Mountain Floodplains. There is substantial biogeographic variation in flora, with a number of species largely limited to the Mountains and foothills, some to the lower Piedmont.

Although nonforested communities are more limited in acreage in Piedmont and Mountain Floodplains, they are important parts of the diversity. Piedmont/Mountain Semipermanent Impoundment communities, in beaver ponds, may once have been very extensive. They represent a diverse collection of aquatic, marsh, and shrubland vegetation. Canebrakes, now nearly gone, may once have been extensive. Rocky Bar and Shore communities represent several subtypes, with

sparse to moderate-density vegetation. They range from nearly monospecific to some of the most species-rich communities in North Carolina.

Dynamics: Natural vegetation dynamics in the forests of the Piedmont and Mountain Floodplains theme are similar to those of most upland hardwood forests, with long-lived trees dominating, tree populations multi-aged, and tree replacement primarily in small gaps.

Flash floods can cause local damage, especially in the mountains. Otherwise, though floods in forests of this theme may scour the ground surface locally and disturb herbaceous vegetation, mortality of trees due to erosion or wetness is rare. Most trees are killed by wind, lightning, or disease. Severe storms occasionally create medium or larger canopy gaps. Natural levees, with exposure to the open channel, may be particularly susceptible to windthrow, but the sandy soils of smaller stream bottoms may also make them vulnerable. The author has observed multiple areas where hurricane-caused windthrow in the Piedmont was concentrated in small stream bottoms while adjacent uplands were less disturbed. Increased disturbance of this sort may be the reason for the abundance of *Liriodendron tulipifera, Liquidambar styraciflua*, and other trees that disperse widely, readily occupy openings, and benefit from severe disturbance. Many of the most characteristic alluvial tree species, such as *Platanus occidentalis, Betula nigra, Acer negundo*, and *Celtis laevigata,* also have these traits. However, notably, other trees that have these characteristics, such as *Pinus taeda* and *Pinus virginiana*, while sometimes present in floodplains, are not abundant except in human-cleared areas.

While flooding is not an important natural disturbance in the forested communities in this theme, it is a crucial environmental factor in the nonforest communities in this theme. Scouring, battering, removal of soil, and reworking of sediment are the processes that keep the bar communities open. In Floodplain Pool and Piedmont/Mountain Semipermanent Impoundment communities, long-term inundation prevents establishment of a tree canopy.

Flooding is an important natural process that provides nutrients and redistributes material. Large floods in mountainous areas can leave new deposits of cobbles or boulders along smaller creeks or larger rivers. Piedmont and Mountain Floodplains may have either a net loss or net accumulation of sediment. Wrack, flood-piled litter and wood, or the bare ground they create when they decay or are moved may be important microsites. Thanks to the frequent influx of nutrient-rich fine sediments, floodplain soils are generally the most fertile in these regions.

While sediment accretion is slow at present, there was a period of rapid deposition, especially in Piedmont rivers, during the 1700s and 1800s, caused by erosion driven by widespread clearing and plowing of uplands. This change in sediment dynamics was accompanied by construction of numerous mill dams and by the recent extirpation of beavers. The full consequences of these changes are not clear. Walter and Merritts (2008) suggest that no Piedmont streams, at least in the range of 1st to 3rd order, escaped drastic alteration. Their sediment cores and trenches through floodplain deposits suggest a past with multiple anabranching channels, extensive organic-rich soils, and abundant wetland and aquatic macrophytes rather than the single deep, meandering channel and drier floodplains that prevail today. It should be noted that, though their primary study area in the Pennsylvania Piedmont had a very high density of mills, their map of mill density throughout the Piedmont showed a different situation in North Carolina and South Carolina. Here,

mill density was ¼ to ½ that of Pennsylvania, suggesting that many streams or reaches must have escaped. Even without extensive damming, however, a large influx of sediment may have aggraded floodplains. Walter and Merritts (2008) suggested seepage as the cause of wet conditions in floodplains in the past, with seepage sources now blocked by accumulated sediment. However, such conditions could also have been created by beaver ponds, and they may also have been favored by the cooler, wetter climate of the Pleistocene.

Hydrological changes caused by land clearing and urbanization in watersheds and along tributaries confound these effects. Active headward erosion and entrenchment can still be observed along some smaller streams in both rural and urban areas, and the underlying cause is not always clear. Many of the larger floodplains have also been hydrologically altered, as well as fragmented, by large reservoirs.

Agriculture and secondary succession in its aftermath are important factors in the higher parts of medium and large floodplains. Because bottomlands were the focus of cultivation by Native American cultures, some floodplain areas may have a very long history of repeated shifting cultivation. With European settlement, long term cultivation occurred in many areas that are now forested. Some areas of successional forest are readily recognizable by furrows and by vegetation composition, but some are not as readily distinguishable from unplowed areas as they are in the uplands. The tree species that invade abandoned fields remain more prominent in climax forests. *Liquidambar styraciflua* and *Liriodendron tulipifera* most often dominate successional forests in even-aged stands. Successional patterns were described in detail by Oosting (l942), who noted that *Betula nigra* or *Platanus occidentalis* may form uniform stands in abandoned fields away from the banks and levees where they otherwise occur.

Piedmont and Mountain Floodplains are particularly susceptible to invasion by exotic plants, because of their high fertility, transport of seeds by flood waters, and perhaps local scouring and sediment movement. Land clearing and human disturbance exacerbates invasion, but even the least disturbed floodplains are very vulnerable. Brown (2002) found unusually high numbers of different exotic species in the most frequently flooded riparian sites. Brown and Peet (2003) addressed patterns of invasibility. In general, in minimally altered mountain riparian areas, the number of exotic species increases with the number of native species in riparian communities, and both increase with flooding frequency. The authors conclude that species richness is driven by immigration processes and propagule pressure. However, at the finest scales, native and exotic species richness are negatively correlated, presumably because plants are competing more directly for space. Such relationships have not been examined in the Piedmont but probably are similar.

The most poorly known natural dynamic process of floodplains is that of beavers (*Castor canadensis*). Beavers were extirpated early in European settlement in North Carolina, and they were absent until reintroduced in 1939. They have since spread throughout the state and have been in some areas for decades. But it is unclear to what extent they have reached a natural equilibrium in any given place. Trapping and management of beavers occurs in many areas, and natural predators are no longer present. Beavers prefer 2nd order streams (Snodgrass 1997) and they strongly prefer low gradients. Many Piedmont and most Mountain streams probably are too steep and swift for them. At the least, the higher gradients and occurrence of flash floods would have reduced the life span of beaver dams compared to the Coastal Plain. Aquatic communities in ponds

may have been less stable and less diverse. However, flood-damaged dams could have been rebuilt in the same places rather than leading beavers to relocate. An important question for small streams is whether all parts of a stream are attractive for pond building or if certain sites are naturally favored, and hence whether ponds shifted randomly and eventually affected the whole area, or if certain sites were chronically ponded while others never were. See the description of Piedmont/Mountain Semipermanent Impoundment for more on the dynamics of beavers and beaver ponds.

It is somewhat unclear how important fire naturally was in Piedmont and Mountain Floodplains. Smaller floodplains are well connected to upland forests, as are the peripheral parts of larger floodplains. Fire probably could not spread soon after litter had been redistributed by flooding, but at other times it might carry though most of a forest, at least as far as the river channel. However, moist conditions in floodplains and in adjacent mesic upland forests would limit fire intensity, so that burning might have had limited ecological effect. Additionally, sloughs and swamps would block the spread of fire to many parts of larger floodplains. Given the focus of Native American settlement in larger river bottoms, anthropogenic fire probably was locally very frequent in later prehistsoric times.

One additional major uncertainty about floodplain community dynamics concerns canebrakes. *Arundinaria tecta* is the prevailing cane species in the Piedmont, *Arundinaria gigantea* in the Mountains. Definitive historical references to canebrakes in North Carolina are scarce, compared to states farther south and farther west. Both cane species are common in many large and medium floodplains, and their stalks were widely used by the Cherokee and other native peoples, but it is unclear how numerous or how large the areas dominated by them were. Dominance by cane could have been self-perpetuating in the presence of regular fire, with the flammable vegetation promoting more frequent and intense fires that would perpetuate its dominance.

Comments: Piedmont and Mountain Floodplain communities have been less intensively studied than those of the Coastal Plain. Descriptive site reports are less numerous, especially for vegetation on larger rivers, where few unaltered examples remain, and for the smallest streams, which often are ignored. The smallest stream bottoms also are poorly represented in plots, because they often are narrow enough to make it difficult to fit standard size plots in them. Broad scale vegetation descriptions in the Piedmont, such as Peet and Christensen (1980) and Wells (1974), describe floodplain vegetation but usually in general categories such as alluvial and swamp sites. In the Mountains, many of the most comprehensive studies focus on rugged areas; studies such as McLeod (1988), Newell (1997), Cooper and Hardin (1970), and DuMond (1969) address alluvial vegetation based on the small amounts in their study areas. However, a plot-based study of Piedmont floodplains by Matthews (2011) and of several Mountain Region rivers by Brown (2002) have helped bring specificity and higher resolution to these communities.

The classification of Piedmont and Mountain Floodplain communities has been particularly confusing and problematic. In an attempt to remedy this, the approach of leaving 3rd Approximation community concepts and boundaries largely unchanged has not been followed in this theme. The circumscription and central concepts are modified in several important ways.

The 4th Approximation more distinctly separates Piedmont from Mountain floodplains. While there is a rapid change in floodplain geomorphology and processes between the Piedmont and Coastal Plain, which supports a sharp break in communities at the theme level at the Fall Zone, there is no similar break in character at the Blue Ridge escarpment. Attempting to recognize Piedmont-like rivers in the Mountains did not work well. The 4th Approximation uses a different divide, based on the presence or absence of flora typically associated with the Mountain Region and with states to the west. As in many upland communities, this flora is often present in floodplains in the foothills area of the western Piedmont, and such floodplains are treated as Montane Alluvial Forest.

The Piedmont communities of large floodplains are now treated as more analogous to the bottomland hardwoods and swamps of the Coastal Plain, with each representing a portion of the wetness gradient. Bottomlands are characterized by being dry enough to favor some of the same species found in Brownwater Bottomland Hardwoods, particularly *Quercus michauxii* and *Quercus pagoda*. Swamps are wet enough that these species are scarce or absent. The 3rd Approximation's characterization of bottomlands as typically being dominated by *Liriodendron* or *Liquidambar*, using some of the few descriptions of these communities found at the time, appears to have been based on successional forests. Though these species are present in the less altered examples, their strong dominance suggests past cultivation or clearcutting. Oaks appear abundant in less altered examples. While *Liriodendron* remains typical of Piedmont Bottomland Forest and largely absent from Piedmont Swamp Forest, the broad moisture tolerance of *Liquidambar* makes it equally at home in both.

In addition, the 3rd Approximation's characterization of swamp forests as being largely confined to Triassic basins and making up most of their floodplains was misleading, as was the description of them having *Quercus michauxii* and *Quercus pagoda* widely mixed with species of wetter sites. While some floodplains can be extensively covered by one community or the other, many in both settings are complex mosaics. The bottomland oak species are only minor species in the swamps, largely confined to the Bottomland Transition Variant of Piedmont Swamp Forest. However, it is true that Triassic Basin floodplains tend to be wetter and have more swamp. It is also true that large bottomlands elsewhere are most often dominated by *Liquidambar* or *Liriodendron*, because most have been cultivated in the recent past. Oak-dominated bottomlands are more likely to be found on medium size floodplains and in complex floodplains with much swamp, places that were less suitable for cultivation.

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KEY TO PIEDMONT AND MOUNTAIN FLOODPLAINS

1. Vegetation a forest; a well-developed closed or somewhat open canopy of tall trees present when not recently disturbed.

2. Mountain or mountain-like floodplain; occurring in the Blue Ridge region or occurring in the foothills portion of the western Piedmont and having species characteristic of the Blue Ridge, such as *Betula lenta, Halesia tetraptera, Tilia americana* var. *heterophylla, Betula alleghaniensis*, and *Rhododendron maximum*.

3. Occurring on a large river, with a well-developed floodplain; alluvial species such as *Platanus occidentalis, Betula nigra, Acer negundo, Fraxinus pennsylvanica, Arundinaria gigantea, Alnus serrulata,* and *Boehmeria cylindrica* generally abundant and diverse; species such as *Celtis laevigata, Liquidambar styraciflua, Quercus pagoda, Chasmanthium latifolium*, and *Elymus riparius* may be present.

4. Occurring on a high terrace with alluvial soil but with flooding rare; forest dominated by upland oaks, hickories, or pines, such as *Quercus alba, Quercus rubra, Carya tomentosa, Carya pallida, Pinus rigida*, or *Pinus echinata*, with a relatively low diversity and abundance of alluvial species and mesophytic species. ..... **Montane Alluvial Forest (High Terrace Subtype)**

4. Occurring on a more typical lower floodplain; forest containing many alluvial or wetland species.

5. Occurring in low areas, such as sloughs, which retain standing water for long periods, or occasionally in uniformly wet floodplains; forest dominated by a small number of the most water-tolerant species, such as *Acer rubrum, Fraxinus pennsylvanica*, *Carpinus caroliniana, Boehmeria cylindrica, Impatiens capensis, Carex* spp., and *Lycopus*, with limited presence of more mesophytic species. ..... **Montane Floodplain Slough Forest**

5. Occurring on typical floodplain surfaces that are not flooded for long periods nor high enough to be very dry; alluvial species are common and diverse, though mixed with mesophytic and some upland species. ..... **Montane Alluvial Forest (Large River Subtype)**

3. Occurring on a small river or creek, with limited but some floodplain development; alluvial species present in limited abundance and diversity; often a canopy of species shared with Acidic Cove Forest (*Tsuga canadensis, Acer rubrum, Betula lenta, Liriodendron tulipifera*, etc. combined with species of rich sites, such as *Lindera benzoin, Asimina triloba, Carpinus caroliniana, Rudbeckia laciniata*, and *Amphicarpaea bracteata*. ..... **Montane Alluvial Forest (Small River Subtype)**

2. Piedmont floodplain; occurring in the eastern or central Piedmont, or, if occurring in the western Piedmont, lacking species characteristic of the Blue Ridge.

6. Occurring on a large floodplain on a large river or on a medium-sized creek within a Triassic basin; fluvial landforms such as natural levees, sloughs, bottomlands, and terraces large enough to support separate communities; at least two different forest communities present in the floodplain on at least one side of the river.

7. Community occurring in a low portion of the floodplain, in sloughs, backswamp basins, or occasionally in uniformly wet floodplains; flooded for substantial periods; canopy naturally dominated by water-tolerant species such as *Acer rubrum, Fraxinus pennsylvanica, Ulmus americana, Quercus lyrata*, or *Quercus phellos*, with limited presence of other floodplain species and no with no mesophytic or upland species; herb layer dominated by water-tolerant species such as *Saururus cernuus, Boehmeria cylindrica, Ludwigia palustris*, and wetland *Carex* species, though other floodplain species may be present. ..... **Piedmont Swamp Forest**

7. Community not in a low portion of the floodplain; not flooded for long periods; water-tolerant species of trees and herbs may be present but do not dominate and are confined to limited wet microsites.

8. Community occurring adjacent to the river, on a natural levee (higher depositional area next to the channel) or on a level or lower area that has distinct vegetation; alluvial species such as *Platanus occidentalis, Betula nigra, Acer negundo, Celtis laevigata,* and *Fraxinus pennsylvanica* dominant or codominant under natural conditions, though widespread species such as *Liriodendron tulipifera* and *Liquidambar styraciflua* may codominate and species of rich sites such as *Carya cordiformis, Acer floridanum*, and *Juglans nigra* may be abundant.

9. Community on a higher levee that also has abundant *Fagus grandifolia* and often other upland species along with alluvial species (Note that Piedmont Alluvial Forest can also have these species along with alluvial species). ..... **Piedmont Levee Forest (Beech Subtype)**

9. Community on a more typical levee or riverbank, lacking *Fagus grandifolia* and most other upland species. .....**Piedmont Levee Forest (Typic Subtype)**

8. Community not adjacent to a river channel or, if so, not showing any different character from the rest of the floodplain; on fluvial ridges, terraces, or uniform flats that are not extremely wet; forest with limited or no *Platanus occidentalis, Betula nigra, Acer negundo*, or *Celtis laevigata* (except occasionally in successional condition); dominated by bottomland oaks, hickories, *Liquidambar styraciflua*, and *Liriodendron tulipifera*; may have some upland species.

10. Community on a high terrace or higher fluvial ridges; flooding infrequent, though soils are alluvial; forest with a substantial component of upland species such as *Quercus rubra, Quercus alba,* and *Fagus grandifolia*, along with bottomland oaks, hickories, and other species; more water-tolerant species such as *Quercus lyrata, Ulmus americana*, and wetland herbs such as *Saururus cernuus, Juncus effusus*, and wetland *Carex* spp. generally absent ....**Piedmont Bottomland Forest (High Subtype)**

10. Community on lower floodplain ridges or possibly a low terrace; flooding more frequent, though still generally of brief duration; forest with limited upland species; bottomland oaks, hickories, *Liquidambar*, and *Liriodendron* dominate in natural condition; wetland herbs more widespread, though not dominant.

11. Forest with *Quercus palustris* or *Quercus bicolor* as a substantial component; rare community of the northern Piedmont. ..... **Piedmont Bottomland Forest (Northern Low Subtype)**

11. Forest without *Quercus palustris* or *Quercus bicolor*, or with only limited amounts; widespread community of the eastern and central Piedmont. .. **Piedmont Bottomland Forest (Typic Low Subtype)**.

6. Occurring on a small floodplain, either on an intermittent stream, a 1st to 3rd order stream, or on a larger river with a confined floodplain and without large fluvial landforms such as natural levees, sloughs, bottomlands, and terraces that support separate communities; only one forest community in the floodplain on both sides of the stream; composition mixed throughout the width of the floodplain, with alluvial species occurring with widespread species and mesophytic species throughout the floodplain.

12. Floodplain well-developed, though medium sized or small; well-developed channel present; multiple alluvial species such as *Platanus occidentalis, Fraxinus pennsylvanica, Betula nigra, Acer negundo*, and *Celtis laevigata* present and fairly abundant, though *Liquidambar* or *Liriodendron* usually dominate. .....**Piedmont Alluvial Forest**

12. Floodplain very small and/or marginally developed, though distinct from upland; channel may or may not be well developed; forest with few or no alluvial species; *Liriodendron,*

Liquidambar, or *Quercus phellos* generally dominate; upland species such as *Fagus grandifolia, Quercus rubra*, or *Quercus alba* may be abundant.

13. Community in an unusually flat area with hardpan conditions (shrink/swell soils) associated with mafic or clayey rocks; generally occurring with Upland Depression Swamp Forest or Xeric Hardpan Forest; canopy generally dominated by *Quercus phellos* and *Liquidambar styraciflua*. .....**Piedmont Headwater Stream Forest (Hardpan Subtype)**

13. Community in a typical small floodplain, without hardpan conditions; associated with typical acidic or basic upland communities; canopy dominated by *Liriodendron* or *Liquidambar* along with upland species..... **Piedmont Headwater Stream Forest (Typic Subtype)**

1. Vegetation not a forest; trees, if present at all, not forming a true canopy over most of the community due to long-term standing water, frequent flood damage, lack of time since the substrate was deposited, or dominance by *Arundinaria*.

14. *Arundinaria tecta* or *Arundinaria gigantea* forming a dense thicket; tall trees may be present but do not form a full canopy ..... **Piedmont/Mountain Canebrake**

14. *Arundinaria* absent or sparse.

15. Community a natural depression or blocked slough which holds standing water permanently or through much of the growing season. ..... **Floodplain Pool**

15. Community not a natural depression; open because of long-term standing water created by a beaver dam or because of frequency and severity of flooding.

16. Community presently or recently part of a beaver pond; if the beaver pond has drained, vegetation remains wetter and distinctly different from floodplain forest communities.

17. Community with semipermanent standing water deep enough to eliminate most emergent vegetation; vegetation of floating aquatic plants such as *Lemna* or *Nymphaea*, submersed aquatic plants, or vascular vegetation absent over most of the area; emergent vegetation limited to edges and higher microsites; other plants limited to microsites on logs, stumps, and bases of a few surviving trees ....**Piedmont/Mountain Semipermanent Impoundment (Open Water Subtype)**

17. Community with only shallow standing water or with water drained but vegetation not recovered to typical floodplain forest.

18. Community dominated by herbaceous vegetation; shrubs and trees limited.

19. Community in the Mountains or mountain-like foothills region. ...**Piedmont/Mountain Semipermanent Impoundment (Montane Marsh Subtype)**.

19. Community in the Piedmont, outside of the foothills region.....**Piedmont/Mountain Semipermanent Impoundment (Piedmont Marsh Subtype)**.

18. Community dominated by shrubs or young trees; in Piedmont or Mountains..... ..... **Piedmont/Mountain Semipermanent Impoundment (Shrub Subtype)**

16. Community not recently affected by impoundment by beavers; kept open by frequency and severity of flooding; located in or adjacent to the river channel.....**Rocky Bar and Shore** (see key A).

Key A. Rocky Bar and Shore.

1. Substrate predominantly of bedrock, kept largely free of soil by flood scouring; plants limited to small pockets of sediment and to fractures in the rock.

2. Community in the Mountains. ..... **Mountain Bedrock Scour Subtype**

2. Community in the Piedmont, known only along the Yadkin River in the Uwharrie region. ....**Yadkin Falls Bedrock Scour Subtype**

1. Substrate of loose deposited material, ranging from boulders and cobbles to sand and silt.
   3. Community in shallow flowing water at least most of the time; substrate with abundant boulders or cobbles; sparse to moderate vegetation generally consisting of a single strongly dominant species.
      4. Community dominated by *Carex torta*; in the Mountain region or mountain-like foothills. .. .. **Twisted Sedge Subtype**
      4. Community not dominated by *Carex torta*; generally in the Piedmont region.
         5. Community dominated by *Justicia americana*. ..... **Water Willow Subtype**
         5. Community not dominated by *Justicia americana*.
            6. Community dominated by *Podostemum ceratophyllum* on submerged rocks; potentially throughout the Piedmont. ..... **Riverweed Subtype**
            6. Community dominated by *Zizaniopsis miliacea*; confined to the eastern Piedmont near the fall zone. ..... **Southern Wild Rice Subtype**
   3. Community substrate above water level except in flood; substrate a mix of sand, silt, cobbles, and potentially boulders.
      7. Community a mix of species with some shrub component, with *Xanthorhiza simplicissima* or *Alnus serrulata* generally most abundant; on medium to small rivers; in the Mountain region or foothills. ..... **Alder--Yellowroot Subtype**
      7. Community not a mix with *Xanthorhiza* or *Alnus* predominant; in the Mountains or Piedmont; on medium to large rivers.
         8. Community strongly dominated by *Zizaniopsis miliacea*; confined to the eastern Piedmont near the fall zone. ..... **Southern Wild Rice Subtype**
         8. Community a variable mix of species, including small trees, shrubs, perennial and annual herbs, generally with no strong dominant; often very high species richness..... **Mixed Bar Subtype**

MONTANE ALLUVIAL FOREST (SMALL RIVER SUBTYPE)

Concept: Montane Alluvial Forests are communities of floodplains in the Mountain Region and foothills of the upper Piedmont. They consist of a mix of species of alluvial or floodplain settings combined with those of Rich Cove Forests and other upland communities. The Small River Subtype occurs on smaller floodplains, where upland species predominate and characteristic alluvial species are less abundant.

Distinguishing Features: Montane Alluvial Forests are distinguished from Rich Cove Forests and Acidic Cove Forests, with which they may share many species, by evidence of flooding as well as by more than a trace presence of some of a characteristic suite of wetland or alluvial indicator species, such as *Platanus occidentalis, Betula nigra*, and *Alnus serrulata*. Not all flat valley bottoms near streams develop as Montane Alluvial Forests; many are Rich Cove Forest or Acidic Cove Forest indistinguishable from those on slopes. The alluvial indicator species may codominate, but usually are less abundant. Sites that lack them altogether 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 nonriverine wetlands where these habitats 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 *Betula lenta, Tsuga canadensis, Halesia tetraptera*, *Tilia americana* var. *heterophylla, Aesculus flava, Betula alleghaniensis,* 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 are occasional. Also characteristic is a combination of acid-tolerant canopy species such as *Liriodendron tulipifera, Tsuga canadensis, Betula lenta, Acer rubrum, Betula alleghaniensis*, and *Halesia tetraptera* with lower strata of richer sites, such as *Asimina triloba, Lindera benzoin, Carpinus caroliniana, Rudbeckia laciniata, Amphicarpaea bracteata*, or any of a number of species shared with Rich Cove Forests. However, lower strata often are at least partly dominated by *Rhododendron maximum* or *Leucothoe fontanesiana*, and acid-tolerant herbs may predominate. In contrast, the Large River Subtype generally has more abundance and diversity of alluvial indicator plant species present. These include 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, 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.

The Small River Subtype may resemble Swamp Forest–Bog Complex in its dominant canopy trees and shrubs, but it will contain multiple alluvial species throughout the community. Wetland species

may be present in small numbers but will not be concentrated in boggy openings with *Sphagnum* and multiple species characteristic of bogs.

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).

Sites: The Small River Subtype occurs on flat areas near streams or small rivers. The characteristics that lead to Montane Alluvial Forest on some of these areas but not on many others are not well known.

Soils: The Small River Subtype probably generally occurs on some kind of alluvial soil, but it may often not be recognized in mapping. Mapped soils include Toxaway (Cumulic Humaquept), Rosman (Fluventic Haplumbrept), or Transylvania (Fluventic Humic Dystrudept)

Hydrology: The Small River Subtype is intermittently flooded. Flooding is of brief duration and probably doesn't happen in most years. Because of high stream gradients, these areas may have flash floods with substantial current, occasionally enough to be a significant natural disturbance. Other than in local small seepages or depressions, soils are probably well drained when not flooded.

Vegetation: The Small River Subtype may be dominated or codominated by *Liriodendron tulipifera, Tsuga canadensis*, or *Acer rubrum*, or more often is a diverse mix of trees. Characteristic floodplain species are present in several strata, but usually in low numbers. *Platanus occidentalis* is the most frequent such species, but *Betula nigra* may also occur. Other species that occur with high frequency in CVS plot data or site descriptions, also generally noted in local studies such as Newell (1997), McLeod (1988), Cooper and Hardin (1970), and Dumond (1969), are *Pinus strobus, Fraxinus americana*, and *Quercus alba.* Also fairly frequent are *Quercus rubra, Fagus grandifolia, Betula nigra*, and *Aesculus flava*. A diversity of other canopy trees may occasionally be present, including *Carya cordiformis*, other *Carya* spp., *Betula alleghaniensis*, and *Juglans nigra*. The understory is usually dominated by *Carpinus caroliniana*, and *Acer rubrum, Halesia tetraptera*, or other canopy species may be abundant. Other frequent understory species include *Ilex opaca, Oxydendrum arboreum, Cornus florida*, less frequently *Nyssa sylvatica*, *Asimina triloba*, *Acer pensylvanicum*, and a number of others. The shrub layer usually includes patches dominated by *Rhododendron maximum* and *Leucothoe fontanesiana*, and *Lindera benzoin* may dominate some examples. Other frequent shrubs include *Xanthorhiza simplicissima* (usually on the stream bank but sometimes more widespread), *Hydrangea arborescens, Arundinaria gigantea, Alnus serrulata, Hamamelis virginiana, Kalmia latifolia, Cornus amomum*, and *Calycanthus floridus*. A great diversity of additional species is found with low frequency. Vines are usually not extensive, but *Toxicodendron radicans* and the exotic *Lonicera japonica* occur with high frequency. The herb layer may be sparse to dense but is seldom as lush as in Rich Cove Forests. *Polystichum acrostichoides, Rudbeckia laciniata, Arisaema triphyllum, Parathelypteris noveboracensis, Mitchella repens, Athyrium asplenioides*, *Viola sororia*, and the exotic *Microstegium vimineum* are frequent in both CVS plot data and site descriptions. *Dichanthelium boscii, Sanicula canadensis, Eurybia divaricata, Ranunculus recurvatus,* and *Potentilla canadensis* are also at least fairly frequent in plot data, while *Impatiens capensis*, *Ageratina*

altissima var. *altissima, Packera aurea, Tiarella cordifolia, Boehmeria cylindrica, Eutrochium purpureum, Amphicarpaea bracteata, Juncus effusus, Osmundastrum cinnamomeum*, and *Scirpus polyphyllus* are fairly frequent in site reports. The genera *Carex*, *Viola*, and *Solidago* are frequent, but include multiple species and often aren't identified to species. A tremendous diversity of additional species occurs with low frequency, including most species of Rich Cove Forest, many of oak forests, species shared with other floodplain forests, and some wetland species. Of 440 species in the CVS plots used, 114 occur in only one plot, another 83 in two. A similar diversity of species, many of them different ones, is mentioned in only one or two site reports.

Range and Abundance: Ranked G3. Good remaining examples are fairly rare in North Carolina, with fewer than 30 occurrences known. Alluvial sites are not uncommon in montane areas, but very few examples of their communities remain intact. Surrounded by more rugged terrain, the alluvial valleys are the favored sites for fields, houses, towns, highways, and reservoirs,

The NVC association is considered widespread, ranging southward to Georgia, westward to Tennessee and Kentucky, and possibly into Virginia. However, its concept may not match North Carolina's community well and may be overly broad.

Associations and Patterns: The Small River Subtype may occur as either a large patch or small patch community. Bands may be 100 acres or more along a river. Other patches are naturally limited by small areas of floodplain development, which give way to steeper slopes and upland vegetation both upstream and downstream. Examples generally are bordered by Rich Cove Forest or Acidic Cove Forest on adjacent slopes. They may occasionally be associated with Swamp Forest–Bog Complex or Southern Appalachian Bog in areas where drainage becomes poor. They may contain small patches of Floodplain Pool or Low Elevation Seep.

Variation: The Small River Subtype is an extremely variable community. The large number of low-constancy species in both plots and sites is interesting, since most are common in the region and since flooding allows more seed dispersal than in many communities. The distance decay of similarity described by Brown (2002) for several larger rivers likely also is an important factor in the Small River Subtype. It may suggest great variation in environmental conditions. Individual occurrences may be heterogeneous or fairly uniform. Variation associated with stream and valley size, soil fertility, and amount of alluvial influence should be studied further. Two variants are tentatively defined, based on elevation and potentially biogeography:

1. Montane Variant occurs in the Blue Ridge region itself.
2. Foothills Variant occurs in the foothills area east of the Blue Ridge escarpment. It may contain Piedmont species that are scarce or absent in the Montane Variant.

Dynamics: Dynamics are generally like those described for the Piedmont and Mountain Floodplains theme as a whole. In their detailed study of age structure in alluvial forests at Coweeta, Hedman and Van Lear (1995) described old-growth stands as having broken heterogeneous overstories with various sized gaps and various sized trees filling them, interspersed with dominant and superdominant trees. The average diameter was diluted by the many small trees. The stands were uneven aged, with a steeply sloping size distribution for trees up to 30 cm dbh, indicating most do not live that long. The curve was flatter for trees that had reached the canopy, where they can live a long time, and steepened as mortality increased with old age. The authors also suggested

that *Tsuga canadensis*, *Pinus strobus*, and oaks increased in old growth, while *Liriodendron, Betula*, *Tilia*, and *Prunus serotina* were more prevalent in early successional stages.

As in all floodplain forests, sediment deposition provides a nutrient subsidy, though this may not be very different from the nutrient status of Rich Cove Forests. This community is perhaps more susceptible to serious disturbance by flooding than the Large River Subtype. Occasional extreme flash floods may substantially rework sediments, uproot trees, and scour out herbs, at least in parts of an occurrence.

Beavers may impound the Small River Subtype where the stream gradient is low enough, but it is unclear what proportion of examples are susceptible.

Comments: As discussed in the theme description, the relationship of Piedmont and Mountain Floodplain communities has been changed from the 3rd Approximation. Montane Alluvial Forest now includes foothills floodplain communities which contain montane flora as described here, and the Piedmont Alluvial Forest has been narrowed to communities that lack it. Even larger Mountain floodplains don't tend to have communities differentiated by natural levee and bottomlands, so the distinction between the Large River Subtype and Small River Subtype is more subtle and is treated as a difference between subtypes rather than full types.

No community analogous to Piedmont Headwater Stream Forest has been recognized in the Mountains. Small streams there tend to be associated with steeper slopes, and they support upland forests instead. However, an example of a possible analogous community in the South Mountains needs further investigation.

Reports on the Small River Subtype in published literature are scarce. However, McLeod (1988) and Newell (1997) included some data on the Small River Subtype.

Liriodendron tulipifera - Pinus strobus - (Tsuga canadensis) / Carpinus caroliniana / Amphicarpaea bracteata Forest (CEGL008405) is an equivalent and fairly similar association in the Central Appalachians.

Rare species:
Vascular plants: *Glyceria laxa,* and *Thalictrum macrostylum.*

References:
Brown, R.L. 2002. Biodiversity and exotic species invasion in Southern Appalachian riparian plant communities. Ph.D. dissertation, University of North Carolina-Chapel Hill.

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Hedman, C.W., and D.H. Van Lear. 1995. Vegetative structure and composition of Southern Appalachian riparian forests. Bulletin of the Torrey Botanical Club 122:134-144.

McLeod, D.E. 1988. Vegetation patterns, floristics, and environmental relationships in the Black and Craggy Mountains of North Carolina. Ph.D. Dissertation, UNC-Chapel Hill.

Newell, C.L. 1997. Local and regional variation in the vegetation of the Southern Appalachian Mountains. Ph.D. dissertation, University of North Carolina, Chapel Hill.

MONTANE ALLUVIAL FOREST (LARGE RIVER SUBTYPE)

Concept: Montane Alluvial Forests are communities of floodplains in the Mountain Region and foothills of the upper Piedmont. They consist of a mix of species of alluvial or floodplain settings combined with those of Rich Cove Forests and other upland communities. The Large River 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: Montane Alluvial Forests are distinguished from Rich Cove Forests and Acidic Cove Forests, with which they may share many species, by evidence of flooding as well as by more than a trace presence of some of a characteristic suite of wetland or alluvial indicator species, such as *Platanus occidentalis, Betula nigra*, *Alnus serrulata*, and *Xanthorhiza simplicissima*. The Large River Subtype usually has a substantial number of alluvial species. It is distinguished from the Small River Subtype by floristic differences that include the presence of a large suite of lowland floodplain plants, such as *Liquidambar styraciflua, 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.

Synonyms: *Platanus occidentalis - Liriodendron tulipifera - Betula (alleghaniensis, lenta) / Alnus serrulata - Leucothoe fontanesiana* Forest (CEGL004691).
Ecological Systems: South-Central Interior Large Floodplain (CES202.705).

Sites: The Large River Subtype occurs along larger rivers, which tend to be at lower elevations. Most or all examples are on 4th or higher order streams.

Soils: The Large River Subtype occurs on distinctive alluvial soils. Series mapped for known examples include Biltmore (Typic Udipsamment), Iola (Fluvaquentic Dystrudept), Potomac (Typic Udifluvent), and Dellwood (Fluventic Haplumbrept). However, of the soils listed by Brown (2002) as predominant along her three study rivers, only Colvard (Typic Udifluvent) is an alluvial soil. The others are upland Typic Hapludults (Evard, Clifton, Saluda), or other upland soils (Hayesville, Rabun, Edneyville, Ditney).

Hydrology: The Large River Subtype is intermittently flooded. Flooding is of fairly brief duration, though longer than in the Small River Subtype, and doesn't happen in most years. The gradient is less than in the Small River Subtype, and catastrophic flash floods are less likely. Nevertheless, flooding can occasionally be a significant natural disturbance that topples trees, scours smaller plants, or deposits new sediment, as well as moving litter and woody debris and creating wrack piles. Other than in local small seepages or depressions, soils are probably well-drained when not flooded, but large flat areas may be less well drained than in the Small River Subtype.

Vegetation: The Large River Subtype is a forest of highly variable composition. In data collected by CVS and Brown (2002), primarily on three rivers, the only highly constant species that

sometimes dominate are *Liriodendron tulipifera* and *Acer rubrum*. However, trees with fairly high frequency and are sometimes abundant include *Platanus occidentalis, Halesia tetraptera, Tsuga canadensis, Juglans nigra, Quercus alba, Quercus rubra, Robinia pseudo-acacia, Carya tomentosa, Carya cordiformis*, and *Juglans cinerea*. Other canopy trees that have lower frequency in the plot data but may be present in some examples include *Betula lenta, Fraxinus pennsylvanica, Pinus strobus, Aesculus flava, Fagus grandifolia, Tilia americana* var. *heterophylla*, *Betula nigra, Liquidambar styraciflua, Quercus imbricaria*, and *Pinus rigida*. The most constant understory species, often dominant, is *Carpinus caroliniana*. Other fairly frequent understory trees include *Cornus florida*, *Ilex opaca, Nyssa sylvatica, Amelanchier laevis,* and *Prunus serotina*, as well as canopy species. Frequent shrubs include *Lindera benzoin, Xanthorhiza simplicissima, Cornus amomum, Rhododendron maximum, Pyrularia pubera, Alnus serrulata, Ilex verticillata, Alnus serrulata*, *Viburnum cassinoides, Kalmia latifolia*, *Corylus americana, Euonymus americanus*, and *Arundinaria gigantea*, along with the exotic *Ligustrum sinense* and *Rosa multiflora*. *Toxicodendron radicans*, *Parthenocissus quinquefolia*, and *Clematis virginiana* are vines that are highly constant, and *Vitis aestivalis, Smilax rotundifolia, Smilax glauca,* and the exotic *Lonicera japonica* are frequent in plot data. The herb layer is even more variable. Frequent species that may be abundant include *Impatiens capensis, Festuca subverticillata, Verbesina alternifolia, Solidago rugosa, Parathelypteris noveboracensis, Solidago curtisii*, and *Carex blanda*. Other frequent herb species in plot data include *Rudbeckia laciniata, Polystichum acrostichoides, Viola sororia, Persicaria virginiana, Boehmeria cylindrica, Eutrochium purpureum, Galium triflorum, Geum canadense, Amphicarpaea bracteata, Elymus virginicus, Eurybia divaricata, Verbesina occidentalis, Arisaema triphyllum, Apios americana, Ranunculus recurvatus, Lycopus virginicus, Bidens aristosa, Sanicula canadensis, Stellaria pubera, Cryptotaenia canadensis, Oxalis stricta, Dioscorea villosa, Elephantopus carolinensis, Athyrium asplenioides, Leersia virginica, Dichanthelium laxiflorum, Eutrochium maculatum, Passiflora lutea, Salvia lyrata, Sedum ternatum, Solidago flexicaulis, Viola stricta, Arisaema dracontium, Blephilia ciliata, Bromus pubescens, Carex laxiflora, Dichanthelium commutatum*, and *Stachys latidens*. Less frequent species in plots, but perhaps frequent on other rivers, include *Laportea canadensis, Luzula multiflora, Luzula acuminata, Pilea pumila, Packera aurea, Mitchella repens, Glyceria striata, Tradescantia subaspera, Persicaria longiseta*, and *Actaea racemosa*.

Range and Abundance: Ranked G2?. Large intact occurrences are particularly rare in North Carolina. Many of the rare remnants are on river islands or in narrow bands. Large rivers are limited in the North Carolina Mountains, and floodplains that are not flooded by reservoirs or occupied by fields or developed areas are scarce and fragmented. This community is also attributed to Tennessee, South Carolina, and possibly Georgia.

Associations and Patterns: The Large River Subtype occurs naturally as a large patch community, with some examples potentially once occupying hundreds of contiguous acres. However, many of the examples that now remain are naturally small patches, occurring on islands or in flats too small to cultivate or develop. The Large River Subtype may contain embedded High Terrace Subtype or Montane Floodplain Slough patches and may border Rocky Bar and Shore along the river. Patches of Piedmont/Mountain Canebrake may once have been common inclusions, though the frequency is unclear. Adjoining uplands may contain any upland community, including cove, oak, and pine forests, as well as cliffs.

Variation: 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 reservoirs, farming, pasturing, and development leaves too few remnants to distinguish overall natural patterns. 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 *Arundinaria gigantea* 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. Since vegetational differences may be due to differences in elevation, river size, river gradient, and biogeography or dispersal limitations, as well as land use history, it is not clear how to define variants based on them.

Dynamics: The dynamics of the Large River Subtype are similar to those of the Piedmont and Mountain Floodplains theme in general. They are expected to be intermediate between the Small River Subtype and the floodplain communities of the Piedmont.

Comments: Besides the NVC association synonymized with this subtype, several others are attributed to North Carolina, creating confusion.

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.

Rare species:
Vertebrate animals: *Ambystoma talpoideum*.

References:

Brown, R.L. 2002. Biodiversity and exotic species invasion in Southern Appalachian riparian plant communities. PhD dissertation, University of North Carolina-Chapel Hill.

MONTANE ALLUVIAL FOREST (HIGH TERRACE SUBTYPE)

Concept: Montane Alluvial Forests are communities of floodplains in the Mountain Region and foothills of the upper Piedmont. They consist of a mix of species of alluvial or floodplain settings combined with those of Rich Cove Forests and other upland communities. The High Terrace 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 or pine species dominate.

Distinguishing Features: Montane Alluvial Forests are distinguished from upland forests by evidence of flooding as well as by more than a trace presence of some of a characteristic suite of wetland or alluvial indicator species, such as *Platanus occidentalis, Betula nigra*, *Alnus serrulata*, and *Xanthorhiza simplicissima*. In the High Terrace Subtype, the abundance of these species is low, but the combination of them with species of dry uplands is unique. 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.

Synonyms: *Quercus (alba, coccinea, falcata, velutina) / Kalmia latifolia* Temporarily Flooded Forest (CEGL004098).
Ecological Systems: South-Central Interior Large Floodplain (CES202.705).

Sites: The High Terrace Subtype occurs on higher floodplain areas, which may be obvious terraces or may appear simply as ridges or high areas of floodplain. They may even occur on islands in the river. They may occur either in gorges or in open river valleys.

Soils: Soils are alluvial soils, perhaps old enough to have more horizon development than those in lower areas. The few known examples are mapped as Rosman (Fluventic Humic Dystrudept) and Woolwine-Fairview-Westfield complex (Typic Kanhapludult). It is unclear if the latter is recognized as an upland soil or is treated as an inclusion.

Hydrology: The High Terrace Subtype is intermittently or infrequently flooded for brief periods. The description of the most closely related NVC association says flooding occurs annually for examples in Alabama, but this frequency appears unlikely in the known North Carolina examples.

Vegetation: The High Terrace Subtype is generally dominated by upland oaks, pines, or hickories but includes species shared with other floodplain communities as well as possibly mesic communities. Plot data collected by CVS, NatureServe, and by Brown (2002), as well as site descriptions, show a range of possible codominant trees, including *Quercus alba, Quercus rubra, Quercus velutina, Quercus montana, Pinus rigida, Pinus virginiana, Pinus strobus, Pinus echinata, Carya tomentosa, Carya cordiformis, Carya pallida, Acer rubrum, Platanus occidentalis, Robinia pseudo-acacia, Fraxinus pennsylvanica, Fraxinus americana, Tsuga canadensis, Betula lenta*, and *Quercus imbricaria*. Understory trees with high constancy are *Carpinus caroliniana, Cornus florida*, *Ilex opaca*, *Halesia tetraptera*, and *Nyssa sylvatica*. Also frequent are *Oxydendrum arboreum, Sassafras albidum, Amelanchier laevis*, and *Acer pensylvanicum*. The shrub layer may be open or dense. Species as least fairly frequent and

sometimes abundant include *Pyrularia pubera, Kalmia latifolia, Calycanthus floridus, Viburnum cassinoides, Hamamelis virginiana, Rhododendron maximum*, and *Arundinaria gigantea*, while *Euonymus americanus* and *Xanthorhiza simplicissima* may also be frequent. The same vines frequent in most floodplains, *Toxicodendron radicans, Parthenocissus quinquefolia* and *Smilax rotundifolia,* are frequent in the High Terrace Subtype, though cover is generally not high. The herb layer ranges from moderate to dense and is similarly variable. Species with high constancy in plot data include *Carex pensylvanica, Potentilla canadensis, Polystichum acrostichoides*, and *Chimaphila maculata*. *Piptochaetium avenaceum* may dominate a few examples. Other herbs at least fairly frequent include *Dichanthelium laxiflorum, Dichanthelium clandestinum, Danthonia spicata, Carex laxiflora, Sanicula canadensis, Maianthemum racemosum, Elephantopus carolinianus, Dioscorea villosa, Solidago* spp. (*erecta, curtisii, flexicaulis, caesia, juncea), Amphicarpaea bracteata, Salvia lyrata, Prunella vulgaris, Verbesina alternifolia, Eurybia divaricata, Lysimachia quadrifolia, Hylodesmum nudiflorum, Galium circaezans, Scutellaria elliptica*, and *Heuchera americana*. A great number of other herb species occur with lower frequency. They include widespread rich-site species such as *Prosartes lanuginosa* and *Dichanthelium boscii*, typical floodplain species such as *Luzula multiflora* and *Arisaema triphyllum,* and species of dry uplands such as *Pityopsis graminifolia, Coreopsis major*, and *Yucca filamentosa*. A combination of species otherwise typical of disparate communities is typical of individual examples of the High Terrace Subtype.

Range and Abundance: The synonymized NVC association is ranked G4? but this community likely is much rarer. It appears extremely rare in North Carolina, with only a handful of examples known. Examples are known on the Little Tennessee, French Broad, and Nolichucky, as well as the Jacob Fork in the foothills. They presumably could be found on any larger or medium size river, but occurrence on flat land with only infrequent flooding likely has led to the loss of most examples that once existed, and those that remain tend to be small.

Associations and Patterns: The High Terrace Subtype may potentially occur with the Large River Subtype or with Montane Floodplain Slough and may occur adjacent to Rocky Bar and Shore communities along the river. However, examples may border uplands and river channels and not be associated with any other floodplain community.

Variation: The handful of known examples are all quite different from each other. An example with Carya pallida on the Nolichucky River seems quite different from the examples on the Little Tennessee, though both fit within the concept of this subtype. Because examples are so few, patterns of variation have not been sorted out.

Dynamics: Dynamics are similar to other Piedmont and Mountain Floodplain forests. Though flooding is less frequent, nutrient input, sediment deposition, litter movement, and other effects are a recognizable influence. Especially in confined gorges, floods may have enough current to cause disturbance to vegetation. A component of weedy species is often present even where there has not been artificial disturbance. Because conditions are dry and many examples are adjacent to uplands, fire may be an important influence in some examples.

Comments: The NVC synonymy of this type is questionable. The association was defined as a Cumberland Plateau community; it was initially extended to North Carolina based on a Blue Ridge

Parkway plot at Sandy Bottom. However, several other examples of this subtype are known. This association seems the closest existing fit in the NVC, but a new association may be appropriate.

Rare species:
Vascular plants: *Bromus latiglumis*.

References:
Brown, R.L. 2002. Biodiversity and exotic species invasion in Southern Appalachian riparian plant communities. Ph.D. dissertation, University of North Carolina-Chapel Hill.

MONTANE FLOODPLAIN SLOUGH FOREST

Concept: Montane Floodplain Slough Forests are wetland forests in lower areas of large mountain river floodplains, generally formed as abandoned channel segments or naturally blocked low areas. Long flooding duration restricts composition largely to hydrophytic species.

Distinguishing Features: Montane Floodplain Slough Forests are distinguished from Montane Alluvial Forests by having a longer flooding period, which leads to vegetation dominated by wetland species. While many species of both communities can occur in either, only the most water-tolerant shared species, such as *Boehmeria cylindrica, Impatiens capensis, Onoclea sensibilis, Lycopus* spp., and *Carex* spp. are abundant or frequent in Montane Floodplain Slough Forest. *Acer rubrum* var. *trilobum, Nyssa biflora, Salix nigra, Acer saccharinum, Cephalanthus occidentalis*, and many herbs are virtually never found in Montane Alluvial Forest, while others are found only in the wettest microsites.

Montane Floodplain Slough Forests are distinguished from Floodplain Pools by having shorter-term flooding. Trees are able to root throughout the community at normal forest densities, while Floodplain Pools support them primarily on the edges. Montane Floodplain Slough Forests are distinguished from Piedmont/Mountain Semipermanent Impoundment by lacking present or recent impounded water. If a wetland area is not in an obvious depression surrounded by drier vegetation, care should be taken to determine if a beaver dam is responsible.

Montane Floodplain Slough Forest may potentially be difficult to distinguish from the Floodplain Subtype of Low Elevation Seep. Seeps are saturated for long periods of time, longer than Montane Floodplain Slough Forest sites tend to be. However, they are configured so that standing water does not occur except for the brief periods that the entire floodplain is inundated. The two communities may share many wetland species, but the overall vegetation reflects the different environment. Species characteristic of saturated sites, such as *Sphagnum* spp., *Lorinseria areolata, Impatiens capensis*, and most *Carex* species are more abundant and diverse in seeps, as are some less flood-tolerant species such as *Lindera benzoin*. The two communities can potentially occur together, with a seep grading into a slough forest as the influence of seepage diminishes away from the upland edge and a basin becomes deeper.

Synonyms: *Acer rubrum var. trilobum – Fraxinus pennsylvanica / Carex crinita - Peltandra virginica* Forest (CEGL004420).
Ecological Systems: South-Central Interior Large Floodplain (CES202.705).

Sites: Montane Floodplain Slough Forests occur in low places in large- to medium-sized floodplains in the Mountain Region and potentially the foothills. They may be sloughs, overflow channels, abandoned channel segments, or areas where drainage has become blocked by alluvial deposition. It is possible they would form in abandoned beaver ponds if wetness were increased by clay deposition or remnants of a dam.

Soils: Montane Floodplain Slough Forest soils are mapped as a variety of alluvial soils, including Codorus (Fluavquentic Dystrudept), Iotla (Fluvaquentic Dytrudept), Cullowhee (Fluvaquentic Humadept), and Hatsboro (Fluvaquentic Endoaquept). They may represent inclusions of wetter

soil than these series. Sloughs that are closed basins typically without current have clay deposited in still water. Sloughs that are overflow channels likely have sandy soils, or interlayered sand, silt, and clay. Those that stay saturated much of the time may have organic-rich soils.

Hydrology: Montane Floodplain Slough Forests are regularly flooded for long periods. Standing water may persist into the growing season but seldom or never lasts through the season. Some examples are in overflow channels, where substantial current may occur during floods, while others hold water but have no more current than the rest of the floodplain in floods.

Vegetation: Montane Floodplain Sloughs are dominated by wetland and floodplain tree species. *Acer rubrum*, sometimes var. *trilobum*, is constant in plot data and site descriptions, and *Fraxinus pennsylvanica* is also frequent. Other canopy species are variable. They include *Platanus occidentalis, Liriodendron tulipifera,* and less frequently, *Nyssa sylvatica, Betula nigra, Pinus rigida, Pinus strobus*, ands *Salix nigra*. The understory, if there is one, is most often dominated by *Carpinus caroliniana* or canopy species. Species uncommon in the region, including *Nyssa biflora* or *Acer saccharinum,* may be present in a few examples. Shrubs tend to be low in density. They include a variety of water-tolerant species, none at very high frequency, including *Cornus amomum, Alnus serrulata, Ilex verticillata, Cephalanthus occidentalis, Leucothoe fontanesiana*, *Viburnum cassinoides, Rosa palustris*, *Itea virginica,* and even some more typical of bogs, such as *Toxicodendron vernix* and *Eubotrys racemosa*. The exotic *Ligustrum sinense* or *Rosa multiflora* may be present. Vines are not abundant, but *Lonicera japonica, Toxicodendron radicans, Muscadinia rotundifolia*, or other species may be present. Herbs may be dense, but where water stands the longest, the ground may be bare or may be occupied mainly by short-lived plants. Frequent herb species include *Boehmeria cylindrica, Impatiens capensis, Bidens frondosa, Lycopus* spp., *Carex* spp. (including *crinita, lupulina, tribuloides, stipata, atlantica,* and others), and *Microstegium vimineum*. A number of wetland species may be present at lower frequency, including *Mimulus ringens, Onoclea sensibilis, Persicaria punctata, Glyceria striata, Orontium aquaticum, Peltandra virginica, Sparganium americanum*, and many others. Species more typical of seeps or bogs may occasionally be present, including *Lorinseria areolata, Oxypolis rigidior, Platanthera peramoena, Osmundastrum cinnamomeum*, and *Sphagnum* sp. Species shared with other floodplain forests, such as *Elymus virginicus* or *Rudeckia laciniata*, may be present in small numbers. The exotic *Murdannia keisak* is a particular threat to these communities; it can come to dominate the ground cover.

Range and Abundance: Ranked G1. This community is very rare in North Carolina, with only a few examples known. Examples are scattered through the Mountain Region. The equivalent association is not attributed to any other state except possibly Tennessee.

Associations and Patterns: Montane Floodplain Slough Forests are small patch communities. They usually are embedded in Montane Alluvial Forest (Large River Subtype) but may be adjacent to uplands. They may occasionally be embedded in the Small River Subtype. They may occur near Swamp Forest–Bog Complex, Southern Appalachian Bog, Low Elevation Seep, or other wetland communities.

Variation: No variants are recognized. Examples vary in wetness and also in amount of sediment deposition and current during floods. They also vary in flora from more alluvial to more bog-like,

probably in response to fertility and to how much the soil remains saturated when standing water is absent.

Dynamics: Montane Floodplain Slough Forests flood more often and for longer duration than other mountain floodplain forests. Water stands long enough to exclude most upland species. Though not well known, it is likely that wetness kills plants that established in dry years, and that wet years are stressful even for some of the established plants. During dry conditions, the high fertility and reduced competition may lead to high productivity.

Some sloughs are in overflow channels, where they may carry substantial currents during floods. For them, scouring, movement of wrack, and battering by floating material may be an additional natural disturbance, at least in small areas. The most extreme scouring may change the drainage patterns, potentially making them either wetter or drier. This could naturally turn a Montane Floodplain Slough Forest into Montane Alluvial Forest (Large River or Small River Subtype) or, alternatively, into Floodplain Pool.

Being in the lowest parts of the floodplain, Montane Floodplain Slough Forests may be particularly susceptible to impoundment by beavers. It is possible that residual effects of beaver ponds – residual dam materials, altered channels, and clay deposition, could make sites wetter and lead to the creation of Montane Floodplain Slough Forest patches.

Comments: Montane Floodplain Slough Forests are analogous to Piedmont Swamp Forests in their geomorphic environment and in their relationship to other floodplain communities. They differ because of the higher gradients and differing flood dynamics in mountainous terrain, as well as because of the Blue Ridge flora.

Rare species:
Vascular plants: *Campanula aparinoides* var. *aparinoides, Platanthera peramoena,* and *Thalictrum macrostylum*.
Vertebrate animals: *Glyptemys muhlenbergii*.

References:

PIEDMONT ALLUVIAL FOREST

Concept: Piedmont Alluvial Forests are forests of narrow floodplains, either on 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. These forests contain a mixture of alluvial and upland species.

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 present but are of limited abundance, while in the Piedmont Headwater Stream Forests they are more predominant.

Piedmont Alluvial Forests are distinguished from Mesic Mixed Hardwood Forests by the presence of characteristic alluvial and wetland species, such as *Platanus, Betula*, *Lindera benzoin,* and *Xanthorhiza simplicissima*. Additional species such as *Lindera benzoin*, *Aesculus sylvatica, Elymus virginicus, Elymus hystrix,* and *Chasmanthium latifolium* 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 that have characteristic montane species should be classified as Montane Alluvial Forest.

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).

Sites: Piedmont Alluvial Forests occur along most 2nd and 3rd order streams, some 1st order streams, and along higher order streams where the floodplain is narrow.

Soils: Soils are loamy or sandy and fertile alluvial soils with limited horizon development. Most are mapped as Chewacla (Fluvaquentic Dystrudept), with many also mapped as Congaree (Typic Udifluvent), Wehadkee (Typic Fluvaquent), and a few mapped as Peawick (Aquic Hapludult) or Riverview (Fluventic Dystrudept). A number are small enough to not be distinguished from upland soils in mapping.

Hydrology: Piedmont Alluvial Forests are intermittently flooded for brief periods. Flood flows often have substantial current. When not flooded, soils are moist but are wet only in small microsites associated with seepage or small depressions or sloughs.

Vegetation: Piedmont Alluvial Forests are naturally closed forests except in canopy gaps. Matthews, et al. (2011), CVS plot data, and qualitative site reports show the canopy is often strongly or weakly dominated by *Liriodendron tulipifera* or *Liquidambar styraciflua*, but sometimes is a mix without a strong dominant. It usually includes some individuals of more specifically alluvial species: *Platanus occidentalis, Betula nigra, Fraxinus pennsylvanica, Acer negundo, Celtis laevigata*, and *Ulmus americana*. Other trees of rich upland or floodplain sites, such as *Acer floridanum, Juglans nigra, Ulmus rubra*, *Carya cordiformis, or Carya ovata* are present less frequently, but can be abundant, while *Quercus phellos, Pinus taeda*, *Quercus nigra,* or *Acer rubrum* may also be present. Some typically upland trees, particularly *Fagus grandifolia, Quercus rubra*, *Quercus alba*, or *Pinus echinata* are also usually present. The understory may be dominated by *Acer floridanum, Acer negundo, Carpinus caroliniana, Ilex opaca*, *Asimina triloba, Cornus florida*, or a mix of species. Species more typical of uplands, such as *Oxydendrum arboreum* or *Nyssa sylvatica,* may also occur. The shrub layer may be sparse or fairly dense, with *Lindera benzoin* or the exotic *Ligustrum sinense* or *Elaeagnus umbellata* often dominant, and *Aesculus sylvatica* sometimes present. *Xanthorhiza simplicissima* is often present near the channel in rocky areas. Vines often are prominent and fairly diverse: *Parthenocissus quinquefolia, Toxicodendron radicans, Muscadinia rotundifolia, Smilax rotundifolia, Smilax bona-nox, Campsis radicans, Bignonia capreolata*, and the exotic *Lonicera japonica* are present with high constancy. The herb layer is quite variable, with a diversity of species potentially present. Patches may be dominated by both widespread mesic species such as *Polystichum acrostichoides*, *Athyrium asplenioides*, and in some places *Parathelypteris noveboracensis*, and by characteristic alluvial species such as *Chasmanthium latifolium, Elymus virginicus,* or *Elymus hystrix*. Other species with high constancy in plots include *Geum canadense, Amphicarpaea bracteata, Boehmeria cylindrica, Arisaema triphyllum, Botrypus virginicus, Oxalis stricta/dillenii*, *Salvia lyrata, Festuca subverticillata, Sanicula canadensis,* and *Carex blanda.* Other characteristic species of moderate or lower frequency include *Viola sororia, Galium circaezans, Galium triflorum*, *Persicaria virginiana, Impatiens capensis, Ranunculus abortivus, Carex radiata, Carex oxylepis, Solidago caesia, Dichanthelium commutatum, Verbesina occidentalis, Verbesina alternifolia, Phryma leptostachya, Juncus coriaceus, Brachyelytrum, Galium aparine, Rudbeckia laciniata, Podophyllum peltatum, Carex debilis, Glyceria striata, Symphyotrichum* spp., *Leersia virginica,* and *Lycopus virginicus*. In spring, *Claytonia virginica, Erythronium umbilicatum, Thalictrum thalictroides, Hepatica americana*, and *Stellaria pubera* may be present. The herb layer can often become dominated by exotic species, particularly *Microstegium vimineum*, ground-covering *Lonicera japonica, Glechoma hederacea,* and *Stellaria media.*

Range and Abundance: Ranked G4. This is one of the most widely distributed natural communities in the Piedmont, a matrix community that makes up a minority of the landscape mosaic in most places other than the foothills. Patches tend to be narrow. They may be connected in dendritic networks that amount to substantial acreage or they may be segmented by degraded vegetation or man-made barriers. In the past they likely were segmented by beaver ponds. The related NVC association, as defined, ranges from Georgia to Maryland and westward into

Tennessee and West Virginia. It probably is defined more broadly than the concept represented here.

Associations and Patterns: Piedmont Alluvial Forests may be bordered by any Piedmont upland community, with Mesic Mixed Hardwood Forest and Dry-Mesic Oak–Hickory Forest being most common. Smaller upstream reaches and tributaries may have Piedmont Headwater Stream Forest. Piedmont Alluvial Forests, where not disrupted, connect downstream to larger floodplain communities such as Piedmont Bottomland Forest.

Variation: Piedmont Alluvial Forest is one of the broadest and most heterogeneous community types in the 4th Approximation. Vegetation varies in amounts of alluvial, upland, and generalist species (*Liquidambar* and *Liriodendron*), in diversity of the herb layer, and in heterogeneity of microsites, but these patterns are confusing. Matthews, et al. (2011) recognized two associations that correspond to Piedmont Alluvial Forest. They could be tried as variants. However, they appear to combine several characteristics in surprising ways, so that it is hard to know how to apply them to new occurrences.

1. *Liriodendron tulipifera – Liquidambar styraciflua / Lindera benzoin / Amphicarpaea bracteata* appears to have more alluvial influence, with more indicators of high fertility, but there are contradictory indications such as greater abundance of *Fagus* and smaller role for *Betula nigra*.
2. *Liriodendron tulipifera – Betula nigra / Cornus florida / Sanicula canadensis var. canadensis* has a larger upland component (e.g., *Oxydendrum arboreum* and *Quercus alba*) and lower fertility, but also apparently has more *Betula nigra*, which is less frequent on smaller streams.

Based on the author's experience, a different set of variants could be tried. These are based on the size of the river, with a third variant for small stream bottoms in the Uwharrie Mountains area that have distinctive species composition. Despite Mathews, et al. (2011) noting that floodplains communities are similar on narrow floodplains regardless of size of the stream, there are some differences in vegetation and presumably in dynamics that seem a promising basis for subdivision.

1. Creek Variant occurs along smaller streams in most of the Piedmont, generally 1st to 3rd order, of a size that never is associated with larger floodplain communities. They tend to be dominated by *Liquidambar* and *Liriodendron* with a smaller and less diverse component of alluvial species and a larger component of upland species. They conceptually grade to Piedmont Headwater Stream Forests.

2. River Variant occurs along larger streams, generally 4th order or larger, of a size that in other geologic settings would support large floodplain communities. They tend to be dominated by a mix of *Liquidambar* with more *Platanus, Celtis, Fraxinus*, and with the presence of alluvial species that seldom appear along smaller creeks, such as *Betula nigra* and *Acer negundo*. They have fewer upland trees, though *Quercus rubra, Fagus grandifolia Acer floridanum* and others may be present. They conceptually grade to Piedmont Levee Forest. They show further variation between examples that are lower or higher relative to the river. Scouring by floods and redistribution of litter and wood is more vigorous than in the Creek Variant.

3. Uwharrie Variant occurs along many of the smaller streams in the Uwharrie Mountains area. The canopy is a mix of *Liquidambar, Liriodendron*, and upland species like the Creek Variant, but several shrub species occur in it that are seldom present elsewhere. Most frequent is *Kalmia latifolia,* but *Cyrilla racemiflora, Symplocos tinctoria*, *Calycanthus floridus, Alnus serrulata*, and *Hamamelis virginiana* are frequently present. Though shrubs are generally not extremely dense, herb diversity tends to be lower. A provisional association in the NVC — *Fagus grandifolia – Quercus* spp. / *Kalmia latifolia – Hamamelis virginiana / Galax urceolata* Forest [Provisional] (CEGL004549) — may correspond to this. It 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 that corresponds to Piedmont Alluvial Forest or Piedmont Headwater Stream Forest.

Dynamics: Dynamics of Piedmont Alluvial Forests are similar to those described for the Piedmont and Mountain Floodplains theme in general. Given that Walter and Merritts (2008) found most mill dams on 1st to 3rd order streams, it is likely that Piedmont Alluvial Forests are the communities most affected by them, though dams were less dense than in their study area in Pennsylvania.

Comments: Piedmont Alluvial Forests and the related Piedmont floodplain communities have been some of the most confusing communities in the 3rd Approximation, and they remain difficult to classify. One of the most difficult problems has been the treatment of small floodplains on larger rivers. The 3rd Approximation treated them as Piedmont Levee Forest, limiting Piedmont Alluvial Forest to small streams. Based on later field experience and the work of Matthews, et al. (2011), the 4th Approximation broadens the concept of Piedmont Alluvial Forest to include them. At the same time, experience has shown that all floodplain communities in the Mountain Region and many in the foothills are distinct from those of the rest of the Piedmont and are better treated as Montane Alluvial Forest. Thus, the previous concept of Piedmont/Low Mountain Alluvial Forest has been split into Piedmont and Mountain portions. However, Piedmont Alluvial Forest remains a heterogeneous collection with particularly gradual gradation into conceptually related communities.

Published literature on Piedmont Alluvial Forests is uncommon. However, qualitative descriptions in the Natural Heritage Program's county inventories and site survey reports are abundant. Morgan (1962) likely is one of a number of local theses that provide some description.

Rare species:
Vascular plants: *Baptisia alba, Cardamine dissecta, Carex impressinervia, Eurybia mirabilis, Fothergilla major, Hexastylis naniflora, Magnolia macrophylla, Phacelia colvillei, Primula meadia,* and *Stewartia ovata.*

References:
Matthews, E.M., R.K. Peet and A.S. Weakley. 2011. Classification and description of alluvial plant communities of the Piedmont region, North Carolina, U.S.A. Applied Vegetation Science 14:485-505.

Morgan, J.T. 1962. A vascular flora of Morrow Mountain State Park. M.A. Thesis, UNC-Chapel Hill.

Walter, R.C., and D.J. Merritts. 2008. Natural streams and the legacy of water-powered mills. Science 319: 299-301.

PIEDMONT HEADWATER STREAM FOREST (TYPIC SUBTYPE)

Concept: Piedmont Headwater Stream Forests are forests of floodplains along the smallest Piedmont streams, generally intermittent to first or second 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 characteristic floodplain species. The Typic Subtype covers most examples, on 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 near absence of alluvial species such as *Platanus occidentalis, Betula nigra*, and *Celtis laevigata*, though other riparian species such as *Xanthorhiza simplicissima, Lindera benzoin*, or wetland species such as *Osmundastrum (Osmunda) cinnamomeum, Osmunda spectabilis (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 but are frequent, sometimes dominant, in the Hardpan Subtype.

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).

Sites: Piedmont Headwater Stream Forests occur in the smallest, least well-developed floodplains, along intermittent or first order perennial streams, occasionally on second order streams. Floodplains are not well developed, but some area of flat land with alluvial soil or evidence of transported sediment, as well as of flooding, is present.

Soils: Soils are often sandy but probably are heterogeneous. They presumably are more fertile than the adjacent uplands but less so than in larger floodplains. They probably represent some kind of Entisol or Inceptisol. Soil mapping almost never distinguishes them from the adjacent upland soils.

Hydrology: Piedmont Headwater Stream Forests are intermittently flooded for brief periods. Flood flows can have substantial current. When not flooded, soils are moist but are wet only in small microsites associated with seepage or small depressions or sloughs.

Vegetation: Piedmont Headwater Stream Forests are usually dominated by *Liriodendron tulipifera* or by a mix of species where it is abundant. *Liquidambar styraciflua* is usually present and sometimes codominant. Upland species, most constantly *Quercus alba* but almost as frequently *Quercus rubra* or *Fagus grandifolia* are usually abundant. *Acer rubrum* often is in the canopy as well as the understory. A wide variety of additional canopy species occur with low frequency and low abundance, including *Pinus taeda, Pinus echinata, Carya ovata, Ulmus alata, Fraxinus* sp., and *Quercus phellos*. Understory species with high constancy and often reported as dominant in qualitative site reports are *Ilex opaca* and *Oxydendrum arboreum*, less often *Carpinus caroliniana*. Among the large number of species that may occur at low frequency and abundance are *Cornus florida, Nyssa sylvatica, Juniperus virginiana,* and *Magnolia tripetala*. Shrubs are generally sparse and variable. Species include *Hamamelis virginiana, Ilex decidua, Xanthorhiza simplicissima, Hypericum hypericoides, Arundinaria tecta, Alnus serrulata*, and a diversity of others. In the Uwharrie Mountains area, *Kalmia latifolia* may be present. Vines may include *Parthenocissus quinquefolia, Smilax rotundifolia, Muscadinia rotundifolia*, and less frequently *Toxicodendron radicans*, *Bignonia capreolata*, and others. The exotic *Ligustrum sinense, Elaeagnus umbellata*, and *Lonicera japonica* are sometimes present but at much lower frequency and generally less cover than in Piedmont Alluvial Forest. The herb layer may be fairly dense or sparse. The most constant species is *Polystichum acrostichoides*, which may dominate patches. A large pool of other herbs may occur, most with low frequency. A number are shared with adjacent mesic or dry-mesic upland forests, such as *Hexastylis arifolia, Polygonatum biflorum, Danthonia spicata, Phegopteris hexagonoptera, Podophyllum peltatum, Galium* spp., *Nabalus altisismus*, and *Elephantopus tomentosus*. A number are widespread species but are not often present in the adjacent upland forests, such as *Chasmanthium laxum, Carex* spp., *Parathelypteris noveboracensis, Athyrium asplenioides, Iris cristata, Packera aurea, Arisaema triphyllum, Amphicarpaea bracteata, Ranunculus* spp., *Botrypus virginicus, Sanicula canadensis,* and *Viola* spp. Some are species shared with other floodplain forests having more alluvial influence, but occurring with lower frequency and abundance, such as *Elymus hystrix, Elymus virginicus, Leersia virginica, Luzula acuminata, Boehmeria cylindrica*, and the exotic *Microstegium vimineum*. Some are wetland species present locally in small numbers, such as *Osmundastrum cinnamomeum*, *Lycopus virginicus, Lobelia cardinalis, Onoclea sensibilis*, various *Carex* spp., and *Sphagnum* sp. In general, whatever the adjacent upland community and the species shared with it, the diversity is higher in the Piedmont Headwater Stream Forest and includes multiple species not found uphill.

Range and Abundance: Ranked G3G4 but probably more common. The Typic Subtype occurs throughout the Piedmont except in mountainous foothill areas. The equivalent NVC association is poorly known. North Carolina is the only state it is definitively present in, but it could potentially range through the Piedmont, from Maryland to Georgia.

Associations and Patterns: Piedmont Headwater Stream Forests usually occur in narrow bands, sometimes only 5-10 meters wide. Bands may be hundreds of meters long, but many are interrupted by areas where upland communities come all the way to the stream channel, and many quickly join larger floodplains with Piedmont Alluvial Forest. They are matrix communities in the sense of being widely distributed in landscape mosaics but are not well developed in every natural landscape. Most examples grade to Mesic Mixed Hardwood Forest or Dry-Mesic Oak–Hickory

Forest or their basic counterparts. They join downstream into Piedmont Alluvial Forest or directly to larger floodplains.

Variation: Examples are heterogeneous at a fine scale. Variation among occurrences is not well known. Examples in the Uwharrie Mountains area that contain *Kalmia latifolia* may warrant distinguishing as a variant, as was done in Piedmont Alluvial Forest, but this is less clear. An example in Box Creek Wilderness is surrounded by montane communities and may represent a distinct variant or an unrecognized mountain analogue.

Dynamics: Dynamics of Piedmont Alluvial Forests are similar to those described for the Piedmont and Mountain Floodplains theme in general, except alluvial movement is less and flooding is even less likely to cause mortality for any plants. However, the author's observations suggest even these small floodplains are more susceptible to windthrow than nearby upland forests.

Comments: Piedmont Headwater Stream Forest is one of the more recently recognized community types. In the 3rd Approximation, it was treated as poorly developed Piedmont/Low Mountain Alluvial Forest or as part of the Mesic Mixed Hardwood Forest or Basic Mesic Forest. Qualitative site descriptions are fewer than for most communities, because they often were ignored or their descriptions were mixed with those of larger floodplains. Very little plot data exist for it either, partly because many occurrences are not wide enough to easily fit homogeneous plots. It was not recognized in Matthews, et al. (2011), apparently because few or no plots represented it.

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.

Rare species:
Vascular plants: *Carex impressinervia* and *Collinsonia tuberosa*.

References:
Matthews, E.M., R.K. Peet and A.S. Weakley. 2011. Classification and description of alluvial plant communities of the Piedmont region, North Carolina, U.S.A. Applied Vegetation Science 14:485-505.

PIEDMONT HEADWATER STREAM FOREST (HARDPAN SUBTYPE)

Concept: Piedmont Headwater Stream Forests are forests of floodplains along the smallest Piedmont streams, where flooding and alluvial processes have some, but limited, influence on vegetation and most characteristic alluvial species are absent or scarce. The Hardpan Subtype is a rare community that occurs in flat terrain with dense or shrink-swell clay soils and is transitional to Upland Depression Swamp Forest or Mixed Moisture Hardpan Forest. Limited rooting depth, lack of internal soil drainage, and soil texture give these sites a distinctive character.

Distinguishing Features: Piedmont Headwater Stream Forests are distinguished from other floodplain communities by the near absence of alluvial species such as *Platanus occidentalis, Betula nigra*, and *Celtis laevigata*. The Hardpan Subtype is distinguished from the Typic Subtype by occurring in unusually gently-sloping bottoms with dense clay hardpan substrate, and by characteristic vegetation. *Quercus phellos*, and sometimes *Quercus michauxii*, *Carya ovata*, or *Carya carolinae-septentrionalis,* are abundant in this subtype while largely absent in the Typic Subtype. *Liriodendron* is correspondingly scarce in the Hardpan Subtype.

The Hardpan 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.

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).

Sites: The Hardpan Subtype occurs in areas of unusually flat terrain, usually associated with mafic rocks such as gabbro or diabase. They could potentially occur in acidic clayey sites as well. A floodplain landform may be difficult to discern; the community may or may not be associated with a visible topographic change. A distinct stream channel with defined banks and bed may cross it, or the focus of flow may be merely a line of exposed soil where water has removed the litter.

Soils: Because of the low gradient and dense soil, alluvial movement likely is minor, and soil profiles may not differ from adjacent areas. Known examples are associated with mafic rocks and their soils presumably are high in base saturation. Soil mapping does not distinguish these floodplains from the adjacent upland soils. They are mapped as part of the associated hardpan or shrink-swell soils such as Iredell (Vertic Hapludalf) or Lignum (Aquic Hapludult).

Hydrology: The Hardpan Subtype is intermittently to seasonally flooded. Because of the impermeable soil and the low gradient in both the floodplain and the adjacent uplands, water flow is slow and flooding may persist for a longer time than in most Piedmont floodplains. Flooding is shallow and current slow, sufficient to redistribute litter but able to move only limited sediment or coarser material.

Vegetation: The Hardpan Subtype is most often dominated by *Quercus phellos* and *Liquidambar styraciflua*. Frequent in site descriptions and the few CVS plots are *Carya ovata, Carya carolinae-septentrionalis, Acer rubrum (*including var. *trilobum* as well as *rubrum*)*, Ulmus americana*, *Fraxinus* sp., and *Quercus alba*. *Liriodendron tulipifera* may be present but is less important than in the Typic Subtype. Other species that occur with low frequency but are notable include *Quercus michauxii, Quercus shumardii*, *Quercus pagoda*, and *Celtis laevigata*. The understory often contains *Ulmus alata, Carpinus caroliniana*, and *Nyssa sylvatica*. Shrubs are generally sparse, and none have high frequency. They include both species of other floodplain forests, such as *Lindera benzoin* and *Ilex decidua*, but also species of wetter areas, such as *Vaccinium fuscatum, Ilex verticillata*, and *Eubotrys racemosa*. Vines include *Smilax rotundifolia, Toxicodendron radicans, Campsis radicans, Lonicera sempervirens*, and the exotic *Lonicera japonica*. The herb layer is usually moderate to dense. *Danthonia spicata, Glyceria striata, Leersia virginica, Chasmanthium latifolium, Elymus virginicus*, and the exotic *Microstegium vimineum* have moderate to high frequency. *Carex* species as a group are also frequent and abundant, and multiple species are represented. *Isoetes* sp. sometimes forms dense stands in sloughs or even in slow channel beds. Many other herbs occur with low frequency, including wetland species such as *Ludwigia alternifolia, Lycopus virginicus*, *Osmunda spectabilis*, and *Oxypolis rigidior*; common floodplain species such as *Arisaema triphyllum, Mitchella repens*, and *Viola* spp.; species often associated with weedy settings, such as *Ambrosia artemisiifolia, Apocynum cannabinum*, and *Oxalis dillenii*; and a variety of others, such as *Solidago rugosa, Podophyllum peltatum*, *Hypoxis hirsuta*, *Endodeca serpentaria, Scutellaria integrifolia,* and *Lobelia puberula*.

Range and Abundance: Ranked G2. The handful of examples is scattered in the eastern Piedmont, mostly in areas with substantial amounts of mafic rock. The equivalent NVC association is poorly known. North Carolina is the only state it is definitively present in, but it could potentially range from Virginia to Georgia.

Associations and Patterns: The Hardpan Subtype is a small patch community with limited length, which gives way to the Typic Subtype or to Piedmont Alluvial Forest as the stream and floodplain becomes more developed downstream. It is associated with other hardpan communities such as Upland Depression Swamp Forest, Mixed Moisture Hardpan Forest, sometimes Xeric Hardpan Forest, and often with upland communities of mafic rocks such as Dry-Mesic Basic Oak–Hickory Forest.

Variation: Examples vary in how extremely the hardpan character is developed. If examples are found on acidic hardpans, they likely will represent a distinct variant or possibly a different subtype.

Dynamics: Dynamics of the Hardpan Subtype are not well known but are presumed to be generally similar to other Piedmont floodplain communities. They do not have the sandy soils that seem to contribute to increased susceptibility to windthrow in the Typic Subtype, but shallow rooting may have the same effect. Because of the low gradient, scouring by floods probably is negligible, and the nutrient subsidy provided by flooding likely is smaller.

Comments: This community is newly recognized and has limited exploration to date. However, several CVS plots represent it. It is more distinct from the Typic Subtype than are most subtypes, but recognition of it can still be subtle in the transition to other communities.

Rare species: No rare species are known to be associated with this community.

References:

PIEDMONT LEVEE FOREST (TYPIC SUBTYPE)

Concept: Piedmont Levee Forests are forest communities of natural levee deposits or river front riparian zones on large Piedmont floodplains. The Typic Subtype encompasses the common examples where characteristic levee species such as *Platanus occidentalis, Betula nigra, Celtis laevigata*, and *Acer negundo* dominate in combination with widespread species such as *Liquidambar styraciflua, Liriodendron tulipifera*, and *Acer rubrum*. *Fagus grandifolia* is scarce or absent.

Distinguishing Features: The Piedmont Levee Forest community is distinguished from other communities of large Piedmont floodplains, as well as uplands, by significant presence of the characteristic levee species: *Platanus occidentalis, Betula nigra, Acer negundo*, and *Celtis laevigata* in natural condition. *Fraxinus pennsylvanica* too distinguishes it from communities other than Piedmont Swamp Forest. It is distinguished from Piedmont Alluvial Forest by occurring on larger floodplains — those with differentiated levee, bottomland, and terrace zones large enough to support distinct communities. The distinguishing characteristic is the size of the floodplain, not the river. Where large rivers flow through confined areas without extensive floodplain development, the narrow floodplains generally support Piedmont Alluvial Forest, with a mix of levee, bottomland, and upland species. 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 medium size creeks in Triassic basins.

Piedmont Levee Forests are distinguished from Montane Alluvial Forests 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 limited component of other upland species.

Synonyms: *Fraxinus pennsylvanica – Platanus occidentalis – Celtis laevigata / Chasmanthium latifolium* Piedmont River Levee Forest (CEGL007013).
Ecological Systems: Southern Piedmont Large Floodplain Forest (CES202.324).

Sites: Piedmont Levee Forests occur on natural levees, stable forested point bar deposits, or on the river front edge of flatter terraces. They occur on broad floodplains, usually along larger rivers. They may also occur on creeks as small as 3rd order in Triassic basins, where broad floodplains form more readily. Even on larger rivers, Piedmont Levee Forests require a substantial floodplain and are generally absent where floodplain width is limited.

Soils: Soils are coarse or medium-textured, formed in recent alluvial deposits with little or no horizon development. Most examples are mapped as Congaree (Typic Udifluvent), Chewacla (Fluvaquentic Dystrudept), or Wehadkee (Fluvaquentic Endoaquept). Soils are among the most fertile in the Piedmont, thanks to ongoing nutrient input.

Hydrology: Piedmont Levee Forests are intermittently flooded for short periods. The flood flow can have substantial current.

Vegetation: Piedmont Levee Forests are naturally closed forests punctuated by canopy gaps. The forest is a varying mix of a large pool of possible species. Frequent species in Matthews, et al. (2011) and site descriptions include *Fraxinus pennsylvanica, Platanus occidentalis, Betula nigra, Celtis laevigata*, *Acer negundo, Liquidambar styraciflua, Liriodendron tulipifera, Ulmus americana, Ulmus alata, Juglans nigra, Acer floridanum,* and *Acer rubrum*. Less frequent trees include *Quercus phellos, Carya cordiformis, Carya ovata, Carya carolinae-septentrionalis, Quercus michauxii, Quercus nigra, Quercus pagoda,* and a few *Quercus alba, Quercus rubra*, or *Fagus grandifolia*. The understory is frequently dominated by *Carpinus caroliniana, Acer negundo*, or *Asimina triloba*. Other species, such as *Ilex opaca, Cornus florida,* or *Nyssa sylvatica*, may also occur. The shrub layer is general moderate to fairly dense. Dominant species are most often *Ilex decidua, Lindera benzoin*, *Arundinaria tecta*, or currently, exotic species such as *Ligustrum sinense*. Other shrubs include *Aesculus sylvatica, Viburnum prunifolium, Alnus serrulata*, or the exotic *Rosa multiflora*. Vines are often extensive and fairly diverse. Highly constant species include *Toxicodendron radicans, Smilax rotundifolia, Muscadinia rotundifolia, Parthenocissus quinquefolia, Bignonia capreolata*, and the exotic *Lonicera japonica*, less constant *Campsis radicans, Thyrsanthella difforme*, and *Vitis sp.* The herb layer is generally dense, sometimes lush. *Chasmanthium latifolium* or *Elymus virginicus*, or exotic species such as *Microstegium vimineum* or *Glechoma hederacea* may dominate, but often it is a diverse mix with no strong dominant. The most constant additional species include *Boehmeria cylindrica, Arisaema triphyllum,* several *Carex* species (e.g., *radiata, amphibola*), *Festuca subverticillata, Persicaria virginiana*, *Glyceria striata*, *Galium aparine*, and *Viola* spp. Fairly frequent species include *Polystichum acrostichoides, Persicaria* spp., *Laportea canadensis, Carex intumescens, Carex typhina, Sanicula canadensis, Geum canadense, Pilea pumila, Verbesina alternifolia, Verbesina occidentalis, Commelina virginica, Dichanthelium commutation, Leersia virginica, Lycopus virginicus, Impatiens capensis, Juncus coriaceus*, and *Solidago* sp. Other herbs that are lower constancy in plot data but appear characteristic include *Elymus hystrix, Corydalis flavula, Osmorhiza longistylis, Asarum canadense, Melica mutica*, and *Arisaema dracontium*.

Range and Abundance: Ranked G3G4. This community occurs throughout the Piedmont except in the foothills area. Recognizable examples are abundant on large rivers and are often present when no other floodplain communities remain. A strip is often left when the rest of a floodplain is cleared or clearcut, and higher levees may remain forested when lower areas are drowned by impoundments. However, examples that are at full natural width, not subject to extreme edge effects from both sides, and not dominated by exotic plants in one or more strata are rarer. Examples without hydrology modified by upstream dams or urbanization are more rare still. The equivalent NVC association ranges from Virginia to Georgia.

Associations and Patterns: Piedmont Levee Forests occur naturally as large patch communities, forming continuous, though fairly narrow, bands that would add up to substantial acreage. Many examples now exist as small patches. Piedmont Levee Forest grades into Piedmont Swamp Forest or Piedmont Bottomland Forest away from the channel. It usually is bordered by the river channel, but Sand and Mud Bar or Rocky Bar and Shore communities may border it.

Variation: Plot data analysis by Matthews, et al. (2011) recognized two kinds of levee forests, which are treated as variants. However, they noted substantial overlap in settings and soil

characteristics. The author, too, has observed the nominal plant species in different combinations. These variants need further investigation into how distinct they are.

1. Sugarberry-Elm Variant, which they named *Ulmus americana–Celtis laevigata/Lindera benzoin/Osmorhiza longistylis* tends to occur farther downstream, on larger floodplains, and to be more fertile.
2. Ash-Sycamore Variant, which they named *Fraxinus pennsylvanica–Platanus occidentalis/Acer negundo/Chasmanthium latifolium* tends to occur farther upstream, farther inland, tends toward smaller floodplains, and though fertile, is somewhat less so. The composition suggests an earlier stage of succession, but given its occurrence in different settings, as well as the avoidance of obviously successional vegetation in CVS sampling, it is more likely a result of different flooding dynamics.

Dynamics: General dynamics of Piedmont Levee Forests are similar to Piedmont and Mountain Floodplains in general. The current during floods is stronger on the levees than in most other parts of the floodplain. Vegetation may be battered by floating debris and soil may be locally scoured, though it is rare for large plants to be killed by this. Some tree mortality occurs through undercutting along the riverbank. Conversely, new deposition of bars can create new sites for forest development; however, these processes appear much slower than in the Coastal Plain, despite the stronger currents and greater potential for sediment movement.

Natural levees form because sediment deposition is concentrated on the riverbank. The coarsest material falls out there; sand deposits are common, though a layer of silt and clay is also left at the end of floods. The periodic input of nutrients in flood-deposited sediment makes levee sites very fertile, perhaps the most fertile sites in the Piedmont, and plant growth is rapid in these communities. The levees may have been the most affected by the massive influx of sediment during the early decades of European agriculture and by ongoing changed conditions. Rates of erosion in uplands remain higher than natural. The loss of forest cover and the increase in bare ground and impervious surfaces has led to faster runoff, while large dams have altered flood regimes and have removed sediment from some reaches.

Piedmont Levee Forests are among the most susceptible communities to invasion by exotic plants, due to a combination of high fertility, higher light levels along the bank, creation of bare ground patches by flood scouring and wrack movement, and dispersal of seeds by floodwaters. *Lonicera japonica, Microstegium vimineum,* and *Ligustrum sinense* have come to dominate large areas to the exclusion of the native herb layer, while *Glechoma hederacea, Stellaria media, Rosa multiflora, Youngia japonica, Murdannia keisak, Hedera helix, Nandina domestica*, and a number of other species sometimes become abundant.

Most of the ecological characteristics of Piedmont Levee Forest communities are probably related to flooding and river dynamics. The most characteristic tree species have traits of ruderal or early successional species, such as small or readily dispersed seeds, response to high fertility and light, and rapid growth. Many will spread from the levees into cleared or logged areas in other parts of the floodplain, acting as early successional species there. However, it appears that the less altered Piedmont Levee Forests did not originate by catastrophic disturbance and that these species are stable long-term components. Characteristics of increased susceptibility to windthrow because of

the sandy soils and open edge on the channel, high light levels, high fertility, removal of litter and local creation of bare ground by scouring may favor such characteristics. Large-seeded, slower-growing trees are also components of the community, but they generally are much less abundant on the levees than in other parts of the floodplain.

Comments: Piedmont Levee Forest communities share many species with Brownwater Levee Forest (High Levee Subtype), enough that individual plots can be difficult to distinguish. However, the differences in river gradients, hydrology, and sediment dynamics, as well as landscape patterns (e.g., the addition of Cypress–Gum Swamp), as well as floristic differences at broader scales, make it a worthwhile boundary.

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. Several other associations have been attributed to levee forests in the North Carolina Piedmont, while at the same time being attributed to other regions. Two of those problematic associations have been dropped from the NVC or are no longer are attributed to North Carolina. The remaining one — *Betula nigra – Platanus occidentalis / Alnus serrulata / Boehmeria cylindrica* Forest (CEGL007312) — is a broadly defined concept attributed to all southeastern states, including the North Carolina Piedmont and Coastal Plain. It is used as a synonym for Brownwater Levee Forest (Bar Subtype), but in the Piedmont would overlap the concept of Piedmont Levee Forest.

Rare species:
Vascular plants: *Cardamine douglassii, Enemion biternatum, Euphorbia mercurialina, Eurybia mirabilis, Phacelia colvillei, Silphium perfoliatum,* and *Urtica chamaedryoides*.

References:
Matthews, E.M., R.K. Peet and A.S. Weakley. 2011. Classification and description of alluvial plant communities of the Piedmont region, North Carolina, U.S.A. Applied Vegetation Science 14:485-505.

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

PIEDMONT LEVEE FOREST (BEECH SUBTYPE)

Concept: Piedmont Levee Forests are forest communities of natural levee deposits or river front riparian zones on large Piedmont floodplains. The Beech Subtype encompasses examples on higher, more stable levees, where *Fagus grandifolia* is a major component.

Distinguishing Features: The Piedmont Levee Forest community is distinguished from other communities of large Piedmont floodplains, as well as uplands, by significant presence of the characteristic levee species: *Platanus occidentalis, Betula nigra, Acer negundo*, and *Celtis laevigata* in natural condition. *Fraxinus pennsylvanica* too distinguishes it from communities other than Piedmont Swamp Forest. It is distinguished from Piedmont Alluvial Forest by occurring on larger floodplains — those with differentiated levee, bottomland, and terrace zones large enough to support distinct communities.

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, which have some, though usually less, *Fagus*, by occurrence on a large floodplain with differentiated landforms. The characteristic levee species are also present in larger numbers and greater diversity. 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 and adjacent to a stream or river.

Synonyms: *Fagus grandifolia – Acer barbatum / Asimina triloba / Toxicodendron radicans / Carex blanda* Forest (CEGL007321).
Ecological Systems: Southern Piedmont Large Floodplain Forest (CES202.324).

Sites: The Beech Subtype occurs on natural levee deposits or the river front edge of flatter terraces. The known examples are in Triassic basin floodplains and near the Fall Zone, on medium size streams rather than large rivers.

Soils: Soils are coarse or medium-textured, formed in recent alluvial deposits with little or no horizon development. Most examples are mapped as Chewacla (Fluvaquentic Dystrudept) or Wehadkee (Fluvaquentic Endoaquept).

Hydrology: The Beech Subtype is intermittently flooded, usually only for brief periods.

Vegetation: The Beech Subtype canopy includes codominant or abundant *Fagus grandifolia*. *Fraxinus pennsylvanica, Liquidambar styraciflua*, and *Betula nigra* have high constancy in known occurrences. Other species that are fairly frequent in known examples include *Quercus phellos, Quercus pagoda,* and *Liriodendron tulipifera*. A number of species occur at lower frequency, including *Platanus occidentalis, Ulmus americana, Quercus michauxii, Quercus alba*, and *Ulmus americana*. In the understory, *Carpinus caroliniana* is the most constant species, and *Acer floridanum, Ilex opaca, Asimina triloba*, and *Crataegus* spp. are fairly frequent. *Ilex decidua* often dominates the shrub layer. Other frequent species include *Arundinaria tecta, Viburnum*

prunifolium, Viburnum dentatum/ carolinianum/recognitum), and the exotic *Ligustrum sinense*. Vines are often prominent. Constant species in the known sites are *Toxicodendron radicans* and *Bignonia capreolata*. Other frequent species include *Smilax rotundifolia, Parthenocissus quinquefolia,* and the exotic *Lonicera japonica*; other typical species of floodplains, such as *Muscadinia rotundifolia* and *Campsis radicans*, may also be present. The herb layer generally is dense. *Chasmanthium latifolium, Carex* spp., *asarum canadense*, or *Microstegium vimineum* may dominate patches. In season, spring ephemeral species such as *Claytonia virginica, Erythronium umbilicatum*, and *Thalictrum thalictroides* may be abundant. A large number of additional species may occur, most with low cover and fairly low frequency, including *Persicaria virginiana, Arisaema triphyllum, Viola* spp., *Mitchella repens, Sanicula canadensis*, *Sanicula canadensis, Geum canadense, Epifagus virginiana, Athyrium asplenioides*, and many others.

Range and Abundance: Ranked G3? Only a few occurrences are known in North Carolina, but this subtype may be overlooked or difficult to recognize in earlier site descriptions. However, it has not been found in most floodplains surveyed since the concept was distinguished. The known examples are all in Triassic basins or near the fall zone. If this proves true with more study, it limits the abundance in the state compared to most floodplain communities. The equivalent NVC association ranges from North Carolina to Georgia.

Associations and Patterns: The Beech Subtype, like the Typic Subtype, is associated with Piedmont Bottomland Forest and potentially Piedmont Swamp Forest in broad floodplains. It appears to be a small patch community but could occur as long narrow bands that would add up to a large patch size.

Variation: The Beech Subtype is a relatively narrowly defined community. Its variation is not well known.

Dynamics: General dynamics of the Beech Subtype are similar to the Typic Subtype and to Piedmont and Mountain Floodplains in general. Because the levees are higher above the stream in the Beech Subtype, and appear to occur along streams with lower gradients, flooding probably is even shorter in duration but also probably less energetic than in the Typic Subtype.

Comments: This subtype was not recognized in Matthews, et al. (2011). It is unclear if any plots represent it.

Rare species:
Vascular plants: *Enemion biternatum.*

References:
Matthews, E.M., R.K. Peet and A.S. Weakley. 2011. Classification and description of alluvial plant communities of the Piedmont region, North Carolina, U.S.A. Applied Vegetation Science 14:485-505.

PIEDMONT BOTTOMLAND FOREST (HIGH SUBTYPE)

Concept: Piedmont Bottomland Forests are communities of the higher parts of large Piedmont floodplains, away from the river and naturally dominated by a mix of bottomland oaks, hickories, *Liriodendron tulipifera*, and *Liquidambar styraciflua*, rather than the characteristic Piedmont Levee Forest species. They occur on terraces, on the higher parts of depositional ridge and swale systems, and on some wide flat floodplains. The High Subtype represents those on the highest 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-sized floodplains. Most examples have been found on medium-sized rivers, but examples probably once were more common on higher terraces of larger rivers as well.

Distinguishing Features: Piedmont Bottomland Forests are distinguished from Piedmont Levee Forests 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 riverbank.

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, et al. (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, et al. (2011) did not include samples of them, communities of high bottomlands with *Fagus grandifolia* dominant or co-dominant are included in this subtype.

Synonyms: *Liquidambar styraciflua – Quercus (phellos, nigra, alba) / Carpinus caroliniana* Forest (CEGL007006).
Ecological Systems: Southern Piedmont Large Floodplain Forest (CES202.324).
Oak-hickory flats (Matthews, et al. 2011).

Sites: Piedmont Bottomland Forests occur on floodplain ridges and on irregular or flat terraces well above the river. They usually are behind a natural levee or riparian zone with Piedmont Levee Forest but may sometimes extend to the river channel.

Soils: Soils are coarse to fine-textured alluvial soils. Most are mapped as Chewacla (Fluvaquentic Dystrudept), less often as Riverview (Fluventic Dystrudept) or other alluvial soils.

Hydrology: The High Subtype is intermittently flooded for short periods; it may go some years without flooding. Wetness varies with microtopography and soil texture. Though parts may be well-drained when the river is not in flood, local low areas or areas with clayey soils may be poorly drained.

Vegetation: The High Subtype is a forest with a mix of trees that includes both bottomland and upland species. In the Matthews, et al. (2011) plot data analysis, the most constant abundant canopy trees were *Liquidambar styraciflua* and *Acer rubrum*, but *Quercus phellos, Quercus nigra, Quercus pagoda, Quercus nigra, Liriodendron tulipifera, Ulmus americana, Ulmus alata*, *Fagus grandifolia*, and *Fraxinus pennsylvanica* occurred with at least fairly high frequency (25-75%). Additional species that occur with lower constancy include *Carya ovata, Carya cordiformis,* and *Carya carolinae-septentrionalis*. *Carpinus caroliniana* is the most constant and usually dominant understory species, but *Ilex opaca, Cornus florida*, and *Ilex opaca* may be abundant. The shrub layer is generally moderate in density. The most frequent species are *Ilex decidua, Viburnum prunifolium, Euonymus americana,* and *Arundinaria tecta*. Less frequent species include *Aesculus sylvatica, Asimina triloba*, and infrequent in plots at least, *Ligustrum sinense*. Vines are diverse. Frequent species include *Bignonia capreolata, Parthenocissus quinquefolia, Smilax rotundifolia, Toxicodendron radicans, Muscadinia rotundifolia, Lonicera japonica*, and less frequently, *Gelsemium sempervirens* and *Vitis* spp. The herb layer may be dense but more often is sparse to moderate. Species with high frequency include *Chasmanthium latifolium, Asarum canadense, Carex* spp. (*intumescens, debilis*, and others), *Elymus virginicus, Commelina virginica, Elephantopus carolinensis, Ranunculus abortivus, Dichanthelium commutatum, Sanicula canadensis, Boehmeria cylindrica, Polygonatum biflorum, Poa cuspidata*, *Arisaema dracontium*, *Solidago* spp., and *Viola* spp. *Microstegium vimineum* can be dense but is less likely to be than in Piedmont Levee Forest. Less frequent herbs in plot data include *Dichanthelium boscii, Elymus hystrix, Hexastylis arifolia, Salvia lyrata, Carex typhina, Impatiens capensis, Leersia virginica*, and *Ruellia caroliniensis*. *Chasmanthium laxum, Persicaria virginiana, Packera aurea, Polystichum acrostichoides*, *Cryptotaenia canadensis*, *Melica mutica, Danthonia spicata, Mitchella repens,* and a variety of other species have also been noted in site surveys.

Range and Abundance: Ranked G3G4 but probably rarer. In North Carolina, the High Subtype occurs throughout the eastern and middle Piedmont, both in Triassic Basins and on large rivers elsewhere. Known good occurrences are fewer than the Typic Low Subtype. The association also occurs in Virginia and possibly in South Carolina and Georgia.

Associations and Patterns: The High Subtype occurs naturally as a large patch community but is now often reduced to small remnants. Few occurrences are large. It is usually associated with Piedmont Levee Forest, sometimes with Piedmont Swamp Forest or with the Typic Low Subtype, but sometimes occupies all or most of a floodplain's width. It may contain embedded Floodplain

Pools. On the edge of the floodplain, it will grade to various mesic or dry-mesic upland forests, most commonly Mesic Mixed Hardwood Forest.

Variation: Examples of the High Subtype are quite variable in plant composition, but the widespread and varying levels of alteration make natural patterns difficult to discern. Matthews, et al. (2011) recognized three types of oak-hickory flats, the broad grouping equivalent to the High Subtype. However, one was associated with smaller floodplains and, though grouped with high bottomlands in their analysis, shares many species with Piedmont Alluvial Forest and would probably be recognized as it in the field. A second was represented only by a few plots from a single Triassic Basin site. Because plots from other Triassic basins did not group with it, it is not taken as indicating a distinct Triassic basin variant, and it is unclear why it appears different.

Dynamics: As the most elevated of Piedmont floodplain communities, the High Subtype is flooded least frequently and for the briefest periods. Unlike the Piedmont Levee Forest, flood waters likely have slowed by the time they spread out over this community, so that scouring and even movement of litter and debris may be minimal. However, deposition of sediment, with its nutrient subsidy, presumably still is important in making these communities more fertile and productive than uplands, and in support their distinctive vegetation. It is unclear how the altered hydrological regimes caused by land clearing in the watersheds has affected them.

Beaver ponds are probably much less frequently created in the High Subtype but may occur where sloughs or tributary streams can be dammed.

The combination of fertile alluvial soils, flat ground, and limited flooding has made sites of the High Subtype particularly attractive for agriculture. They may have been the primary focus of prehistoric agriculture, and the more intensive colonial and modern agriculture have left few substantial examples unaffected. Where not still cultivated, most areas of appropriate sites support successional vegetation, especially the larger patches on the largest rivers. Even examples that appear the least altered may have been affected by farming long ago, at least the shifting agriculture of prehistoric peoples. Areas that have been cleared or heavily logged in the more recent past tend to be strongly dominated by *Liquidambar* or *Liriodendron*, but *Pinus taeda* may come to dominate. Species of the Piedmont Levee Forest, especially *Platanus occidentalis* but also *Betula nigra, Acer negundo*, *Fraxinus pennsylvanica*, and *Celtis laevigata* sometimes also establish in successional forests in these sites, aided by their readily dispersed seeds and perhaps by remnant levee vegetation usually left at least on the riverbanks.

Comments: As noted in the comments on the Piedmont and Mountain Floodplains theme, the classification of bottomland and swamp forest has been particularly confused, and for that reason the central concepts and circumscription of the 3rd Approximation communities have been changed more than others in the 4th Approximation. The primary confusion for the High Subtype is that it was characterized as being naturally dominated by *Liriodendron* and *Liquidambar*, while that now appears to be a successional condition.

Matthews, et al. (2011) called their class that is equivalent to this subtype oak-hickory flats. They described them as being primarily on medium size floodplains, usually filling relatively featureless floodplains. However, occurrences in the Natural Heritage database also include a number on larger rivers and a number occurring with other communities. This discrepancy may be somewhat

a matter of interpretation, but examples on larger rivers often are small remnants that may have been inaccessible or may have been rejected as too altered.

Rare species:
Vascular plants: *Cardamine douglassii, Phacelia colvillei, Silphium connatum,* and *Silphium perfoliatum.*

References:
Matthews, E.M., R.K. Peet and A.S. Weakley. 2011. Classification and description of alluvial plant communities of the Piedmont region, North Carolina, U.S.A. Applied Vegetation Science 14:485-505.

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

PIEDMONT BOTTOMLAND FOREST (TYPIC LOW SUBTYPE)

Concept: Piedmont Bottomland Forests are communities of the higher parts of large Piedmont floodplains, away from the river and naturally dominated by a mix of bottomland oaks, hickories, *Liriodendron tulipifera*, and *Liquidambar styraciflua*, rather than the characteristic Piedmont Levee Forest species. The Typic Low 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 as it may be in Piedmont Swamp Forest.

Distinguishing Features: Piedmont Bottomland Forests are distinguished from Piedmont Levee Forests by lack or scarcity of the characteristic levee species. They are 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*.

The Typic Low Subtype is distinguished from the Northern Low Subtype by the absence or near absence of *Quercus palustris*. It is distinguished from the High Subtype 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.

Synonyms: *Quercus pagoda – Quercus phellos – Quercus lyrata – Quercus michauxii / Chasmanthium latifolium* Forest (CEGL007356).
Ecological Systems: Southern Piedmont Large Floodplain Forest (CES202.324).

Sites: Piedmont Bottomland Forests occur on floodplain ridges and on irregular or flat terraces well above the river. They usually are behind a natural levee or riparian zone with Piedmont Levee Forest but may sometimes extend to the river channel. The Typic Low Subtype is most extensive and well-developed in Triassic basin floodplains but may potentially occur on any large floodplain.

Soils: Soils are coarse to fine-textured alluvial soils. Most are mapped as Chewacla (Fluvaquentic Dystrudept), less often as Riverview (Fluventic Dystrudept) or other alluvial soils.

Hydrology: The Typic Low Subtype is intermittently flooded for short periods, but somewhat longer and more frequent than the High Subtype. Wetness may vary with microtopography and soil texture. Though parts may be well-drained when the river is not in flood, local low areas or areas with clayey soils may be poorly drained.

Vegetation: The Typic Low Subtype is a forest consisting of a mix of bottomland and swamp species. In Matthews, et al. (2011), the most constant trees are *Fraxinus pennsylvanica, Acer rubrum, Liquidambar styraciflua*, *Quercus phellos*, and *Ulmus americana*, but *Quercus michauxii, Quercus pagoda, Quercus lyrata*, and *Carya carolinae-septentrionalis* are frequent and often dominant or codominant. Other trees that are fairly frequent, though not codominant, include *Quercus nigra* and *Quercus alba*. The understory is dominated by *Carpinus caroliniana*, with no other typical understory species frequent. The only highly constant shrub species is *Ilex decidua*. *Viburnum prunifolium* and *Ligustrum sinense* are fairly frequent, as is *Rubus* sp. Vines are a regular component. *Bignonia capreolata, Parthenocissus quinquefolia, Smilax rotundifolia, Toxicodendron radicans*, and *Lonicera japonica* are highly constant, and *Thyrsanthella difformе* and *Vitis* spp. are also fairly frequent. Herbs have relatively low cover. *Boehmeria cylindrica, Arisaema triphyllum*, *Viola* spp., and *Microstegium vimineum* are highly constant in plots. Other herb species that are at least fairly frequent include *Asarum canadense, Polystichum acrostichoides, Carex* spp. (*intumescens, typhina, tribuloides, blanda, amphibola, caroliniana, debilis* and others), *Ranunculus abortivus, Saururus cernuus, Chasmanthium latifolium, Elymus virginicus, Festuca subverticillata, Galium tinctorium, Glyceria striata, Impatiens capensis, Juncus coriaceus, Persicaria virginiana, Poa cuspidata, Sanicula canadensis, Sceptridium biternatum/dissectum, Solidago* spp., and *Erechtites hieracifolia*.

Range and Abundance: Ranked G2? but perhaps G3. This subtype is scattered in the eastern and central Piedmont. The largest examples are in Triassic basins, but examples in other areas are equally abundant. Good examples appear more numerous than for the High Subtype, as might be expected for wetter, less easily farmed sites, but extensive remnants are still few.

Associations and Patterns: The Typic Low Subtype occurs naturally as a large patch community, occurring either as large expanses or as part of a mosaic with large aggregate area, but it is now often reduced to small remnants. Few occurrences are large. It is usually associated with Piedmont Levee Forest, sometimes with Piedmont Swamp Forest or with the High Subtype, but sometimes occupies all or most of a floodplain's width. It may contain embedded Floodplain Pools. On the edge of the floodplain, it will grade to various mesic or dry-mesic upland forests, most commonly Mesic Mixed Hardwood Forest.

Variation: Variation within this subtype is not well known. Matthews, et al. (2011) had only a single finer grouping in their classification that appears to correspond to this subtype.

Dynamics: As a community at intermediate elevation above the river, the Typic Low Subtype floods at higher frequency and duration than the High Subtype but lower than Piedmont Swamp Forest. Flood currents likely are slow when they reach this community, so that scouring and movement of litter and debris probably are minor, but deposition of nutrients in sediment probably is important for fertility. It is unclear how the altered hydrological regimes caused by land clearing in the watersheds has affected them.

As this subtype is often locally the highest part of its floodplain, beaver ponds probably are relatively unlikely to flood much of it, but ponds may affect it near sloughs and tributary streams.

Comments: As noted in the comments on the Piedmont and Mountain Floodplains theme, the

classification of bottomland and swamp forest has been particularly confused, and for that reason the central concepts and circumscription of the 3rd Approximation communities have been changed more than others in the 4th Approximation. The distinction between the Typic Low Subtype and Piedmont Swamp Forest remains among the more uncertain. As a community dry enough to support a substantial presence of a number of oak species, it is recognized as a subtype of Piedmont Bottomland Forest in the 4th Approximation, with Piedmont Swamp Forest narrowed from its 3rd Approximation concept to include only communities wet enough to largely exclude most of the oak species. However, the analysis by Matthews, et al. (2011) did tie the equivalent community to their swamp and bottomlands group, where it seems to represent the bottomlands. They distinguished them from the higher oak-hickory flats, but it is not entirely clear why. The Typic Low Subtype does share a high abundance of the species most often dominant in swamps. However, it also contains a large number of species shared with the oak-hickory flats and absent in the swamps forests it is grouped with. Further investigation may be needed.

The Matthews, et al. (2011) community that corresponds closely to this subtype is called *Quercus (phellos, pagoda, michauxii) – Ulmus americana / Ilex decidua / Arisaema triphyllum*. They noted that it generally occurred on wide, flat Triassic Basin floodplains. *Quercus lyrata* occurs in it, but only in wet inclusions. However, Natural Heritage Program records include a number of occurrences outside of Triassic basins that appear to represent this community. The reason for this discrepancy needs further investigation.

Rare species:
Vascular plants: *Carex decomposita, Eurybia mirabilis,* and *Urtica chamaedryoides*.
Invertebrate animals: *Gomphus abbreviatus*.

References:
Matthews, E.M., R.K. Peet and A.S. Weakley. 2011. Classification and description of alluvial plant communities of the Piedmont region, North Carolina, U.S.A. Applied Vegetation Science 14: 485-505.

PIEDMONT BOTTOMLAND FOREST (NORTHERN LOW SUBTYPE)

Concept: Piedmont Bottomland Forests are communities of the higher parts of large Piedmont floodplains, away from the river and naturally dominated by a mix of bottomland oaks, hickories, *Liriodendron tulipifera*, and *Liquidambar styraciflua*, rather than the characteristic Piedmont Levee Forest species. The Northern Low Subtype is a Virginia community that occurs along the state line, with only one North Carolina location known. It is similar in wetness to the Typic Low Subtype but contains 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 from the Typic Low Subtype and all other floodplain communities by having abundant *Quercus palustris*.

Synonyms: *Quercus phellos – Quercus (palustris, lyrata) / Ilex decidua / Carex typhina – (Carex grayi)* Forest (CEGL006498).
Ecological Systems: Southern Piedmont Large Floodplain Forest (CES202.324).

Sites: The North Carolina example occurs on a medium size floodplain on a large creek, occurring in lower portions of the floodplain. In Virginia, this community occurs in both large and medium size floodplains.

Soils: The North Carolina example is mapped as Chewacla (Fluvaquentic Dystrudept).

Hydrology: The flood regime appears to be similar to the Typic Low Subtype – intermittently flooded for short periods, but somewhat longer and more frequent than the High Subtype.

Vegetation: In the North Carolina example, the canopy is dominated by *Quercus phellos* and *Quercus bicolor*, with abundant *Quercus palustris* and a few *Quercus michauxii* and *Carya ovata*. The understory has abundant *Quercus palustris*. The shrub layer is dominated by *Viburnum prunifolium* and *Ilex decidua*. The herb layer is dominated by grasses and sedges and *Claytonia virginica* is abundant in the spring. The exotic *Lysimachia nummularia* is also abundant. The NVC, largely based on data on Virginia examples, says *Quercus phellos* is the most constant species, while *Quercus palustris, Quercus lyrata*, and *Quercus michauxii* may dominate in varying combinations. *Quercus bicolor* is infrequent. Other trees include *Ulmus americana, Acer rubrum, Carya ovata, Ulmus alata, Celtis occidentalis*, and *Betula nigra*. *Carpinus caroliniana* is the predominant understory tree, *Ilex decidua* and *Viburnum prunifolium* the most constant shrubs. *Toxicodendron radicans, Smilax rotundifolia*, and *Campsis radicans* are common vines. The herb layer is usually dense. Patches are dominated by *Carex* spp. (*typhina, grayi, tribuloides, radiata, intumescens*), *Leersia virginica, Poa autumnalis, Glyceria striata*, and *Cinna arundinacea*. Other herbs include *Boehmeria cylindrica, Impatiens capensis, Lysimachia ciliata, Lycopus virginicus, Commelina virginica*, and *Saururus cernuus*. Spring ephemerals such as *Claytonia virginica* are also noted, as is frequent invasion by *Lysimachia nummularia*.

Range and Abundance: Ranked G3? This community is extremely rare in North Carolina, with only a single occurrence known. It has a rather narrow global range, limited to the southern half of Virginia.

Associations and Patterns: This community occurs as a small patch. Its North Carolina example is apparently associated with the Typic Low Subtype and may be in a slightly wetter microsite.

Variation: No detail is known about the variation in this subtype.

Dynamics: Dynamics are probably similar to the Typic Low Subtype. The one North Carolina is upstream of a filled railroad grade, which may have increased its wetness.

Comments: This subtype is not covered by Matthews, et al. (2011), and no plots are known to exist in the one North Carolina example. The association was defined in central to southern Virginia, and its occurrence in North Carolina was recognized during the inventory of Kerr Lake lands, which occur in both states (Van Alstine, et al. 1999).

Rare species:
Vertebrate animals: *Hyla versicolor*.

References:
Matthews, E.M., R.K. Peet, and A.S. Weakley. 2011. Classification and description of alluvial plant communities of the Piedmont region, North Carolina, U.S.A. Applied Vegetation Science 14:485-505.

Van Alstine, N.E., G.P. Fleming, and H.E. LeGrand Jr. 1999. A natural heritage inventory of John H. Kerr Reservoir, Virginia and North Carolina. Natural Heritage Technical Report 99-07, Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond, VA, and North Carolina Department of Environment, Health and Natural Resources, North Carolina Natural Heritage Program, Raleigh, NC. 406 pp. plus appendices.

PIEDMONT SWAMP FOREST

Concept: Piedmont Swamp Forests are communities of the wetter parts of large Piedmont floodplains, generally in backswamps and large sloughs but sometimes on low flat floodplains or in depressions on higher 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*, *Quercus phellos*, and *Quercus lyrata*.

Distinguishing Features: Piedmont Swamp Forests are distinguished from all other Piedmont floodplain forests by their 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*, *Boehmeria cylindrica* or other species tolerant of long hydroperiods.

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 water-tolerant 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. Montane Floodplains Slough is a similarly wet community that shares many species, but has a component of typical Blue Ridge flora, lacks some Piedmont species, and is not known to occur outside of the Mountain Region.

Drained beaver ponds that are succeeding to forest may be dominated by *Fraxinus pennsylvanica* and *Acer rubrum*. They should be treated as Piedmont/Mountain Semipermanent Impoundment as long as the history as a beaver pond is apparent and as long as the vegetation appears transient. If the pond changed the stream channel or resulted in deposition of a clay layer that made the site permanently wetter, it may develop into a stable Piedmont Swamp Forest.

Floodplain areas that have become wetter due to artificial impoundment by dams, roads, or other fill should not generally be classified as Piedmont Swamp Forest. They could be considered this type in rare cases where the impoundment is configured so as to create an identical hydrological regime and where enough time has passed for the vegetation to come to equilibrium with a composition resembling natural examples.

Synonyms: *Acer rubrum – Fraxinus pennsylvanica / Saururus cernuus* Forest (CEGL006606). Ecological Systems: Southern Piedmont Large Floodplain Forest (CES202.324).

Sites: Piedmont Swamp Forests occur in backswamp basins and sloughs on large floodplains, occasionally in locally wet areas on higher terraces, and occasionally on less differentiated low floodplains.

Soils: Soils are fine- to medium-textured, poorly drained alluvial soils. Most examples are mapped as Wehadkee (Fluvaquentic Endoaquept) or Chewacla (Fluvaquentic Dystrudept). In the latter case, they likely represent inclusions of the wetter Wedhadkee series.

Hydrology: Piedmont Swamp Forests are seasonally to frequently flooded. They may stay inundated well into the growing season but rarely or never throughout the entire growing season.

Vegetation: Piedmont Swamp Forests are dominated by a mixture of the most water-tolerant tree species of the region. Matthews, et al. (2011) report that *Acer rubrum* and *Fraxinus pennsylvanica* are usually the most abundant species. *Ulmus americana, Liquidambar styraciflua, Quercus lyrata*, *Quercus phellos*, and rarely, *Nyssa aquatica* and *Carya aquatica* may be codominant. Less water-tolerant oaks, such as *Quercus michauxii* and *Quercus pagoda*, are absent or scarce. The understory is dominated by *Carpinus caroliniana* along with canopy species. Shrub cover is low to moderate; *Ilex decidua* is the predominant species, but *Ligustrum sinense* may be fairly abundant. Vines are prominent. *Bignonia capreolata, Parthenocissus quinquefolia, Toxicodendron radicans, Smilax rotundifolia, Muscadinia rotundifolia*, and *Lonicera japonica* all have high constancy in plots and may have substantial cover. The herb layer may be sparse to moderate but is lower in diversity than most of the Piedmont floodplain communities. *Saururus cernuus, Boehmeria cylindrica*, *Ludwigia palustris*, or any of several species of *Carex* (e.g., *typhina, crinita, tribuloides, intumescens*) may dominate patches. Other herbs with high to moderate frequency include *Bidens frondosa, Viola* spp., *Chasmanthium latifolium, Dichanthelium commutatum, Carex grayi, Impatiens capensis, Glyceria striata, Lycopus virginicus, Juncus effusus*, *Leersia virginica*, and *Solidago* spp. Though not notable in plots, *Zephyranthes atamasca* and *Dulichium arundinaceum* have also been noted. Other species of higher bottomlands, such as *Persicaria virginiana, Pilea pumila, Ranunculus abortivus*, and *Microstegium vimineum* also occur fairly frequently in low abundance.

Range and Abundance: Ranked G3G4 but likely rarer. See comments below for discussion of the relationship to the NVC association. In North Carolina, this community is potentially scattered through the Piedmont, other than in the foothills, but both acreage and number of occurrences are disproportionately concentrated in the Triassic basins.

Associations and Patterns: Piedmont Swamp Forest occurs with other communities of large Piedmont floodplains, including Piedmont Levee Forest and Piedmont Bottomland Forest. It may occur as small patches or may potentially dominate large patches.

Variation: Matthews, et al. (2011) recognized five associations within their swamp group. One of these is treated as Piedmont Bottomland Forest (Typic Low Subtype). The other four are tentatively treated as variants here. Some may be distinctive enough to ultimately be treated as subtypes, but some may be transitional or overlap other community types.
1. Typic Variant, called *Fraxinus pennsylvanica-Acer rubrum-Ulmus americana/Ilex decidua-Crataegus marshallii/Carex typhina-Saururus cernuus* is the most typical of the concept and the most abundant sampled.
2. Overcup Oak Variant, called *Quecus lyrata – Acer rubrum – Fraxinus pennsylvanica/Saururus cernuus,* is very similar to the Typic Variant but is codominated by *Quercus lyrata*.
3. Water Tupelo Variant, called *Carya aquatica – Nyssa aquatica*, is a rare occurrence dominated by these Coastal Plain species, in the PeeDee basin near the Fall Zone. This variant needs to be investigated to see if it would be better treated as a disjunct example of a Coastal Plain community. If not, though extremely rare, it appears the most distinct of the variants and probably should be treated as a subtype.

4. Levee Transition Variant is called *Fraxinus pennsylvanica – Betula nigra – Platanus occidentalis/Alnus serrulata /Boehmeria cylindrica*. In addition to the trees more typical of levees and shrubs more typical of riverbanks than floodplaint interior, this variant contains species in all strata that are shared with Piedmont Levee Forest. Matthews, et al. (2011) note that they occur in narrower floodplains that are confined by bedrock, farther inland and not in Triassic basins, and that they have sandier soils than other swamps. They also suggest that the wetness may be due to seepage or natural or manmade impoundment. Only 6 plots were found in this group. Further investigation is needed into their ecological setting, whether they would be better treated as part of Piedmont Levee Forest, and into how natural they are.

Dynamics: Piedmont Swamp Forests are flooded for longer durations than other Piedmont floodplain forest communities. The input of sediment makes them fertile, but the wetness, greater clay content, and acidity associated with it makes them less productive. The prolonged flooding appears to be important in keeping out uncharacteristic plant species and giving the community its distinctive composition. Altered flood regimes may more significantly detract from their natural character than for other Piedmont floodplain forests.

As in Piedmont Levee Forest, the most abundant canopy trees have ruderal life history traits and act as successional species in other communities. It is unclear if this implies a greater disturbance frequency in Piedmont Swamp Forests. Other early successional tree species of uplands, and even of levees, are not frequent in them, presumably because of wetness. Though soils are not as loose as in other floodplain communities, trees may still be more susceptible to windthrow than in uplands because of shallow rooting in the wet soils. In addition, though not well documented under natural conditions, flooding may occasionally be long enough to be a natural stress that contributes to mortality of established plants. This can happen more easily under altered conditions. A number of swamp forests have been diked to make green tree reservoirs. In some, the canopy appears similar to before impoundment, though often more stressed, but the lower strata tend to be visibly altered. In others, the increased hydroperiod ultimately kills the trees. Incidental impoundment by roads and other fill may also potentially lead to canopy mortality.

The sites of many Piedmont Swamp Forest occurrences, those in sloughs or basins with narrow outlets, are also particularly susceptible to being impounded by beavers.

Comments: The relationship of the NVC association linked to this community is unclear. That association is defined as extending into the Coastal Plain of Delaware and Maryland. At the same time, it does not extend to South Carolina and Georgia, where most floodplain communities are shared with North Carolina. Yet there is no reason to think North Carolina's Piedmont Swamp Forest is more northern in affinities than its other floodplain communities. Further analysis may lead to splitting or reconfiguration of this association in NVC.

The concept of this community has been narrowed from the Piedmont/Mountain Swamp Forest of the 3rd Approximation. Swamp-like floodplain forests of the Mountain Region are now treated as Montane Floodplain Slough. However, a couple of broader swampy forests in the upper French Broad River basin remain of uncertain classification, and these may represent disjunct examples of Piedmont Swamp Forest.

As noted in the comments on the Piedmont and Mountain Floodplains theme, the classification of bottomland and swamp forest has been particularly confused, and for that reason the central concepts and circumscription of the 3rd Approximation communities have been changed more than others in the 4th Approximation. Piedmont Swamp Forests now more specifically represent a portion of the floodplain moisture gradient, wet enough to have limited abundance of the typical bottomland oaks. They are more extensive in Triassic basins but can occur in all large floodplains. They are distinctly rarer and much less extensive than Piedmont Bottomland Forest.

Rare species: No rare species are known to be associated with this community.

References:

Matthews, E.M., R.K. Peet, and A.S. Weakley. 2011. Classification and description of alluvial plant communities of the Piedmont region, North Carolina, U.S.A. Applied Vegetation Science 14:485-505.

PIEDMONT/MOUNTAIN CANEBRAKE

Concept: Piedmont/Mountain Canebrakes are communities dominated by dense thickets of *Arundinaria gigantea*, treeless or with an open canopy. No well-developed examples are known to remain in North Carolina.

Distinguishing Features: Piedmont/Mountain Canebrakes are distinguished by having a dense shrub layer of *Arundinaria gigantea*, occurring with limited tree cover. Areas of cane that appear to be naturally developed, or are restored in plausible natural settings, should be regarded as this type. Areas where *Arundinaria* occurs at low to moderate density under a typical forest canopy are not included, nor are stands of *Arundinaria appalachiana* in uplands. Abundance of *Arundinaria gigantea* in a forest may suggest past occurrence of a canebrake but should not be taken as proof of a former canebrake without additional evidence. Methods of finding sites of past canebrakes, other than definitive site-species historical descriptions, are not known.

Piedmont/Mountain Canebrakes are distinguished from Peatland Canebrakes by occurring different regions, different environments, and in being dominated by *Arundinaria gigantea* rather than *Arundinaria tecta*.

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).

Sites: Piedmont/Mountain Canebrakes may potentially occur in either small or large floodplains. They are believed to be primarily in the Mountain Region but could occur in the upper Piedmont.

Soils: Piedmont/Mountain Canebrakes could potentially occur on any floodplain soil. If particular soil conditions are necessary, they are not known.

Hydrology: Canebrakes occurred on drier floodplain sites; they presumably were flooded intermittently for brief periods.

Vegetation: The vegetation is characterized by a dense stand of *Arundinaria gigantea*, which may be 10 to 20 feet tall or more. Trees may be absent, but an open or sparse canopy of any of the trees of any of the Montane Alluvial Forest subtypes may be present. Other shrubs may occur at low density beneath the cane or may be more abundant in open spots.

Range and Abundance: Ranked G2? This community has largely disappeared from North Carolina. Only a couple of small, poorly developed examples of questionable origin are known. The former abundance, acreage, and distribution in North Carolina is unclear. It is generally believed to have been more prominent in the Mountains. Though Native Americans in the Piedmont were reported to use cane, and large cane stalks were reported to have been seen, it is less clear if there were well-developed canebrakes. The rough range map in Triplett, et al. (2010) show *Arundinaria gigantea* occurring only in the Blue Ridge and possibly western Piedmont in North Carolina, though it extends into the Coastal Plain in Georgia and southern South Carolina. The NVC association is attributed to a very wide range, extending from Virginia to Florida and

westward to Texas and Missouri, and the NVC description cites several places where remnants occur. The nearest substantial remnant appears to be near the Ocmulgee River in the Georgia Piedmont or upper Coastal Plain.

Associations and Patterns: Piedmont/Mountain Canebrakes are generally described as large patch communities, though it is unclear how extensive examples in North Carolina were. They presumably were smaller than those on the much larger floodplains farther west. They presumably occurred with various floodplain forests and likely bordered uplands at the edge of floodplains.

Variation: Nothing is known of the variation in this community. It is unlikely that the NVC association was uniform over the large range of climate and physiography to which it is attributed.

Dynamics: Most of what is believed about canebrake dynamics is interpreted from historical sources. The widespread belief that they were maintained by fire is almost certainly true; the climate and sites where they occurred are capable of supporting forests. However, it is likely that a dense stand of cane is competitive enough to inhibit tree establishment even without fire. This likely was a situation of alternative stable states, where the flammability of dense cane promoted intense fires that would kill trees and sustain canebrakes, while the limited flammability in floodplain forests dampened fires. Because *Arundinaria* can spread by rhizomes, established canebrakes might be able to expand into adjacent forests as long as fire was sufficiently frequent, but might shrink in periods when fire became infrequent. If canebrakes with open tree canopies exist, may be a nonequilibrium situation, where previously established trees persist but cannot reproduce.

It is assumed by many that fire intervals were very frequent and were largely human caused. As with the fire regime in other communities, most fires may have been ignited by humans near their settlements, but it is less clear that fires would not have occurred without them. The existence of numerous species adapted to fire required a period of evolution much longer than human presence in the hemisphere. It is also likely that fire frequencies as high as often believed to have occurred around human settlements would not have been good for *Arundinaria*, which replenishes its biomass more quickly than trees but likely still requires several years free of fire to retain vigor.

It is widely believed, as stated in the NVC description, that canebrakes are early successional communities and may have all gotten their start in abandoned aboriginal fields. However, it is a misleading characterization to group them with typical ruderal-dominated early-successional vegetation. *Arundinaria gigantea* is like most bamboos in fruiting only extremely rarely. Unlike the wind-dispersed herbs and trees that we presently see capturing abandoned clearings, it could invade only from well-established stands on the edge. Canebrakes are unlikely to have been a frequently shifting community. While trees are likely to replace them if there is no fire, it is probably better to view them like prairies and barrens, as a stable community that is maintained by burning at an appropriate frequency and does not readily recover from disturbances that kill the dominant plants.

Before native human populations were decimated by disease, they practiced shifting agriculture in sites similar to where canebrakes are believed to have occurred. Thus, it is possible that canebrakes were created by abandoned fields. However, *Arundinaria* could capture old fields before trees did

only if there were frequent fire. It thus seems unlikely that widespread invasion coincided with the decline in human population if it depended solely on a human-caused fire regime. Canebrakes probably were not attractive places for aboriginal shifting agriculture. Without plows, the *Arundinaria* rhizomes could not be eliminated as trees could by girdling, and cane would have quickly regrown as it did from fires. Given the usefulness of cane, it seems more likely that people would have maintained them as a source of material. But the vast size of canebrakes reported in other states seems far beyond what people could have used or chosen to maintain.

Comments: The most definitive historical references to extensive canebrakes are from states farther west, primarily those around the Mississippi River. Smaller canebrakes are reported in the Cumberland Plateau,

Rare species: No rare species are known to be associated with this community.

References:

Platt, S.C., and C.G. Brantley. 1997. Canebrakes: An ecological and historical perspective. Castanea 62:8-21.

Triplett, J.K., K.A. Oltrogge, and L.G. Clark. 2010. Phylogenetic relationships and natural hybridization among the North American woody bamboos (Poaceae: Bambusoideae: Arundinaria). American Journal of Botany 97:471-492.

FLOODPLAIN POOL

Concept: Floodplain Pools are sloughs or depressions in floodplains that hold standing water much or all of the year. Vegetation is sparse or consists largely of aquatic plants except at the edges. 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 Piedmont/Mountain 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. The vascular plant species present in Floodplain Pools vary widely among examples. Most examples are naturally small, but examples smaller than 0.1 acre are not well enough developed to be recognized.

Synonyms: 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).

Sites: Floodplain Pools occur primarily in large- to medium-sized floodplains in both the Piedmont and Mountains. They may be near the river, on terraces, or at the edge of the upland. Most are clearly abandoned channel segments. Overflow channels that become blocked by natural levee deposition are a common origin.

Soils: Little is known about the soils of Floodplain Pools. Clay probably is deposited in the still water and may form a layer more impermeable than the surrounding alluvium.

Hydrology: Floodplain Pools are either permanently flooded or seasonally flooded for long parts of the growing season. Flooding by the river may be frequent or uncommon, depending on where they are located. When not flooded by the river, they are filled by rainfall and runoff from their immediate surroundings. Those in overflow channels may have substantial current during floods, which may scour the bed and deposit sand.

Vegetation: Floodplain Pool communities generally have sparse or no vegetation in the middle. Trees may overhang from the adjacent floodplain or upland community, but at least some are often rooted in the wetter conditions at the edge of the pool. *Fraxinus pennsylvanica* and *Acer rubrum* (perhaps often var. *trilobum*) are highly constant in site descriptions. *Quercus lyrata, Quercus phellos, Liquidambar styraciflua*, and *Carpinus caroliniana* are frequent. Somewhat less frequent species include *Platanus occidentalis, Ulmus americana, Betula nigra*, and *Salix nigra*. Shrubs are also often present, most frequently *Cephalanthus occidentalis*, but potentially including *Ilex decidua, Ilex verticillata, Alnus serrulata, Cornus amomum*, *Eubotrys racemosa, viburnum nudum*, and other wetand species. Herbs are largely confined to the edge as well. *Saururus cernuus* and various *Carex* species (*crinita, debilis, stipata, alata, lupulina* and others) are highly constant,

and *Persicaria* spp. are frequent. *Peltandra virginica, Impatiens capensis, Osmunda spectabilis*, and other wetland species often occur. A large number of other herbs of wetlands and of the surrounding floodplain forests may be present on the edges. More aquatic species, such as *Lemna* sp. and *Eragrostis hypnoides*, have been noted only occasionally.

Range and Abundance: Ranked G3. Floodplain Pools are scattered at low density through the Piedmont and at lower density in the valleys of the Mountain Region. Many unknown ones may exist since they cannot generally be seen on aerial photos or topographic maps. The synonymized NVC association is wide ranging to the north, occurring as far as Connecticut and possibly westward to Ohio and Tennessee. This probably is not a true reflection of the range of North Carolina's community. Similar communities likely occur at least in South Carolina and Georgia, and communities well to the north probably are very different.

Associations and Patterns: Floodplain Pools are small patch communities, many less than one acre in size. They may occur in clusters that have larger aggregate acreage but are seldom more than a few acres together.

Variation: Floodplain Pools are presumably highly variable, though the variation is not well understood. Duration of standing water, frequency of river flooding, occurrence of scouring, steepness of the basin, and age, as well as biogeographic region, may all cause variation. Two distinct variants can be recognized based on the aquatic animal communities:
1. Regularly Flooded Variant is flooded often by overbank stream flow and seldom dries up. It supports fish as the dominant animal component much of the time. This variant may be an important refugium for juvenile fish – a place where they can mature in the absence of larger predatory fish while still being able to return to the river before the pool dries up.
2. Infrequently Flooded Variant occurs on higher terraces or areas that are not flooded in most years. They are filled by rainwater rather than river water most years. They generally are free of fish and are attractive for amphibians. These differences are not known to be reflected in macro-vegetation, but they are important ecologically. The Infrequently Flooded Variant may also be important for the amphibian component of the surrounding floodplain and upland forests.

Differences between Piedmont and Mountain examples should also be sought. There are a large number of species that are known only from Piedmont examples. Fewer only from Mountain examples, but both have very low frequency among examples in their region.

Dynamics: Short-term Floodplain Pool dynamics are driven by the hydroperiod of standing water, as well as by river flooding. Shallower pools which dry up most years must have drastic seasonal fluctuations in aquatic fauna and may have short-lived plants that appear during drawdown. Pools may also change in composition in response to climatic cycles, with plants establishing during droughts which may then persist during wetter periods. In examples in overflow channels, floods may be a significant natural disturbance, causing major turnover of aquatic organisms and potentially scouring and reshaping the substrate. In other pools, river flooding may be only a minor event.

In long-term dynamics, a few Floodplain Pools near the river channel may be short-lived, potentially drained by channel movement or erosion, or buried by sediment deposition. But most

pools probably remain in place for decades if not centuries. They are probably more stable and persistent than Piedmont/Mountain Semipermanent Impoundments, though it is not certain this was true in the past. In the longer term, like Oxbow Lakes, Floodplain Pools are geologically short-lived. Sediment deposition will eventually fill them.

Comments: Floodplain Pools are transitional between vegetated wetland communities and aquatic communities. They are more distinctive for their aquatic fauna (and probably microflora) than for their higher plant communities.
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Floodplain Pools are somewhat analogous to the Oxbow Lake communities of the Coastal Plain. However, the geomorphic processes that form them differ in important ways, the flooding dynamics are different, and the lack of *Taxodium*, *Nyssa biflora*, and other Coastal Plain species gives them a very different character.

The wide-ranging northern NVC association is a questionable fit for North Carolina's Floodplain Pools. It was synonymized because no better fitting association was found. The floodplain pool environment must occur wherever there are large floodplains with similar geomorphic processes. How the biota vary is not well known. There is no reason to think that North Carolina's pools have more northern biotic affinities than its other floodplain communities, nor that they are not more similar to those that probably occur in South Carolina, Georgia, and other states to the south.

Rare species:
Vertebrate Animals: *Ambystoma talpoideum* and *Hemidactylium scutatum*.

References:

PIEDMONT/MOUNTAIN SEMIPERMANENT IMPOUNDMENT (OPEN WATER SUBTYPE)

Concept: Piedmont/Mountain Semipermanent Impoundments are portions of Piedmont and Mountain floodplains affected by impoundment by beaver dams, along with rare small man-made ponds that resemble them. They include drained beaver ponds that are still distinguishable from pre-impoundment conditions.

The Open Water Subtype consists of open water, submersed aquatic plants, or floating-leaved aquatic plants, with little emergent vegetation, occurring in deeper ponds or portions of ponds.

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, a situation that is fairly frequent in the Coastal Plain but almost never occurs in the Piedmont or Mountains. Both small ponds and larger reservoirs in the Piedmont and Mountains tend to bear little resemblance to natural beaver ponds and should not be treated as natural communities.

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 over a substantial area. They may contain herbs, shrubs, or small trees growing on the bases of dead trees or stumps, and these may sometimes be abundant. Only larger expanses of deep open water should be counted as occurrences; these generally are wide ponds or long segments of a large stream channel. Small water-filled channels in otherwise more vegetated impoundments should be treated as parts of the other subtypes.

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).

Sites: Piedmont/Mountain Semipermanent Impoundments occur on floodplains of streams or rivers. Beavers generally prefer second order streams (Snodgrass 1997), but they can use smaller or larger streams. Ponds are also common on large river floodplains, where beavers dam sloughs or tributary streams. Beavers strongly prefer low gradient streams, and many Piedmont and especially Mountain streams are probably too swift for them.

Soils: Piedmont/Mountain Semipermanent Impoundments can occur on any floodplain soil, though impoundment modifies the preexisting soil if the pond lasts very long. Besides saturation, depletion of oxygen, and reduction, the still water of ponds traps sediment and may allow deposition of relatively pure clay or organic matter over sizeable areas. Kroes and Bason (2015) noted that ponds could be significant repositories for carbon storage, and that, though sediments in channels tend to wash out quickly if the dam was breached, sediment stored elsewhere in floodplains might remain in place for centuries.

Hydrology: The Open Water Subtype is permanently or nearly permanently flooded, with moderate to deep water.

Vegetation: This community may consist largely of open water with no visible macrophytes, or it may consist of sparse to dense floating-leaf or free-floating plants. *Nymphaea odorata* and floating *Sparganium americanum* are the most frequent species, or *Lemna* spp., *Azolla caroliniana*, *Wolffia brasiliensis*, and *Spirodela punctata* may dominate. Occasional ponds may have *Nuphar advena*, *Brasenia schreberi*, or *Nelumbo lutea*. Exotic macrophytes may potentially invade. Emergent plants, surviving trees, and plants rooted on stumps or logs may be sparsely present.

A diverse community of animals may use the ponds, including frogs and toads, lizards, turtles, snakes, and birds that are not common in the surrounding forest (Metts et al. 2001).

Range and Abundance: Ranked G4G5. This subtype occurs throughout the Piedmont and Blue Ridge, and presumably occurs in neighboring states.

Associations and Patterns: This community can be the only extensive community in a pond, but it is more often a central zone with the Shrub Subtype or one of the marsh subtypes around the edges and at the upper end. In ponds where the beaver dam is within the stream channel, the Open Water Subtype may be confined to a narrow band in the channel.

Variation: Examples vary in types and in presence of macrophytes, but specific variants or patterns need further study. The Mountain examples appear more likely to have unvegetated open water, but such situations are common in the Piedmont, too.

Krues and Bason (2015) described a physical typology of beaver ponds that may be useful in describing their variation. The main pond forms are described as: inundating (filling the floodplain), channel (flooding the channel only), and discontinuous (flooding part of floodplain and channel but with high ground on levees or rises). This may be helpful, though additional categories would perhaps be needed for sloughs and for backswamps in large floodplains. The cluster configurations of pioneer (single pond), disjunct serial (several ponds nearby), and stair step serial (ponds running together) by the same authors also appears useful.

Dynamics: Beaver pond dynamics are unique among North Carolina's natural communities, contrasting with the stable site-driven mosaic that makes up most of the natural community landscape. They are among the most dynamic of communities, appearing and potentially disappearing rapidly, and occupying sites that previously supported very different communities.

Pond dynamics are dependent on the behavior of individual beaver families and on the dynamics of beaver populations. Each beaver colony consists of one breeding pair, along with subadult offspring and young. A given colony may maintain several ponds and several lodges or bank burrows. They are territorial, with a family excluding other beavers, so colonies are non-overlapping. New beavers will not move into a site if adult beavers are present (Allen 1982). Snodgrass (1997), at Savanna River Plant, found colonies to be separated by more than 100 meters.

Individual ponds form rapidly when beavers build a dam large and high enough to form a deep pond. Most trees die quickly, though more water-tolerant trees may survive on the edges. Young examples of the Open Water Subtype have recently dead trees, which gradually fall and decompose, eventually leaving a largely open water pond. Stumps may persist for many years, providing microhabitats for non-aquatic plants as well as for animals.

Colonization by aquatic plants takes some time, though it is not clear how long. Presumably this depends on proximity of populations and the abundance of dispersal vectors such as waterfowl. Beavers themselves could contribute to dispersal from nearby ponds, too. More mature ponds are probably more diverse, as aquatic species accumulate over time.

When a dam is abandoned, the deep pond usually drains quickly, and the Open Water Subtype succeeds to one of the other subtypes, eventually returning to a floodplain forest community if not impounded again. If the pond lasts for a long time, sediment deposition may fill it, leading to succession from the Open Water Subtype to other subtypes. While drained ponds in northern states may persist as wet meadows for 50 years or more (Wright et al. 2002), forest return is much more rapid in most of North Carolina.

Beavers may directly affect the vegetation in and around ponds, though this is particularly poorly known in the Open Water Subtype. Beavers are generalist herbivores but have strong food preferences (Allen 1982). Though they are most widely known for eating trees and shrubs, they prefer herbaceous vegetation if it is available, including most of the aquatic species named above. While it has been suggested that their preferences among woody plants may influence forest succession in adjacent areas, a similar effect of selective feeding on herbaceous plants has not been suggested. However, it is at least conceivable.

The natural population dynamics of beavers and beaver ponds remain poorly known. No record remains of beaver populations and behavior in early European times in most of the country, and indeed, the trade in beaver skins appears to have led to extirpation or substantial reductions by both Native Americans and European trappers before European settlers arrived in most localities. However, the declines in Native American populations due to disease, war, and displacement may have led to rebounding beaver populations. Populations almost everywhere throughout the huge range of North American beavers are recovering from the heavy exploitation and often complete extirpation of the past. There is extensive literature on beavers, but relatively little specific to the South. Population dynamics may well be different where ponds do not freeze over in winter, where herbaceous food is often available year-round, and where landscapes and potential predators are different. Beavers were extirpated from North Carolina long ago but were reintroduced in 1939. They have now returned throughout most of the state, but at different times and rates. In addition, trapping and management to reduce their effect on forests, agriculture, and human infrastructure are widespread, and few ponds can be assumed to be free of such influences. An important question is the extent to which populations were naturally controlled by predation, and how this affected the life span of colonies. While it is possible that predation of one of the breeding pair would lead to abandonment of the pond, it would seem more likely that resident helpers or dispersing beavers would quickly replace them and that there would be no interruption in occupation.

Beaver ponds are widely believed to create a shifting mosaic, functioning as a metapopulation, with creation of individual ponds followed by abandonment and succession, and new ponds created elsewhere as beaver move. Crucial parameters that remain unknown are how much of a natural landscape would be occupied by which stages of beaver ponds at any given time, and how much of the landscape would ever be affected by them. Walter and Merrits (2008), in Pennsylvania, excavated stream sediment profiles below the European era deposits. They found that all exhibited multiple stable channels, organic-rich sediment across the width of the floodplain, and macrofossils of aquatic and scrub-shrub plants. Though they suggested this was a result of groundwater discharge, it seems more suggestive of beaver ponds. They cited studies finding similar results in the Piedmont from South Carolina to Pennsylvania. However, they did not address the question of how much of the time a given place was in a beaver pond versus a floodplain forest. Beaver ponds could be the depositional environment of much of the floodplain sediment without being present most of the time.

Snodgrass (1997) found up to 27% of stream length affected by impoundments in some small watersheds, but much less in larger watersheds. Forty-one years after reintroduction, without management during most of that time, they had affected only 9% of stream length and 0.5% of the land area. He also found 0.1 square meter/ha/year newly impounded. Brzyski (2005), in the Georgia Coastal Plain, found only 0.07 colonies/km of stream, a very low density. Kroes and Bason (2015), in the Virginia and North Carolina Coastal Plain, found about 1 pond/100 sq. km. In the Adirondacks, Wright et al. (2002) found 26.7% of stream length affected, and 3.32% of the landscape. In all these studies, it is unclear how fully beaver populations had recovered, nor how much ongoing trapping and other management was occurring. Some referred to human destruction of ponds.

While beaver pond dynamics are sometimes portrayed as random colonization events followed by abandonment when woody food resources are consumed, the scenario is no doubt more complicated, with preferred sites occupied much of the time, marginal sites abandoned more quickly and spending less time ponded, and some areas unsuitable and rarely or never ponded. Fryxell (2001), working in boreal forest, found beaver occupancy to be complex, with a small number of ponds being source populations and a larger number being sinks whose colonies did not reproduce at replacement levels. About 20% of the ponds persisted through the 11-year study, but many pond sites were abandoned and recolonized repeatedly within that period. Rather than a shifting mosaic, the landscape appeared to consist of sites that were repeatedly reoccupied long before succession was completed. Abandonment appeared to have less to do with depletion of food than with marginal habitat that did not support consistent reproduction. The stable colonies had ponds with abundant aquatic plants, which might mean better food supply; however, it is unclear if those ponds are stable because they have more aquatic plants or if they have more aquatic plants because they are more stably maintained by beavers.

Comments:

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PIEDMONT/MOUNTAIN SEMIPERMANENT IMPOUNDMENT (MONTANE MARSH SUBTYPE)

Concept: Piedmont/Mountain Semipermanent Impoundments are portions of Piedmont and Mountain floodplains affected by impoundment by beaver dams, along with rare small man-made ponds that resemble them. This includes drained beaver ponds that are still distinguishable from pre-impoundment conditions. The Montane Marsh Subtype covers portions of Mountain examples with emergent or nonaquatic herbaceous vegetation predominating.

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 this almost never occurs in the Piedmont or Mountains. Both small ponds and larger reservoirs in the Piedmont and Mountains tend to bear little resemblance to natural beaver ponds and should not be treated as natural communities.

As presently defined, the Montane Marsh 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 more forbs and *Carex* species, sometimes flora shared with bogs, and without the many species of Coastal Plain affinities that can be present in the Piedmont. Species in the Montane Marsh Subtype but scarce or absent in the Piedmont Marsh Subtype include *Carex atlantica*, *Carex debilis*, *Carex folliculata*, *Cicuta maculata*, *Scirpus expansus*, *Chelone obliqua*, *Dichanthelium clandestinum*, *Eupatorium fistulosum*, *Eupatorium perfoliatum*, *Glyceria melicaria*, *Houstonia serpyllifolia*, *Hydrocotyle americana*, *Juncus gymnocarpus*, *Osmundastrum cinnamomeum*, *Oxypolis rigidior*, *Rubus alleghaniensis*, *Symphyotrichum puniceum*, *Thelypteris palustris*, and *Viola cucullata*.

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.

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).

Sites: Piedmont/Mountain Semipermanent Impoundments occur on floodplains of streams or rivers. Beavers generally prefer second order streams (Snodgrass 1997), but they can use smaller or larger streams. Ponds are also common on large river floodplains, where beavers dam sloughs or tributary streams. Beavers strongly prefer low gradient streams, and many Mountain streams are clearly too swift for them.

Within beaver ponds, the Montane Marsh Subtype typically occurs as a zone on the edges or fills the bed of drained ponds. Beavers sometimes build small dams within entrenched channels, where

open water is confined to the channel itself, and in these cases, marsh created by the raised water table may occupy a broad part of the floodplain.

Soils: Piedmont/Mountain Semipermanent Impoundments can occur on any floodplain soil, though impoundment modifies the preexisting soil if the pond lasts very long. Besides saturation, depletion of oxygen, and reduction, the still water of ponds traps sediment; this may allow deposition of relatively pure clay over sizeable areas, though this probably is less likely than in the Piedmont or Coastal Plain. Kroes and Bason (2015) noted that ponds could be significant repositories for carbon storage, and that, though sediments in channels tend to wash out quickly if the dam is breached, sediment stored in other parts of floodplains might remain in place for centuries.

Hydrology: The Montane Marsh Subtype may be permanently or seasonally flooded with shallow water or may be unflooded but permanently saturated. Portions may also be affected by groundwater discharge.

Vegetation: Montane Marsh Subtype vegetation is dominated by herbaceous plants. Woody plants may be present with sparse to moderate cover, either as surviving trees, shrubs, and small trees established on edges and on stumps, or young trees and shrubs beginning to invade drained ponds. The herbaceous vegetation tends to be extremely variable among sites and is usually very patchy and heterogeneous within sites. The community as a whole may be quite rich in species in mature sites. Species strongly dominating in patches are less frequently noted than in the Piedmont Marsh Subtype.

Plant species that are often abundant include *Juncus effusus*, *Scirpus cyperinus*, *Sciprus expansus*, *Carex lurida*, *Carex atlantica*, *Carex debilis*, *Carex folliculata*, *Leersia oryzoides*, *Impatiens capensis*, *Dulichium arundinaceum*, *Mimulus ringens*, *Chelone obliqua,* and *Typha latifolia*. *Sparganium americanum* often dominates in drowned channels that have deeper water than most of the marsh but may dominate larger expanses. Other species that are fairly frequent include *Boehmeria cylindrica*, *Dichanthelium clandestinum*, *Persicaria sagittata*, *Persicaria arifolia*, *Arisaema triphyllum* (including ssp. *stewardsonii*), *Athyrium asplenioides*, *Bidens tripartita*, *Cinna arundinacea*, *Epilobium coloratum*, *Eupatorium fistulosum*, *Eupatorium perfoliatum*, *Galium tinctorium*, *Glyceria melicaria*, *Houstonia serpyllifolia*, *Hydrocotyle americana*, *Juncus gymnocarpus*, *Ludwigia palustris*, *Lycopus virginicus*, *Osmundastrum cinnamomeum*, *Oxypolis rigidior, Sagittaria latifolia*, *Rubus alleghaniensis*, *Sambucus canadensis*, *Scutellaria lateriflora*, *Symphyotrichum puniceum*, *Thelypteris palustris*, and *Viola cucullata*. Woody species, which may be present in small numbers or as young individuals, include *Alnus serrulata*, *Cornus amomum*, *Rosa palustris*, and *Spiraea tomentosa*.

Range and Abundance: Ranked G4?. The Montane Marsh Subtype may occur throughout the Mountains. It may potentially occur in the foothills region, though no examples have been recorded from there. It is unclear where the transition from Piedmont Marsh to Montane Marsh might occur. This subtype potentially occurs in Virginia, Tennessee, and Georgia, possibly also South Carolina.

Associations and Patterns: This subtype may be either a zone within a complex of other subtypes or may be the only subtype present in drained ponds. In ponds where the dam is confined within

the stream channel, a Montane Marsh Subtype community with a high water table but no standing water may dominate much of the floodplain. This subtype likely borders some other floodplain community, or an upland, on one side. Impoundments may be formed in Southern Appalachian Bog or French Broad Valley Bog communities, where they may drown and replace part or all of the bog, but they may coexist beside it for a time. The bog community will often reestablish itself when the pond drains.

Variation: This subtype is extremely variable among sites and often extremely heterogeneous within sites. While this variation is not well sorted out, two variants are provisionally proposed:
1. Typic Variant consists of typical early successional and generalist wetlands species.
2. Boggy Variant contains *Sphagnum* and other species shared with mountain bogs, such as *Carex folliculata*, *Carex atlantica*, and *Osmundastrum cinnamomeum*. This seems to be associated with acidic seepage. It could also apply to former bogs which were drowned by a beaver pond but retain some of their bog flora.

There may be merit in distinguishing zonal and successional variants, as is done for the Piedmont Marsh Subtype and Shrub Subtype, but there is less information on these variations in the Mountains.

Dynamics: See the more extensive discussion of general beaver pond dynamics under the Open Water Subtype.

The Montane Marsh Subtype, as defined, has variable dynamics, with some being fairly stable zones and others being short-lived natural successional communities. Marsh vegetation may develop quickly when a pond is created or when a pond is drained and exposes a formerly flooded area. It will continue to develop and change over time, as additional species colonize and as the environment evolves. Marsh vegetation may also develop gradually from the Open Water Subtype, as sediment fills an older pond. Conversely, the marsh may be slowly or quickly colonized by shrubs or tree saplings and develop into the Shrub Subtype. Very little is known about the duration of these successional stages within the life of a pond.

A great question remains about the relationship between beaver ponds and mountain bog communities. They occupy similar settings in floodplains or stream bottoms, and a number of known bogs have been impounded by beavers in recent years. Impoundment replaces the bog vegetation with one of the subtypes of Piedmont/Mountain Semipermanent Impoundment, but the bog vegetation often persists on the edge of the pond and reoccupies the site if the pond drains.

The widespread tendency for Southern Appalachian Bog and French Broad Valley Bogs to be invaded by woody vegetation, potentially eliminating the distinctive bog community, has led to a frequent interpretation of bogs as early successional communities. See the extensive discussion of bog dynamics in the Mountain Bogs and Fens theme description. If disturbance is important in maintaining bogs, the most likely source of sufficient natural disturbance to create such early successional conditions is drained beaver ponds. It is therefore often believed that mountain bogs are created by beaver ponds and may be merely another successional stage of them. Though evidence is hard to come by, this hypothesis in its general form does not seem well supported by observations. The Montane Marsh Subtype shares a number of species with bog communities, but

these tend to be the more generalist wetland species. Beaver ponds have a large suite of colonizing (ruderal or early successional) species not found in higher quality bogs, though some are found in bogs disturbed by grazing or removal of large amounts of vegetation. Conversely, higher quality bogs have a suite of species that are conservative, indicate low nutrient conditions, and do not readily disperse. Though there has been little study, it is possible that *Glyptmys muhlenbergii*, though known as bog turtles, would find habitat in the Montane Marsh Subtype.

While bogs can succeed impoundments if they were present before and if their flora persists on the edge, this is not the typical pattern. Most drained impoundments go from Montane Marsh Subtype to Shrub Subtype to forest without becoming a bog. There is no documented case of a place that was not a bog before impoundment becoming one after a pond has drained. In addition, mountain bogs are widely regarded to be more properly considered poor fens, with hydrology driven by ground water input. This is incompatible with the idea of them being a typical successional stage of drained beaver ponds. However, there is a subset of the Montane Marsh Subtype that has more bog-like vegetation, perhaps associated with ground water input, and it would be worth following more closely the future development of such areas.

Comments: As defined, this is an extremely variable and heterogeneous community. The NVC association synonymized below was created to represent beaver pond marshes of the Southern Blue Ridge. Other associations, such as *Juncus effusus* Seasonally Flooded Herbaceous Vegetation (CEGL004112); *Scirpus cyperinus* Seasonally Flooded Southern Herbaceous Vegetation (CEGL003866); and *Typha (angustifolia, latifolia)* - *(Schoenoplectus* spp.) Eastern Herbaceous Vegetation (CEGL006153), have been attributed to North Carolina and could conceivably be interpreted as applying to a few examples or patches of the Montane Marsh Subtype, but they should not be used. *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.

Rare species:
Vascular plants: *Stellaria alsine* and *Thalictrum macrostylum*.
Vertebrate animals: *Glyptemys muhlenbergii, Pseudacris brachyphona*, and *Vermivora chrysoptera.*

References:
Kroes, D.E. and C.W. Bason. 2015. Sediment trapping by beaver ponds in streams of the Mid-Atlantic Piedmont and Coastal Plain, USA. Southeastern Naturalist 14:577-595.

Snodgrass, J.W. 1997. Temporal and spatial dynamics of beaver-created patches as influenced by management practices in a southeastern North American Landscape. Journal of Applied Ecology 34:1043-1056.

PIEDMONT/MOUNTAIN SEMIPERMANENT IMPOUNDMENT (PIEDMONT MARSH SUBTYPE)

Concept: Piedmont/Mountain Semipermanent Impoundments are portions of Piedmont and Mountain floodplains affected by impoundment by beaver dams, along with rare small man-made ponds that resemble them. This includes drained beaver ponds that are still distinguishable from pre-impoundment conditions. The Piedmont Marsh Subtype covers portions of Piedmont examples with emergent or nonaquatic herbaceous vegetation predominating.

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 this almost never occurs in the Piedmont or Mountains. Both small ponds and larger reservoirs in the Piedmont and Mountains tend to bear little resemblance to natural beaver ponds and should not be treated as natural communities.

The Piedmont Marsh Subtype is distinguished by dominance by emergent nonwoody vegetation with vegetation and flora characteristic of the Piedmont region, sometimes with species more typical of the Coastal Plain. 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. Species with high constancy or dominant in Piedmont Marsh and scarce or absent in Montane Marsh include *Carex comosa*, *Carex stipata*, *Persicaria hydropiperoides*, *P. punctata*, other *Persicaria* species other than the tearthumbs, *Echinodorus cordifolius*, *Erianthus giganteus*, *Alisma subcordata*, *Saururus cernuus*, *Pontederia cordata*, *Scirpus polyphyllus*, *Hydrocotyle ranunculoides*, *Hypericum mutilum*, *Onoclea sensibilis*, *Woodwardia areolata*, and *Pluchea camphorata*.

Marshy beaver ponds in the upper Piedmont and foothills should be classified as the subtype their vegetation best resembles.

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).

Sites: Piedmont/Mountain Semipermanent Impoundments occur on floodplains of streams or rivers. Beavers generally prefer second order streams (Snodgrass 1997), but they can use smaller or larger streams. Ponds are also common on large river floodplains, where beavers dam sloughs or tributary streams. Beavers strongly prefer low gradient streams, and many Piedmont streams are probably too swift for them.

Within beaver ponds, the Piedmont Marsh Subtype typically occurs as a zone on the edges or fills the bed of drained ponds. Beavers sometimes build small dams within entrenched channels, where open water is confined to the channel itself, and in these cases, marsh created by the raised water table may occupy a broad part of the floodplain.

Soils: Piedmont/Mountain Semipermanent Impoundments can occur on any floodplain soil, though impoundment modifies the preexisting soil if the pond lasts very long. Besides saturation, depletion of oxygen, and reduction, the still water of ponds traps sediment, and may allow deposition of relatively pure clay or organic matter over sizeable areas. Kroes and Bason (2015) noted that ponds could be significant repositories for carbon storage, and that, though sediments in channels tend to wash out quickly if the dam was breached, sediment stored elsewhere in floodplains might remain in place for centuries.

Hydrology: The Piedmont Marsh Subtype may be permanently or seasonally flooded with shallow water or may be unflooded but permanently saturated.

Vegetation: Piedmont Marsh Subtype vegetation is dominated by herbaceous plants. Woody plants may be present with sparse to moderate cover, either as surviving trees, shrubs, and small trees established on edges and on stumps, or young trees and shrubs beginning to invade drained ponds. The herbaceous vegetation tends to be extremely variable among sites and is usually very patchy and heterogeneous within sites. Descriptions often note several plant species that dominate patches, and though these sometimes may be large areas of near-monoculture, more often the patches are only a few square meters or the dominance is weak. Sizeable areas may have diverse herbaceous vegetation with no obvious dominant. The community as a whole may be quite rich in species in mature sites.

Plant species that frequently dominate patches include *Typha latifolia*, *Juncus effusus*, *Peltandra virginica*, *Scirpus cyperinus*, *Sparganium americanum*, *Impatiens capensis*, *Leersia oryzoides*, and increasingly, *Murdannia keisak*. *Sparganium americanum* often dominates in drowned channels that have deeper water than most of the marsh but may dominate larger expanses. *Carex* spp. and *Persicaria* spp. also often reported as dominant at a generic level. *Carex crinita*, *Carex comosa*, *Carex stipata*, *Persicaria arifolia*, *Persicaria densiflora*, *Persicaria hydropiperoides*, *Persicaria punctata*, and others have been reported as dominating patches, but less frequently. A wide variety of other species have rarely, often only once, been reported as dominating patches: *Decodon verticillatus*, *Echinodorus cordifolius*, *Erianthus giganteus*, *Glyceria septentrionalis*, *Gratiola viscidula*, *Pontederia cordata*, *Sagittaria latifolia*, *Scirpus polyphyllus*, and even *Zizaniopsis miliacea*. Additional herbaceous species with fairly high frequency include *Saururus cernuus*, *Carex lupulina*, *Boehmeria cylindrica*, *Dulichium arundinaceum*, *Ludwigia leptocarpa*, *Ludwigia palustris*, *Lycopus virginicus*, *Penthorum sedoides*, *Sagittaria latifolia*, and *Alisma cordata*. Additional species that are fairly frequent include *Bidens discoidea*, *Bidens laevis*, *Glyceria striata*, *Hydrocotyle ranunculoides*, *Hypericum mutilum*, *Onoclea sensibilis*, *Lobelia cardinalis*, *Pilea pumila*, *Pluchea camphorata*, and *Woodwardia areolata*. The most typical woody species, on edges and on stumps, are *Alnus serrulata*, *Cephalanthus occidentalis*, *Salix nigra*, *Cornus amomum*, *Rosa palustris*, and *Hibiscus moscheutos*. *Fraxinus pennsylvanica* and *Acer rubrum* are the most likely tree species to have survived impoundment and are quick to begin establishing in drained ponds. *Betula nigra*, *Platanus occidentalis*, and *Liquidambar styraciflua* also may occur in drained ponds. Drained pond beds may also have a number of more ruderal species and may become dominated by *Cyperus* spp. and *Microstegium vimineum*.

A diverse community of animals may use the ponds, including frogs and toads, lizards, turtles, snakes, and birds that are not common in the surrounding forest (Metts et al. 2001).

Range and Abundance: Ranked G4?. This subtype may occur throughout the Piedmont. No examples have been described in the foothills region, and it is unclear where the transition from Piedmont Marsh to Montane Marsh might occur. This subtype presumably occurs in South Carolina, and potentially in Virginia, Georgia, and more distant states.

Associations and Patterns: This subtype may occur as single or multiple zones within a complex of other subtypes or may be the only subtype present in recently drained ponds. In ponds where the dam is confined within the stream channel, a Piedmont Marsh Subtype community with a high water table but no standing water may dominate much of the floodplain. This subtype likely borders some other floodplain community, or an upland, on one side.

Variation: This subtype is extremely variable among sites and often extremely heterogeneous within sites. Although patches strongly dominated by a single species often occur, large areas are not strongly dominated. Rather than name variants by fine-scale patches/zones, it seems to more reasonable to seek patterns in total flora or ecology. While more patterns may eventually be recognized, including perhaps examples that have flora with more or less Coastal Plain affinity, for now two variants are recognized:
1. Marsh Zone Variant forms part of a complex in active ponds and is expected to last as long as the pond, or to succeed only slowly to other communities.
2. Successional Marsh Variant occupies the former bed of a drained pond and is expected to quickly succeed to other communities. It typically has a more ruderal flora that can include less water-tolerant species.

Krues and Bason (2015) described a physical typology of beaver ponds that may be useful in describing their variation. The main pond forms are described as: inundating (filling the floodplain), channel (flooding the channel only), and discontinuous (flooding part of floodplain and channel but with high ground on levees or rises). This may be helpful, though additional categories would perhaps be needed for sloughs and for backswamps in large floodplains. The cluster configurations of pioneer (single pond), disjunct serial (several ponds nearby), and stair step serial (ponds running together) by the same authors also appears useful.

Dynamics: See the more extensive discussion of general beaver pond dynamics under the Open Water Subtype.

The Piedmont Marsh Subtype, as defined, has variable dynamics, with some examples being fairly stable zones and others being short-lived natural successional communities. Marsh vegetation may develop quickly when a pond is created or when a pond is drained and exposes formerly flooded area. It will continue to develop and change over time, as additional species colonize and as the environment evolves. Marsh vegetation may also develop gradually from the Open Water Subtype, as sediment fills an older pond. Conversely, the marsh may be slowly or quickly colonized by shrubs or tree saplings and develop into the Shrub Subtype. Very little is known about the duration of these successional stages within the life of a pond.

Comments: As defined, this is an extremely variable and heterogeneous community. 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 very different natural communities in other regions. Other associations are defined based on one or a few species that are patch dominants in this subtype, so that one could potentially apply them to portions of our examples. These include *Juncus effusus* Seasonally Flooded Herbaceous Vegetation (CEGL004112); *Scirpus cyperinus* Seasonally Flooded Southern Herbaceous Vegetation (CEGL003866); and *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.

References:

Kroes, D.E. and C.W. Bason. 2015. Sediment trapping by beaver ponds in streams of the Mid-Atlantic Piedmont and Coastal Plain, USA. Southeastern Naturalist 14:577-595.

Metts, B.S., J.E. Lanham, K.R. Russell. 2001. Evaluation of herpetofaunal communities of upland streams and beaver-impounded streams in the upper Piedmont of South Carolina. American Midland Naturalist 145:54-65.

Snodgrass, J.W. 1997. Temporal and spatial dynamics of beaver-created patches as influenced by management practices in a southeastern North American Landscape. Journal of Applied Ecology 34:1043-1056.

PIEDMONT/MOUNTAIN SEMIPERMANENT IMPOUNDMENT (SHRUB SUBTYPE)

Concept: Piedmont/Mountain Semipermanent Impoundments are portions of Piedmont and Mountain floodplains affected by impoundment by beaver dams, along with rare small man-made ponds that resemble them. They include drained beaver ponds that are still distinguishable from pre-impoundment conditions. The Shrub Subtype encompasses 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.

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, a situation that is fairly frequent in the Coastal Plain but almost never occurs in the Piedmont or Mountains. Both small ponds and larger reservoirs in the Piedmont and Mountains tend to bear little resemblance to natural beaver ponds and should not be treated as natural communities.

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 with an herb layer composed of shade-intolerant species remaining from the pond rather than typical floodplain forest species.

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).

Sites: Piedmont/Mountain Semipermanent Impoundments occur on floodplains of streams or rivers. Beavers generally prefer second order streams (Snodgrass 1997), but they can use smaller or larger streams. Ponds are also common on large river floodplains, where beavers dam sloughs or tributary streams. Beavers strongly prefer low gradient streams, and many Piedmont and especially Mountain streams are probably too swift for them. Within beaver ponds, the Shrub Subtype typically occurs as a zone on the edges, at the upper end, or fills the bed of drained ponds.

Soils: Piedmont/Mountain Semipermanent Impoundments can occur on any floodplain or valley bottom soil, though impoundment modifies the preexisting soil if the pond lasts very long. Besides saturation, depletion of oxygen, and reduction, the still water of ponds traps sediment; this may allow deposition of relatively pure clay or organic matter over sizeable areas. In at least one example in South Carolina, the author has observed a floating mat with the shrubs rooted in it, and this may develop in older ponds in North Carolina too. Kroes and Bason (2015) noted that ponds could be significant repositories for carbon storage, and that, though sediments in channels tend to wash out quickly if the dam is breached, sediment stored in other parts of floodplains might remain in place for centuries.

Hydrology: The Shrub Subtype may be permanently or seasonally flooded with shallow water, but more often is unflooded but saturated.

Vegetation: Vegetation is dominated by woody species, which may range from dense to fairly open. Most frequently dominant is *Alnus serrulata*, and *Salix nigra* and *Cephalanthus occidentalis* are also often dominant. Water tolerant species of trees, such as *Acer rubrum* and *Fraxinus pennsylvanica*, may also be abundant. Herbaceous plants may be present, beneath the shrubs or on stumps and tree bases. Any of the species listed for the Piedmont Marsh Subtype or Montane Marsh Subtype may occur.

Range and Abundance: Ranked G4. The Shrub Subtype may occur throughout the Piedmont and Mountains. It likely occurs in all adjacent states and probably ranges farther. The characteristic species are wide-ranging, so this community could potentially be recognized over a very large range. However, the associated herbaceous species, though not well known, would potentially distinguish more narrowly defined floristic types.

Associations and Patterns: This subtype may occur as single or multiple zones within a complex of other subtypes or may be the only subtype present in recently drained ponds. This subtype likely borders some other floodplain community, or an upland, on one side.

Variation:
Though not well described, two axes of variation can readily be defined in this subtype. Some examples are successional, occurring in drained ponds, containing invading trees and expected to have a short lifespan, while others are long-term zonal communities dominated by open wetland shrubs and expected to last as long as the pond lasts. The differences between Piedmont and Mountain biogeography, enough to define separate subtypes for the marsh communities, are less well marked but presumably can be recognized as variants. Thus, we can define four variants that should prove useful:
1. Montane Shrub Zone Variant.
2. Montane Successional Variant.
3. Piedmont Shrub Zone Variant.
4. Piedmont Successional Variant.

Dynamics: See the more extensive discussion of general beaver pond dynamics under the Open Water Subtype.

The Shrub Subtype, as defined, has variable dynamics, with some being fairly stable zones and others being short-lived natural successional communities. The Shrub Subtype generally develops from one of the marsh subtypes. This may occur simply because it takes longer for the woody plants to establish and grow to dominance when a pond forms or is drained. It may also occur slowly, as sediment gradually fills in parts of a long-lasting pond and creates shallower water. Within the Shrub Subtype, shrubs may quickly give way to young trees in drained ponds.

Comments:

This subtype as defined covers both Piedmont and Mountain examples. The lower diversity among the woody species (and poorly known herbaceous component) suggests less variation than among the marshes.

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.

Rare species:

References:

Kroes, D.E. and C.W. Bason. 2015. Sediment trapping by beaver ponds in streams of the Mid-Atlantic Piedmont and Coastal Plain, USA. Southeastern Naturalist 14:577-595.

Snodgrass, J.W. 1997. Temporal and spatial dynamics of beaver-created patches as influenced by management practices in a southeastern North American Landscape. Journal of Applied Ecology 34:1043-1056.

ROCKY BAR AND SHORE (TWISTED SEDGE SUBTYPE)

Concept: Rocky Bar and Shore communities represent sparse, herbaceous, or shrub vegetation of bedrock, cobble, and gravel areas in or along steam channels, where forest vegetation is prevented from developing by flood scouring or reworking of the substrate. The Twisted Sedge Subtype encompasses examples dominated by *Carex torta* or similar shade-intolerant, tough-rooted grass-like herbs. They generally occur on low cobble or gravel bars that are submerged by flowing water much of the time. They 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 graminoid herbs.

Synonyms: *Carex torta* Herbaceous Vegetation (CEGL004103).
Ecological Systems: South-Central Interior Large Floodplain (CES202.705); South-Central Interior Small Stream and Riparian (CES202.706).

Sites: The Twisted Sedge Subtype usually occurs in shallow flowing water along large creeks or small rivers with substantial current. Most are probably 3rd to 5th order streams. The substrate generally is gravel or cobbles, but it may occur on bedrock with fractures.

Soils: No developed soil is present. Some sand is trapped beneath the gravel.

Hydrology: The Twisted Sedge Subtype occurs around the typical water level, often in shallow flowing water much of the year.

Vegetation: The vegetation is strongly dominated by *Carex torta*, which may be sparse or fairly dense. Often no other vascular plants are present, but a few individuals of *Boykinia aconitifolia, Trautvetteria caroliniensis, Lobelia cardinalis, Xanthorhiza simplicissima*, or other species of other subtypes may be present.

Range and Abundance: Ranked G3G4. In North Carolina, this community is scattered through the Mountain Region. Examples have not been documented in the foothills, but it could occur there. The equivalent NVC association is widespread in the southern and central Appalachian region, ranging from Georgia to Pennsylvania, and including Kentucky and Tennessee.

Associations and Patterns: The Twisted Sedge Subtype occurs as a small patch community. Individual patches are often just a few meters in length and width, but complexes of patches may add up to larger areas. The true area of the larger complexes is poorly known.

Variation: Variation appears to consist primarily of the addition of other plants in the gradation to other subtypes of Rocky Bar and Shore.

Dynamics: The Twisted Sedge Subtype is subject to frequent flooding with substantial current. The streams where it occurs have limited fine sediment deposition and most are clear and oligotrophic. This community probably has low nutrient availability, though growth may still be

more limited by disturbance and mechanical stress than nutrients. Plants are tough but may be battered or uprooted by swift water or by gravel and cobbles carried as bed load in floods. Occasional flash floods may reconfigure bars, permanently destroying patches or creating new patches where the community can develop.

Comments:

Rare species:
No rare species are known to be associated with this community.

References:

ROCKY BAR AND SHORE (ALDER-YELLOWROOT SUBTYPE)

Concept: Rocky Bar and Shore communities represent sparse, herbaceous, or shrub vegetation of bedrock, cobble, and gravel areas in or along steam channels, where forest vegetation is prevented from developing by flood scouring or reworking of the substrate. The Alder-Yellowroot Subtype covers shrubby examples of medium size Mountain and 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, though some trees may be present. 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 nonforested wetland communities by occurring along streams or rivers, in areas subject to flooding and 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 from most subtypes by having a substantial (though still often sparse) shrub presence, with *Alnus serrulata* or *Xanthorhiza simplicissima* generally most abundant. The other subtype with substantial woody plant presence, the Mixed Bar Subtype, has a more mixed composition and structure that may include some trees as well as additional shrub species or, conversely, at times may lack either trees or shrubs.

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).

Sites: The Alder-Yellowroot Subtype occurs on rocky or sandy bars or on scoured bedrock with crevices. This community often is on smaller rivers or large creeks but can occur on larger rivers.

Soils: No well-developed soil is present. The substrate is recently deposited alluvial material or accumulations of material in crevices and pockets in bedrock.

Hydrology: The Alder-Yellowroot Subtype is frequently flooded and is generally a relatively short distance above normal water levels.

Vegetation: The Alder-Yellowroot Subtype consists of a heterogeneous mix of vegetation that has a substantial shrub component and limited tree or herb cover. Both *Alnus serrulata* and *Xanthorhiza simplicissima* are highly constant and usually have some of the highest cover. Other shrubs that are frequent and sometimes have high cover in CVS and Brown (2011) plots, and often are mentioned in site descriptions and local studies such as Newell (1997), Cooper and Hardin (1970), Dumond (1969), include *Rhododendron maximum, Leucothoe fontanesiana, Cornus amomum, Hamamelis virginiana, Rhododendron arborescens*, *Rhododendron minus*, and *Viburnum cassinoides*. *Arundinaria gigantea* may also occur. Most of the tree species typical of

Montane Alluvial Forest may be present in small numbers. *Acer rubrum, Tsuga canadensis, Nyssa sylvatica, Pinus strobus*, *Platanus occidentalis, Carpinus caroliniana, Liriodendron tulipifera*, *Betula lenta*, and *Liquidambar styraciflua* are present at moderate frequency, though some may represent overhanging cover from adjacent forests. Only a few herbs occur with moderate frequency and significant cover: *Dichanthelium clandestinum, Boykinia aconitifolia, Solidago rugosa, Apios americana*, and the exotic *Microstegium vimineum*. A large number of additional herbs occur with moderate frequency but lower cover in plot data, including *Lycopus virginicus, Rudbeckia laciniata, Eurybia divaricata, Houstonia serpyllifolia, Impatiens capensis, Athyrium asplenioides, Bidens* sp., *Polystichum acrostichoides, Viola sororia, Carex torta, Dichanthelium dichotomum* var. *ramulosum, Hypericum mutilium, Amphicarpaea bracteata, Oxalis stricta, Rubus flagellaris, Eutrochium fistulosum, Eutrochium purpureum, Juncus tenuis, Parathelypteris noveboracensis, Persicaria longiseta, Rumex crispus, Trautvetteria caroliniensis*, and *Viola primulifolia*. Several exotic species are also fairly frequent, including *Holcus lanatus,* and *Reynoutria japonica (Polygonum cuspidatum*), but some examples have little or no exotic plant presence.

Range and Abundance: Ranked G3G4. This subtype is scattered in the Mountains, with a few examples in the Piedmont. It probably is overlooked in reports and may occur in areas without other intact natural communities, so it may be more common than records suggest. The equivalent NVC association ranges from Virginia to Alabama and westward to Kentucky and Tennessee.

Associations and Patterns: The Alder-Yellowroot Subtype is a small patch community, with most patches just a few meters wide. It may potentially be associated with other subtypes, especially the Twisted Sedge Subtype. It typically occurs adjacent to Montane Alluvial Forest (Small River Subtype) or to Rich Cove Forest or Acidic Cove Forest but may occur with Montane Alluvial Forest (Large River Subtype).

Variation: This subtype is highly variable, but variation has not been clarified. Variation occurs with some examples conceptually transitional to other subtypes, especially the Mixed Bar Subtype and Twisted Sedge Subtype. Some of the apparent variation among site descriptions may come from incorrect classification.

Dynamics: As with other Rocky Bar and Shore subtypes, the Alder-Yellowroot Subtype is frequently flooded and subject to strong currents, disturbing the vegetation. However, it is dominated by long-lived shrubs, suggesting truly catastrophic disturbance is not common.

Comments: The conceptual distinction between the Alder-Yellowroot Subtype and Mixed Bar Subtype needs further clarification.

Rare species: No rare species are known to be associated with this community.

References:

Brown, R.L. 2002. Biodiversity and exotic species invasion in Southern Appalachian riparian plant communities. Ph.D. dissertation, University of North Carolina-Chapel Hill.

Cooper, A.W., and J.W. Hardin. 1970. Floristics of the gorges on the southern Blue Ridge escarpment. In:The distributional history of the biota of the Southern Appalachians, Part II: Flora. VPI & SU Research Division Monograph. 2.

Dumond, D. 1969. Floristic and vegetational survey of the Chattooga River Gorge. M.S. Thesis, N.C. State University, Raleigh.

Newell, C.L. 1997. Local and regional variation in the vegetation of the Southern Appalachian Mountains. Ph.D. dissertation, University of North Carolina, Chapel Hill.

ROCKY BAR AND SHORE (WATER WILLOW SUBTYPE)

Concept: Rocky Bar and Shore communities represent sparse, herbaceous, or shrub vegetation of bedrock, cobble, and gravel areas in or along steam channels, where forest vegetation is prevented from developing by flood scouring or reworking of the substrate. The Water Willow 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 from all other communities by the dominance of *Justicia americana* and near or complete absence of other vascular plants.

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).

Sites: The Water Willow Subtype usually occurs in shallow flowing water along small rivers with substantial current. Most are probably 4th to 5th order streams. The substrate generally is cobbles, boulders, or bedrock with trapped sand.

Soils: No developed soil is present.

Hydrology: The Water Willow Subtype occurs within shallow flowing water, generally a few inches to two feet deep at normal water levels.

Vegetation: The Water Willow Subtype normally consists exclusively of *Justicia americana*, in sparse to dense stands. Other plants shared with the Mixed Bar Subtype may be present in small numbers. Matthews, et al. (2011) noted *Boehmeria cylindrica* and the exotic *Murdannia keisak* as associates, as well as noting the possibility of overhanging trees.

Range and Abundance: Ranked G4G5. North Carolina examples are known throughout the eastern and central Piedmont. They probably are overlooked and are more abundant than records indicate. As defined, the NVC association is extremely widespread, ranging as far as Georgia, Arkansas, Pennsylvania, and New Jersey.

Associations and Patterns: The Water Willow Subtype is a small patch community, with individual patches potentially hundreds of meters long and clusters of patches potential several acres. It may grade into the Mixed Bar, Riverweed, Southern Wild Rice, or potentially other subtypes of Rocky Bar and Shore. Otherwise, this subtype occurs with various Piedmont and potentially Mountain floodplain forests.

Variation: Variation appears to consist primarily of the addition of other plants in the gradation to other subtypes of Rocky Bar and Shore.

Dynamics: The Water Willow Subtype is subject to frequent flooding with substantial current and potentially battering by bed load material and floating debris. Plants are tough but may be battered

or uprooted by swift water or reworking of the substrate. Occasional flash floods may reconfigure bars, permanently destroying patches or creating new patches where the community can develop. Given the continuous water flow, nutrient levels may be high. Patches may potentially be degraded by excess deposition of fine sediment, as well as by even shallow impoundment of the river.

Comments:

Rare species:
Vertebrate animals: *Notropis mekistocholas*.

References:
Matthews, E.M., R.K. Peet and A.S. Weakley. 2011. Classification and description of alluvial plant communities of the Piedmont region, North Carolina, U.S.A. Applied Vegetation Science 14:485-505.

ROCKY BAR AND SHORE (MIXED BAR SUBTYPE)

Concept: Rocky Bar and Shore communities represent sparse, herbaceous, or shrub vegetation of bedrock, cobble, and gravel areas in or along steam channels, where forest vegetation is prevented from developing by flood scouring or reworking of the substrate. The Mixed Bar Subtype covers communities of both Piedmont and Mountains that consist 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 and is more associated with larger and lower elevation rivers.

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, though some trees may be present. 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 mostly 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, native weedy species, 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.

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).

Sites: The Mixed Bar Subtype occurs primarily along medium to large rivers in both the Piedmont and Mountains, sites that may be a mix of silt, sand, gravel, cobbles, and bedrock outcrop. The looser material is newly deposited or frequently reworked. Sites tend to be lower elevation than most Alder–Yellowroot Subtype occurrences.

Soils: No well-developed soil is present. The substrate is recently deposited alluvial material or accumulations of material in crevices and pockets in bedrock.

Hydrology: The Mixed Bar Subtype is frequently flooded but at least parts of bars may stand fairly high above normal water levels. Because it usually occurs on larger rivers, floods may be of somewhat longer duration than some other subtypes, but nevertheless are short.

Vegetation: The vegetation of the Mixed Bar Subtype is extremely variable in structure and composition, within and among examples, also sometimes at the same site at different times. Trees may be present as a few large individuals, few or many small to medium sized but heavily battered individuals, as seedlings and saplings, or totally absent. Patches may be dominated by shrubs. Herbs may be dense, moderate, or nearly absent, throughout an example or in different patches

within it. The most frequent tree species are characteristic species shared with adjacent floodplain forests. In CVS and Brown (2002) plot data, and similarly in mountain site descriptions, these are *Platanus occidentalis, Acer rubrum, Liriodendron tulipifera, Fraxinus pennsylvanica, Robinia pseudo-acacia, Carpinus caroliniana, Liquidambar styraciflua, Salix nigra,* and *Juglans nigra*. Piedmont sites, generally not represented by plots, include most of the same species, with the addition of *Betula nigra, Acer negundo, Tilia americana* var *caroliniana*, and several others are lower frequency. Shrubs frequent in mountain plots are *Cornus amomum, Alnus serrulata, Lindera benzoin, Physocarpus opulifolius*, *Rubus pensylvanicus*, and the exotic *Rosa multiflora*. Additional species often noted in site reports include *Cephalanthus occidentalis* and *Ligustrum sinense*. Vines are not usually extensive, but *Toxicodendron radicans, Clematis virginiana*, *Parthenocissus quinquefolius*, *Smilax glauca*, and the exotic *Lonicera japonica* are frequent. Herbs include a diverse mix of floodplain species, typically upland species, and both native and exotic weedy species. Weedy and exotic species are abundant even in examples without overt alteration. In mountain plot data, *Dichanthelium clandestinum, Festuca subverticillata*, *Verbesina alternifolia*, and the exotic *Microstegium vimineum* are highly constant and sometimes dominant in patches. *Solidago rugosa, Leersia virginica, Amphicarpaea bracteata,* and the exotic *Phalaris arundinacea* and *Reynoutria japonica* occur fairly frequently and may dominate. Other frequent herbs include *Rumex crispus, Oxalis stricta, Viola sororia, Rudbeckia laciniata, Apios americana, Elymus virginicus, Lycopus* spp., *Boehmeria cylindrica, Impatiens capensis, Geum canadense, Juncus tenuis, Persicaria longiseta, Oenothera biennis, Hypericum mutilum, Verbesina occidentalis, Ambrosia artemisiifolia, Persicaria sagittata, Achillea borealis, Elymus riparius, Persicaria virginiana, Carex lurida, Cryptotaenia canadensis, Euryubia divaricata, Hypericum punctatum, Eupatorium perfoliatum, Galium triflorum, Acalypha rhomboidea*, *Ambrosia trifida, Persicaria punctata, Solidago gigantea, Bidens frondosa, Dichanthelium acuminatum* var. *fasciculatum, Juncus effusus, Potentilla canadensis, Eutrochium purpureum, Helenium autumnale, Mimulus ringens, Polystichum acrostichoides, Heliopsis helianthoides, Chasmanthium latifolium,, Conyza canadensis, Pilea pumila, Sedum ternatum, Solidago curtisii*, and *Rorippa palustris*. Frequent exotic herbs include *Hesperis matrionalis, Artemisia vulgaris, Holcus lanatus, Fallopia scandens, Daucus carota, Trifolium pratense, Glechoma hederacea, Dioscorea polystachya, Saponaria officianilis, Lespedeza cuneata, Arthraxon hispidus, Plantago rugelii, Trifolium repens, Alliaria petiolate*, and *Commelina communis*. A similarly diverse collection of additional species occurs with lower frequency. The pool of herbs in the Piedmont examples largely is within this set. Most of the added species, such as *Saururus cernuus, Elymus hystrix*, and the exotic *Murdannia keisak*, could potentially also occur in the mountains.

Brown (2002) reported these communities have found the highest plot-scale species richness values in the Mountain Region, higher than those of Rich Cove Forests and comparable to the most diverse longleaf pine communities.

Range and Abundance: Ranked G4. North Carolina examples are primarily in the Piedmont but occur in the larger mountain valleys. The overall range of this community is somewhat uncertain. The equivalent NVC association is attributed definitively only to North Carolina and Tennessee, but questionably to Virginia, South Carolina, and Georgia. It or a closely related association likely is present in these states and in Alabama, and possibly other interior states.

Associations and Patterns: The Mixed Bar Subtype is a small patch community. Most patches are less than 1 acre, but complexes of them may be several acres. It occurs most often with Piedmont Alluvial Forest (the Large River Variant) or Piedmont Levee Forest, with Montane Alluvial Forest (Large River subtype), and less often with other floodplain communities. It may also border upland communities.

Variation: The Mixed Bar Subtype is extremely variable – very different among occurrences, heterogeneous within, and sometimes with examples changing drastically with time. For the present, two variants are tentatively recognized. They are expected to differ biogeographically in their flora, but because most of the species can be found throughout the range, it is unclear how distinct they are.
1. Mountain Variant occurs in the Mountain Region and mountainous foothills.
2. Piedmont Variant occurs in most of the Piedmont. It lacks characteristic mountain species such as *Tsuga canadensis* and *Rhododendron maximum*.

Brown's (2002) cluster analysis identified four clusters among the three mountain rivers she studied:

Platanus occidentalis/Cornus amomum (Acalypha rhomboidea, Ambrosia artemisifolia, Oenothera biennis, Robinia pseudoacacia, Rosa multiflora, Salix nigra, Saponaria officionalis) Shrubland

Platanus occidentalis – Betula nigra (*Alnus serrulata, Anthoxanthum odoratum, Apios americanum, Hypericum mutilum, Microstegium vimimeum)* Woodland

Festuca subverticillata – Sciripus expansus – Scheonoplectus tabermontana (Carex vulpinoidea, Eupatorum perfoliatum var. perfoliatum, Glyceria striata, Hypericum mutilum) Herbaceous Vegetation

Leersia virginiana – Impatiens capensis – Hypericum muticum – Boehmeria cylindrica Herbaceous Vegetation.

The first accounted for most of the plots (17), but occurred only on the New and Nolichucky Rivers. The other three clusters ranged from one to three plots, and occurred on the Little Tennessee in combination with the other rivers. This may suggest a potential subdivision of the Mountain Variant, but it is nuclear if it is based on biogeography or on other characteristics of these rivers confounded with geography. This warrants further study, as it is presently unclear how to apply these groupings to bars on other rivers.

Dynamics: As with other Rocky Bar and Shore subtypes, the Mixed Bar Subtype is frequently flooded and subject to strong currents, disturbing the vegetation. The large portion of the vegetation that consists of weedy and short-lived species, along with the often battered appearance of the longer-lived woody plants, attest to the intensity of natural disturbance. High fertility, limited chance for competitive exclusion by larger plants, and high input of propagules from a large source area contribute to both. Brown (2002) and Brown and Peet (2003) concluded that propagule pressure and the predominance of immigration processes over extinction processes were

the primary driver of species richness. They found that number of native and exotic species was positively correlated, except at the finest scales of plots where direct competition for space was most important.

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.

Rare species:
No rare species are known to be associated with this community.

References:
Brown, R.L. 2002. Biodiversity and exotic species invasion in Southern Appalachian riparian plant communities. PhD dissertation, University of North Carolina-Chapel Hill.

Brown, R.L. and R.K. Peet. 2003. Diversity and invisibility of southern Appalachian plant communities. *Ecology* 84:32-39

ROCKY BAR AND SHORE (MOUNTAIN BEDROCK SCOUR SUBTYPE)

Concept: Rocky Bar and Shore communities represent sparse, herbaceous, or shrub vegetation of bedrock, cobble, and gravel areas in or along steam channels, where forest vegetation is prevented from developing by flood scouring or reworking of the substrate. The Mountain Bedrock Scour Subtype encompasses flood-scoured bedrock areas with sparse vegetation consisting of herbaceous and woody plants rooted in bedrock crevices and small soil pockets.

Distinguishing Features: The Mountain Bedrock Scour Subtype is distinguished from most other Piedmont and Mountain Floodplain Forests communities by having predominant substrate of stable bedrock rather than loose material that is reworked by flooding. Any comparable scour communities found in the upper Piedmont should also be classified as this subtype. The Yadkin Falls Bedrock Scour Subtype is distinguished from it by the presence of *Solidago plumosa* as well as by its central Piedmont location. If other bedrock scour communities are found in the eastern Piedmont, a new subtype will likely be needed for them. Other Rocky Bar and Shore subtypes may include some rock outcrops but loose material predominates and is the substrate for most individual plants.

This subtype may grade into a Montane Cliff or other upland rock outcrop community. The boundary is conceptually where flood scouring ceases to be a significant influence, but this may be difficult to discern precisely.

Synonyms: Southern Appalachian Bedrock Scour Herbaceous Vegetation (CEGL004033).
Ecological Systems: South-Central Interior Large Floodplain (CES202.705).

Sites: The Mountain Bedrock Scour Subtype may occur along large to small rivers, primarily in narrow gorges or confined reaches.

Soils: No well-developed soil is present. Plants root in small soil pockets and crevices in rock outcrops or in small deposits of loose sediment.

Hydrology: The Mountain Bedrock Scour Subtype is intermittently flooded for brief periods, ranging from high to low frequency.

Vegetation: Vegetation of this subtype is sparse, consisting of low cover of plants rooted in the limited suitable microsites. The range of potential vegetational variation is not well known, but examples will generally have a mix of long-lived herb, shrub, and tree species along with the short-lived and weedy species typical of most other bar communities. In the only well-documented example, three plots in the Nolichucky River gorge, no plant species has as much as 10% cover. The largest covers, mostly 2-5%, include the woody species *Salix nigra*, *Ulmus alata, Platanus occidentalis, Rosa palustris*, *Ilex verticillata*, and *Toxicodendron radicans*, but also a variety of herbs. The more extensive herbs include *Persicaria longiseta, Andropogon virginicus* var. *virginicus, Ipomoea pandurata, Juncus marginatus, Justicia americana, Dichanthelium acuminatum* var. *fasciculatum*, and the exotic *Reynoutria japonica*. Other herbs with high frequency include species shared with the Mixed Bar Subtype, such as *Dichanthelium clandestinum, Rumex crispus* ssp. *crispus*, *Mimulus ringens* var. *ringens*, *Acalypha rhomboidea,*

Bidens frondosa, Boehmeria cylindrica, Conyza canadensis, Eupatorium perfoliatum, Eutrochium maculatum var. *maculatum, Eutrochium purpureum, Festuca subverticillata*, *Hypericum mutilum* var. *mutilum*, *Lycopus virginicus*, *Oenothera biennis, Oxalis stricta*, and *Solidago juncea*. A few upland species such as *Ionactis linariifolius* are also present. As in the Mixed Bar Subtype, exotic species are numerous. *Microstegium vimineum* is constant, and *Artemisia vulgaris, Arthraxon hispidus* var. *hispidus*, *Dioscorea polystachya, Dysphania ambrosioides, Kummerowia stipulacea, Lespedeza cuneata, Leucanthemum vulgare, Mollugo verticillata*, and *Trifolium repens* occur in at least two of the three plots. A few other woody species are frequent, though as small individuals, including *Acer rubrum, Liriodendron tulipifera, Physocarpus opulifolius* var. *opulifolius, Parthenocissus quinquefolia,* and *Clematis virginiana*. Other examples may be expected to have a different but similarly diverse collection of species.

Range and Abundance: Ranked G3 but probably higher. Some examples may be overlooked or unreported, but only a single well-developed site is known in North Carolina, in the Nolichucky River gorge. The NVC association is only definitively attributed to North Carolina but is questionably attributed to Tennessee and Georgia. More examples are likely to be found, but this appears to be a very rare community. The final impression of abundance may depend on the degree of acceptance of very small examples.

Associations and Patterns: The Mountain Bedrock Scour Subtype is a small patch community, occurring in patches well less than an acre in extent.

Variation: As with many small patch communities and likely more so, the Mountain Bedrock Scour Subtype is likely to be extremely variable among examples. Among three plots, analysis by Brown (2002) identified two clusters, named as *Salix nigra – Ilex verticillata – Polygonum cuspidatum (Andropogon virginiana, Ionactis linariifolius, Ipomea pandurata, Toxicodendron radicans)* Sparse Vegetation and *Ulmus alata – Platanus occidentalis – Rosa palustris /Juncus marginalis – Equisetum arvense (Andropogon virginicus, Dichanthelium acuminatum var. fasciculatum, Justicia americana)* Sparse Vegetation.

Dynamics: Unlike most other bar communities, only limited parts of this subtype are subject to reworking or substantial new deposition of sediment. It is subject to occasional natural scouring by floods but likely is stable for periods of years between floods. Flood scouring may kill some plants, but plants rooted in deeper crevices may well survive to resprout. Nevertheless, the diverse flora rich in weedy species shows that, in addition to inhibiting soil development on the rock, flooding is important in bringing in propagules and disturbing established plants. Natural flood disturbance may be frequent on the lower parts but rare on the upper parts, suggesting a gradient of dynamics approaching those of upland rock outcrops on the higher parts.

Comments: 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.

Rare species:
Vascular plants: *Dicentra eximia* and *Diervilla rivularis*.

References:

Brown, R.L. 2002. Biodiversity and exotic species invasion in Southern Appalachian riparian plant communities. PhD dissertation, University of North Carolina-Chapel Hill.

ROCKY BAR AND SHORE (YADKIN FALLS BEDROCK SCOUR SUBTYPE)

Concept: Rocky Bar and Shore communities represent sparse, herbaceous, or shrub vegetation of bedrock, cobble, and gravel areas in or along steam channels, where forest vegetation is prevented from developing by flood scouring or reworking of the substrate. The Yadkin Falls Bedrock Scour Subtype covers the extremely rare 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.

Distinguishing Features: The Yadkin Falls Bedrock Scour Subtype differs from the other Piedmont subtypes in 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. At present, the presence of *Solidago plumosa* is sufficient to distinguish it. No other bedrock scour communities are known in the Piedmont. If any are found, at least in the central or eastern Piedmont, they may be placed here, but likely will call for a new subtype.

Synonyms: *Schizachyrium scoparium* - *Solidago plumosa* Herbaceous Vegetation (CEGL004459). Ecological Systems: Southern Piedmont Large Floodplain Forest (CES202.324)

Sites: The Yadkin Falls Bedrock Scour Subtype is known from a single site, in the gorge of the Yadkin River where it crosses the Uwharrie Mountains. It occurs on bedrock outcrops along the riverbank, which apparently are kept free of soil development and forest vegetation by scouring by flood waters. It likely was extensive in the gorge but is now confined to the small areas that are not submerged by waters behind Badin Dam and Falls Dam.

Soils: No well-developed soil is present. Plants root in small soil pockets and crevices in rock outcrops or in small deposits of loose sediment.

Hydrology: The Yadkin Falls Bedrock Scour Subtype is intermittently flooded for brief periods. Prior to dam construction, the river likely rose rapidly during floods because of its limited floodplain in the gorge and had rapid flow capable of substantial corrasion. Even with the dams, brief, intense flooding likely occurs occasionally, and probably remains important in maintaining the community. Most of the time, available moisture may be quite limited in shallow soil pockets, but a bit more available in deeper crevices.

Vegetation: This subtype has sparce, patchy vegetation, limited to plants rooted in crevices and small pockets of soil. Most of the plants are herbaceous, but a few shrubs, vines, and small trees are present. The flora is a mix of species shared with other bar subtypes, with rock outcrop communities, with communities of basic upland communities, and ruderal species. *Schizachyrium scoparium* and *Solidago plumosa* are among the most abundant species. Other herbaceous species include *Dichanthelium* sp., *Eurybia pilosa*, *Allium cernuum*, *Manfreda virginica*, *Muhlenbergia*

capillaris, *Phemeranthus teretifolius*, *Hypericum gentianoides*, *Oenothera humifusa*, *Tragia urticifolia, Sporobolus clandestinus,* and *Symphyotrichum dumosum*. Woody species include *Platanus occidentalis, Liquidambar styraciflua, Diospyros virginiana, Ulmus alata, Hypericum prolificum*, *Cornus stricta, Cephalanthus occidentalis, Ilex decidua, Amorpha schwerinii, Gelsemium sempervirens, Campsis radicans,* and *Muscadinia rotundifolia*.

Range and Abundance: Ranked G1. This community is endemic to North Carolina, and only one or two sites remain.

Associations and Patterns: The Yadkin Falls Bedrock Scour Subtype is a small patch community, though it once was probably more extensive in the Yadkin River falls area. It grades to Piedmont Alluvial Forest and Basic Mesic Forest.

Variation: Only a single example is known, but if any more Piedmont bedrock scour communities are found, they potentially could be very different.

Dynamics: Unlike most other bar communities, this subtype is not subject to reworking or substantial new deposition of sediment. It is subject to occasional natural scouring by floods but likely is stable for periods of years between floods. Flood scouring may kill some plants, but plants rooted in deeper crevices may well survive to resprout. Substrate condition created by flood scouring is the most important aspect of being in the floodplain. Natural flood disturbance may be frequent on the lower parts but rare on the upper parts, suggesting a gradient of dynamics approaching those of upland rock outcrops on the higher parts. Floods also bring nutrients and seed input, but these communities are not significantly affected by wetness.

Comments: This subtype appears to be conceptually intermediate between river bar and rock outcrop communities. At the one example, floodplain forest on well-developed soil occurs at similar elevations to the higher parts of this community, suggesting that the rock outcrop as well as the flood scouring is necessary for its occurrence.

Rare species:
Vascular plants: *Solidago plumosa* and *Baptisia albescens*.

References:

ROCKY BAR AND SHORE (RIVERWEED SUBTYPE)

Concept: Rocky Bar and Shore communities represent sparse, herbaceous, or shrub vegetation of bedrock, cobble, and gravel areas in or along steam channels, where forest vegetation is prevented from developing by flood scouring or reworking of the substrate. The Riverweed 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 all other communities by the dominance of *Podostemum ceratophyllum*.

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).

Sites: The Riverweed Subtype is thought to occur primarily on small rivers, in areas with boulder or bedrock streambed.

Soils: No developed soil is present.

Hydrology: The Riverweed Subtype is generally permanently submerged in shallow, fairly swift-flowing water.

Vegetation: The Riverweed Subtype consists of beds of *Podosemum ceratophyllum* attached to rocks. Generally no other vascular plants are present, but sparse stems of *Justicia americana* or other species may occur.

Range and Abundance: Ranked G3G5. The distribution and abundance of this subtype in North Carolina is very poorly known. It is usually overlooked in site reports. The description in the NVC notes that it has drastically declined, mentioning specifically the upper Neuse River basin as a place where it has been lost from most of the places it occurred. The NVC association as defined is extremely widespread. It is attributed as far away as Arkansas, Oklahoma, Maine, and potentially Quebec.

Associations and Patterns: It is not known how large natural patches of this subtype are. It likely is best regarded as a small patch community, with patches limited by reaches of appropriate substrate, but it could potentially run for long distances along rivers.

Variation: Nothing is known of variation.

Dynamics: Little is known about dynamics. The flowing water presumably provides a steady source of nutrients. Patches may be scoured in floods or may be disturbed by rocks moving as bed load. This subtype is extremely sensitive to excess sediment input. It presumably disappears if soft sediment buries its rocky substrate.

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.

Rare species:
No rare species are known to be associated with this community.

References:

ROCKY BAR AND SHORE (SOUTHERN WILD RICE SUBTYPE)

Concept: Rocky Bar and Shore communities represent sparse, herbaceous, or shrub vegetation of bedrock, cobble, and gravel areas in or along steam channels, where forest vegetation is prevented from developing by flood scouring or reworking of the substrate. The Southern Wild Rice Subtype covers areas dominated by *Zizaniopsis miliacea* on rocky river bars.

Distinguishing Features: The Southern Wild Rice Subtype is distinguished from all other communities by dominance of *Zizaniopsis miliacea* in a rocky Piedmont river setting.

Synonyms: *Zizaniopsis miliacea* Coastal Plain Slough Herbaceous Vegetation (CEGL004139). Ecological Systems: Southern Piedmont Large Floodplain Forest (CES202.324).

Sites: The Southern Wild Rice Subtype occurs on low bars of cobbles, gravel, and sand, close to normal low water levels. Known examples are along medium to large rivers.

Soils: The soil consists of recent deposits of sand and gravel.

Hydrology: The Southern Wild Rice Subtype is frequently flooded. Floods may be of somewhat longer duration than some other subtypes, but nevertheless are brief.

Vegetation: The Southern Wild Rice Subtype consists of dense or patchy vegetation dominated by *Zizaniopsis miliacea*. Associated vegetation is not well known. *Justicia americana* may occur in patches, especially near the edge. Small amounts of *Salix nigra, Platanus occidentalis, Betula nigra, Alnus serrulata*, or other trees and shrubs of the Mixed Bar Subtype may be present. A variety of herbs shared with the Mixed Bar Subtype may also be present.

Range and Abundance: G-rank uncertain. This community is known in limited portions of the Cape Fear, PeeDee and potentially Neuse rivers, all near the Fall Zone. It also occurs in South Carolina and Virginia. The relationship to NVC association concepts is unclear. See comments below. It is unclear is any of the other states with this association have it as a Piedmont river bar community.

Associations and Patterns: The Southern Wild Rice Subtype is a small patch community. It may occur in association with our bar subtypes, especially the Water Willow or Mixed Bar Subtype. It may border Piedmont Levee Forest or Piedmont Alluvial Forest on the riverbank.

Variation: Examples vary with the gradation to other communities.

Dynamics: Dynamics of this subtype are poorly known but must be similar to other Rocky Bar and Shore communities in most ways. As with most bar communities, the Southern Wild Rice Subtype is subject to disturbance by flooding, including reworking of the substrate, scouring, battering by floating debris, and new deposition. Because it exists in similar settings to the Mixed Bar Subtype and drier edges of the Water Willow Subtype, it may bear a successional relationship to them. The dense vegetation would require time and stability to develop and might depend on a period free of severe flood disturbance. Once established, the dense root mat of *Zizaniopsis*

probably stabilizes the bar and allows this subtype to persist with less change than most other subtypes. Known examples appear to have withstood record-setting floods in the last few years without obvious major change.

There is some question whether the Southern Wild Rice Subtype is a natural community at all, or if it may represent a recent invasion of the Piedmont by this species which otherwise is confined to tidal rivers and estuaries in North Carolina. Discussion in the botanical community indicates varying beliefs. It is retained for now because the evidence for it being a recent development is not compelling. Spread of *Zizaniopsis* has been noted at the confluence of the Deep and Rocky Rivers, where it overran a rare plant reintroduction site in a place it had not occurred before. Elsewhere there is no clear memory if *Zizaniopsis* was dominant in the past in places where it occurs now. It is unclear what alteration would be responsible for its invasion if it was not previously abundant in the region. Increased sediment loads and altered flood regimes in rivers are two possibilities. The large stand on the Pee Dee River is at a place called Grassy Islands, but the site has been heavily altered by a reservoir and it is not known if this is the eponymous grass. However, the Rocky and Deep Rivers, where recent spread has specifically been noted, are not appreciably controlled by dams and are less loaded with sediment than many Piedmont rivers.

Comments: The relationship of this subtype to the synonymized NVC association is confusing and uncertain. The association was defined as a Coastal Plain slough marsh that was provisionally expanded to cover a Piedmont occurrence in South Carolina and, on that basis, applied to North Carolina's Piedmont community. *Zizaniopsis miliacea* Rocky Riverbed Vegetation may be a better fit conceptually but is defined for Arkansas and Oklahoma.

It is notable that North Carolina does not have any inland *Zizaniopsis* wetlands in the Coastal Plain. Other than tidally influenced area, it is apparently confined to Fall Zone rapids on a few Piedmont Rivers. The species would appear to be capable of establishing in beaver ponds, in both the Piedmont and Coastal Plain, but is not known to have done so in North Carolina.

This subtype apparently is not described in any published literature, at least in North Carolina. Only a single CVS plot contains *Zizaniopsis* in the Piedmont, and it appears to be intermediate, with the species abundant but with *Justicia* dominating.

Rare species:
No rare species are known to be associated with this community.

References: