COASTAL PLAIN FLOODPLAINS

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COASTAL PLAIN FLOODPLAINS THEME

Concept: Coastal Plain Floodplain communities occur on alluvial soils in areas that are presently or were recently influenced by overbank flooding by rivers or streams. Characteristic vegetation distinguishes these communities even where flooding is rare or has been eliminated by dams, stream incision, or other alterations.

Distinguishing Features: Coastal Plain Floodplain communities are distinguished by occurring in floodplains, on alluvial soils, and by having vegetation characteristic of one of the included communities. Where vegetation of Coastal Plain Nonalluvial Wetland Forests and Freshwater Tidal Wetlands looks similar, they may be distinguished by evidence of river flooding and absence of tidal flooding.

Within this theme, communities are distinguished by water type (brownwater, blackwater, or intermediate), and by landforms on which they occur, with vegetation, presumed fauna, and ecosystem processes varying accordingly.

Brownwater rivers are those that enter the Coastal Plain from the Piedmont and have turbid water with a high suspended load of clay and silt. Floodplain soils range from sandy to clayey and are fertile, while larger rivers tend to have well-developed natural levees. Blackwater rivers and streams contain water primarily originating in the Coastal Plain. They have low suspended loads of silt and clay, with water stained by tannins but not turbid. Floodplain soils tend to be sandy or organic and are low in fertility. Intermediate situations exist along streams that originate in clayey areas of the Coastal Plain or where calcareous rocks mitigate the acidity of blackwater streams. Most community types or subtypes have distinctly different vegetation associated with brownwater and blackwater, and sometimes distinct intermediate communities can be recognized.

Nonforested communities occur in areas with permanent water and on recently deposited surfaces. Coastal Plain Semipermanent Impoundments are communities influenced by impounded waters of beaver ponds; old mill ponds that resemble beaver ponds are also included. They range from open water to forests that resemble Cypress–Gum Swamp except in the permanent water and altered lower strata. Oxbow Lakes are permanently flooded communities in abandoned channel segments that are not connected to the river at normal low water. They may have little vegetation or may have open water surrounded by marshy or forested edge zones. Sand and Mud Bar communities are distinguished by occurring on recently deposited sediments along the river bank, lacking a full forest canopy because of frequent flood scouring or lack of time for primary succession to establish a forest.

Among forested floodplain communities, Cypress–Gum Swamps occur in the wetter sloughs and backswamps and are distinguished by strong dominance of *Taxodium* or *Nyssa* species. Bottomland Hardwoods occur on floodplain ridges and terraces where *Quercus* and *Liquidambar* tend to dominate. Levee forests are those on the natural levee adjacent to brownwater river channels, where very active alluvial deposition, high fertility, edge effect of the river, and other environmental factors support diverse forest communities. Blackwater rivers generally do not have distinct natural levees, but a distinctive Blackwater Levee/Bar Forest community may occur on forested point bar deposits. In smaller floodplains, the alluvial landforms are too small to

differentiate communities, and a single Coastal Plain Small Stream Swamp, Sandhill Streamhead Swamp, or Cypress–Gum Swamp community occupies the entire floodplain.

Sites: All Coastal Plain Floodplain communities occur in floodplains, where overbank flooding by a river or stream shapes the community. Coastal Plain Floodplains usually have depositional landforms created by flooding, alluvial deposition, and channel migration: natural levees, sloughs, backswamps, ridge and swale systems, and point bar deposits. On larger rivers, these can have substantial relief. Smaller streams may have similar depositional landforms on a smaller scale, but some have uniformly flat floodplains. Beavers may impound sloughs or smaller streams to create ponds and areas with raised water tables.

Many Coastal Plain rivers have large terraces created in the Pleistocene. Many rivers are underfitted: the present day floodplain is much smaller than the Pleistocene floodplain, and the terraces reflect a larger channel, wider meanders, and larger depositional landforms. Some channel segments are bound in older large channels, while other segments are in more recently formed meander belts.

Soils: Soils include a variety of alluvial soils, often Incepticols and Entisols, sometimes Ultisols on the older terraces. Histosols often occur in wetter swamp areas, especially on blackwater rivers and smaller streams. They may be local, in sloughs, or may fill an entire floodplain. Soil textures vary widely. Sandy soils prevail on natural levees and may predominate on all higher landforms in blackwater floodplains. Brownwater floodplains may have extensive loamy soils. Soils may be clay-rich in brownwater backswamps, while comparable sites on blackwater rivers have organic deposits.

Hydrology: Coastal Plain floodplains generally flood more frequently and for longer duration than Piedmont and Mountain floodplains, but flooding regimes vary substantially. Limited areas such as beaver ponds and oxbow lakes are flooded all year, but more abundant low areas may be flooded well into the growing season. On brownwater rivers, natural levees may trap flood waters behind them, resulting in slow drainage and in floods that last after the river has dropped. In contrast, higher terraces and the highest natural levees may be flooded only briefly, in the deepest floods. Floodwaters initially are flowing, but they may become still in wetter swamps, resulting in anoxic conditions and deposition of the finest texture sediments.

When not flooded, soil drainage varies drastically. The sandy soils, especially on natural levees adjacent to steep banks, may be well drained. Clayey or organic soils in sloughs and backswamps may remain saturated well after floodwaters recede.

River and stream channels may vary in form. Most are meandering single channels, but some have braided or anastomosing channel networks. A few have no visible channel and carry floodwaters throughout a broad flat floodplain. Pleistocene terraces occasionally show a different pattern from the present, with evidence of braided channels where rivers are now meandering (Leigh et al. 2004). The factors that cause these different patterns are not clear. Rivers or streams with different patterns sometimes occur in close proximity.

Vegetation: Coastal Plain Floodplain vegetation varies extremely widely. Most communities are forested, and canopy composition varies in broad categories. Cypress–Gum Swamps, in the wettest forested sites, are dominated by *Taxodium* and *Nyssa* and tend to be low in species richness. Bottomland Hardwoods in less wet sites are dominated by *Quercus*, in combination with *Liquidambar*, *Carya*, or *Pinus*, and are moderate in species richness. Brownwater Levee Forests, on the natural levee deposits along the river, have a more diverse suite of characteristic trees, including *Platanus occidentalis*, *Betula nigra*, *Fraxinus pennsylvanica, Celtis laevigata, Ulmus americana, Juglans nigra, Acer negundo*, and others, along with species of oaks, hickories, and *Liquidambar*. In addition to understory trees, shrubs, and herbs, woody vines are more prominent and diverse in Coastal Plain floodplains than in any other communities. Communities of blackwater rivers are less diverse than those of brownwater rivers; their species composition is generally a subset of the same species but they may share some species with nonriverine wetlands.

Dynamics: Coastal Plain floodplains have complex dynamics because of the interplay of multiple processes, some of them common to most forests, some unique to floodplains.

Natural vegetation dynamics of most of the forest communities 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. Despite the prevalence of flooding, most trees are killed by wind, lightning, or disease rather than wetness or scouring. Hurricanes may cause widespread canopy disruption, creating some medium or larger gaps as well as more numerous small gaps. Effects of a severe hurricane on the Congaree River in South Carolina (Zhao et al. 2006) would probably be similar on North Carolina rivers, at least brownwater rivers. Those effects included creation of some large canopy gaps and numerous smaller gaps. This storm varied in favoring shade-intolerant trees in some areas but increasing shade-tolerant trees elsewhere. It had similar variable effects on species diversity.

The natural levees and channel banks may be particularly susceptible to wind throw because of the sandy soils and exposure on the open edge. Tree species of these communities also tend to be shorter lived but are particularly fast-growing. Cypress–Gum Swamps may be particularly stable, given the extreme longevity of *Taxodium*. Both *Taxodium* and *Nyssa* are well adapted to withstanding wind, and extensive wind throw is limited even in major hurricanes. *Quercus*-dominated bottomland hardwoods are intermediate; hurricanes have been observed to have caused substantial canopy tree mortality in patches.

Woody vines are a particularly prominent part of floodplain communities, where they have more species diversity and perhaps more biomass than in any other North Carolina communities. The author has observed proliferation of vines in floodplains following severe disturbance by both storms and logging. The vine cover appears to be heavy enough to inhibit tree regeneration, but the long-term development of such areas is not known. Older treeless vine-dominated areas are not known. Studies in South Carolina have suggested that vines may have increased in density in brownwater floodplains in both old-growth and second-growth forests in recent decades, a pattern also observed in some tropical forests (Allen et al. 2005, 2007). However, the extreme variability among sites, small number of plots, hurricane disturbance, and changes in density of understory trees make interpretation uncertain. Changes in atmospheric carbon dioxide levels could

conceivably affect vine growth relative to trees, but climatic cycles or variation in natural disturbances such as storms could also cause reversible changes.

Most Coastal Plain floodplains show evidence of channel migration, and scars of past migration structure the landforms over large portions. However, migration is usually very slow or very infrequent. Rivers do not routinely change course in North Carolina. Channels are substantially vegetation-bound (Riggs et al. 1999), limiting how readily they can shift. The author has observed only three cases of meanders being cut off and one case of a more substantial course change, over three decades, despite record-breaking floods. Oxbow lakes are extremely scarce on brownwater floodplains; the frequency of their formation apparently is less than the time needed for alluvial deposition to fill them in. Oxbow lakes are more abundant on blackwater rivers, where much slower alluvial deposition allows them to last much longer, but they are still scarce. The presence of cut banks, fallen and leaning trees on banks, and unforested point bars indicates that meander migration remains active, but the small proportion of floodplains occupied by even older successional point bar vegetation demonstrates how slow the process is.

Most of the evidence of channel migration visible in the landforms of floodplains may have been formed in times of different climate. Either less vegetation, higher rainfall, or more extreme flows could have caused more rapid shifting in the past. Patterns on terraces provide evidence of these differences longer ago, showing wider channels, larger meander radii, and wider floodplains. Some terraces show that the Pleistocene river channel was braided, where a meandering channel now exists. Braided channels indicate greater sediment loading and reduced channel stability. Leigh et al. (2004) note that their existence in the recent geologic past is evidence that the current stability of rivers may be near a threshold and may be readily reversible with a small change in parameters.

Where channel migration is occurring, it creates new landforms that are colonized by natural communities that represent early primary succession, either on the bare sand of point bars or in the open water of oxbow lakes. While the results of channel migration create the environments that structure the community mosaic in most Coastal Plain floodplains, most of that mosaic does not appear to be primary successional communities. Dynamics where cypress swamps are established only as primary successional communities in abandoned channels, as suggested by Shankman and Drake (1990) and Shankman (1991) for western Tennessee, do not seem to be the norm in North Carolina.

Over most of the extent of floodplains, flooding is a natural process but not a significant natural disturbance. Sediment deposition may be extensive but generally in relatively thin layers. Scouring may remove small amounts of sediment but only rarely uproots the smallest plants. Floods move leaf litter and woody debris, creating wrack piles that increase local heterogeneity. Large debris carried by the largest floods may batter plants but does not appear to be a major source of mortality. Floods bring nutrients, making floodplain soils more fertile than other soils. This is especially true for brownwater rivers, with their large load of fine sediment and dissolved nutrients derived from a Piedmont watershed. This is also true, though to a less degree, for blackwater rivers. They are less fertile and presumably less productive but more so than nonriverine wetlands.

While flooding is not generally a significant natural disturbance, it is important in structuring communities and giving them their distinctive character. Altered flood regimes have important effects on communities, though these may be subtle, slow to become evident, and variable. Flood control dams, such as those on the Roanoke and Cape Fear rivers, eliminate the largest floods, leaving the highest portions of the floodplain without any flooding. Gradual invasion by upland vegetation may result. The same control also eliminates the lowest flows of the river and can prolong lower level floods of particular magnitude. This stresses wetter communities, especially the wetter portions of levee forests and bottomland hardwoods, which are subjected to longer flooding than their species are adapted to.

Movement of sediment by floods may also occasionally change communities locally, probably usually slowly but occasionally quickly. If a slough is blocked by sediment deposition along the riverbank, it will become wetter. Conversely, reworking of sediment blockage may improve drainage locally. Migration of point bars may open blocked sloughs. Accretion of sediment may gradually raise land surfaces, resulting in drier conditions for newly established plants. Oxbow lakes and other abandoned channels become shallower over time, as alluvial deposition fills them in. While sediment accretion is slow at present, there was a period of rapid deposition, especially in brownwater rivers, during the 1700s and 1800s caused by erosion driven by widespread clearing and plowing of uplands in the Piedmont. The full consequences of this influx are not clear, but natural levees are higher and perhaps wider and banks correspondingly higher. Sediment production rates are reduced now, thanks to modern agricultural practices and abandonment of much marginal farmland, but they presumably remain much higher than in prehistoric times. Most of the sediment was stored in floodplains in the Piedmont and Coastal Plain, where it continues to work its way downstream. Natural sediment transport rates and dynamics are further confounded by additional potential alterations: urbanization and the channel changes it induces in tributaries, the creation and abandonment of numerous mill ponds in the Piedmont, the presence of medium to large reservoirs, the extirpation and recent resurgence of beavers, navigational improvements, and in downstream reaches, effects of rising sea level.

The most poorly known natural dynamic process of floodplains is that of beavers. Beavers can dam small stream channels or may impound tributary streams or sloughs within large floodplains. A beaver dam on an outlet slough (gut) through a natural levee can impound a large area of backswamp. Beaver ponds can raise the local water table beyond the extent of standing water, in a complex pattern determined by microtopography.

Beavers have been returning to North Carolina for several decades, after a much longer absence since they were extirpated from the entire state during the colonial period. Little is known about their natural population dynamics, predation, disease, nor about past pond longevity and return intervals. An important question for small streams is whether all parts of a stream are suitable for pond building, so that beaver ponds appear randomly and eventually affect the whole area, or if certain favored sites are chronically ponded while others never are. In large river floodplains, only specific sites can be flooded by beaver dams, with the natural levees, high ridges, and some backswamps and sloughs not susceptible.

Fire does not appear to be important in most Coastal Plain Floodplains communities. The interspersion of wet areas leaves many of even the highest areas unlikely to be reached by fire

unless deliberately ignited by people. However, bottomland hardwoods on terraces and adjacent to uplands, as well as smaller floodplains, may burn.

One additional uncertainty about floodplain community dynamics concerns canebrakes. *Arundinaria tecta* is common in several floodplain communities on both brownwater and blackwater rivers, where it can attain moderate densities in the higher light levels near riverbanks. Canebrakes were historically associated with large floodplains in states farther west, but they have not been definitively linked to this setting in eastern North Carolina. The state's historically documented large canebrakes were in peatlands or nonriverine wetlands. Dense canebrakes are highly flammable and can burn intensely and frequently enough to exclude trees. At present densities, it is not continuous enough to promote fire spread. Frequent natural ignition might happen on river terraces where fire could spread from uplands, but that seems unlikely in the riverbank locations where the species currently is abundant.

Comments: Coastal Plain Rivers in the Southeastern US have been widely studied. Many but not all of the findings are applicable to North Carolina rivers. There has been substantial study of the vegetation of Coastal Plain rivers in North Carolina, but intensity has varied. It can be uncertain at times how much of the detailed classification of vegetation of one river applies to others. The Roanoke River has been especially well studied (Rice, et al. 2001), while the Neuse and Cape Fear have also been well studied (Faestal 2012). Blackwater rivers have received less study, with most of the information coming from Natural Heritage Program surveys and CVS plot data. Smaller streams have received much less study, though there are some CVS data.

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KEY TO COASTAL PLAIN FLOODPLAINS

1. Community forested, dominated by trees with closed to somewhat open canopy
   2. Forest very wet, dominated by combinations of *Nyssa* spp. and *Taxodium* spp., with *Acer rubrum, Populus heterophylla*, and possibly *Fraxinus* generally the only other canopy species present.
      3. Canopy containing *Nyssa aquatica*, which may be dominant, codominant, or present in substantial numbers.
         4. *Nyssa aquatica* dominant, or codominant with *Taxodium distichum*; *Nyssa biflora* absent or scarce; occurring on brownwater rivers such as the Roanoke, Tar, Fishing Creek, Neuse, and Cape Fear..... **Cypress—Gum Swamp (Brownwater Subtype)**
         4. *Nyssa aquatica* and *Nyssa biflora* codominant, with or without *Taxodium distichum*; occurring on Coastal Plain rivers or streams with clay input from clay-rich watersheds or with calcareous influence..... **Cypress—Gum Swamp (Intermediate Subtype)**
      3. Canopy lacking *Nyssa aquatica* or nearly so; occurring on blackwater rivers or smaller blackwater creeks with little to no clay input.
         5. Forest in deep bays ("coves") in abandoned channel segments connected to the river channel; exposed only at very low water; canopy usually open; *Taxodium distichum* or *Taxodium ascendens* usually dominant; trees generally with large buttresses and small trunks; often with a tall shrub/understory layer of *Cephalanthus occidentalis* or *Planera aquatica*. ...**Cypress—Gum Swamp (Blackwater Cove Subtype)**
         5. Forest in sloughs or backswamps, including abandoned channel segments; flooded for long periods but exposed at normal low water; canopy generally dense if not recently disturbed; trees with large trunks if old; *Cephalanthus* and *Planera* absent or minor. ....**Cypress-Gum Swamp (Blackwater Subtype)**
   2. Canopy with tree genera other than *Taxodium* and *Nyssa* dominant or at least abundant, though *Taxodium* or *Nyssa* may codominate.
      6. Forest on a natural levee or point bar along the current (or recent past) channel of a brownwater river such as the Roanoke, Tar, Fishing Creek, Neuse, and Cape Fear; forest a mix of trees that includes *Platanus occidentalis, Betula nigra, Fraxinus pennsylvanica, Celtis laevigata*, or *Acer negundo*, as well as more widespread species.
         7. Forest on a young point bar deposit, only newly dominated by trees; canopy generally dominated by *Platanus occidentalis, Betula nigra, Salix nigra*, or *Salix caroliniana*, with few other species; canopy often somewhat open; species shared with Sand and Mud Bar communities, such as *Coleataenia rigidula* often present. ..... **Brownwater Levee Forest (Bar Subtype)**
         7. Forest on a natural levee.
            8. Forest on a high natural levee and the inner Coastal Plain; canopy a diverse mix of species, including the above but also including *Celtis laevigata, Fraxinus pennsylvanica, Acer negundo*, and others; community containing species such as *Aesculus sylvatica, Lindera benzoin, Laportea canadensis, Nemophila aphylla (microcalyx)*, and *Corydalis flavula* that are shared with Piedmont levees. .....**Brownwater Levee Forest (High Levee Subtype)**
            8. Forest on a natural levee of medium or lower height above the river; canopy may be a diverse mix of species but somewhat less so; the above suite of shrubs and herbs shared with Piedmont levees generally not present.
               9. Forest on a natural levee or point bar of medium height above the river, in the inner to middle Coastal Plain, sometimes on the back slope of a higher natural levee; canopy generally a diverse mix of species but usually dominated by *Fraxinus pennsylvanica, Ulmus americana*, and *Liquidambar styraciflua*; *Taxodium* and *Nyssa* minor or absent..... . ..... **Brownwater Levee Forest (Medium Levee Subtype)**

9. Forest on a low natural levee along downstream parts of the river or on the back slope of a higher natural levee; canopy limited to more water-tolerant species such as *Fraxinus pennsylvanica, Quercus laurifolia, Quercus lyrata,* Carya *aquatica,* and *Taxodium distichum*. ....**Brownwater Levee Forest (Low Levee Subtype)**

6. Forest not on a natural levee on a brownwater river; located away from the river or located along the channel of a blackwater river or a smaller stream.

10. Forest in a small floodplain, with depositional landforms (ridges and sloughs) absent or too small to differentiate different communities (generally little more than 10 meters wide); canopy a mix of species of different moisture tolerance, often including *Liriodendron, Liquidambar, Quercus, Nyssa,* or *Taxodium* in varying combinations.

11. Forest dominated by a mix of species that are tolerant of extremely acidic, saturated conditions, including *Liriodendron tulipifera, Nyssa biflora, Acer rubrum, Pinus serotina, Pinus taeda*, and *Chamaecyparis thyoides* but almost never includes *Quercus* or *Liquidambar*; forest generally with a dense shrub layer with species such as *Lyonia lucida, Cyrilla racemiflora,* and *Ilex coriacea* that are shared with Streamhead Pocosins; community in the Sandhills Region or rarely in similar terrain elsewhere in the Coastal Plain. .....**Sandhill Streamhead Swamp**

11. Forest dominated by a mix of species less confined to extremely acidic, saturated conditions, that may include *Liriodendron, Liquidambar*, *Acer rubrum,* several species of oaks, *Pinus taeda, Nyssa biflora*, *Taxodium*, and occasionally species of mesic uplands but does not include *Pinus serotina* or *Chamaecyparis thyoides*; shrub layer open or dense but including species in addition to the above, such as *Eubotrys racemosa, Lindera benzoin, Morella cerifera*, or *Cornus stricta*..... **Coastal Plain Small Stream Swamp**

10. Forest in a large floodplain of a blackwater or brownwater river, limited to a particular set of large depositional landforms such as ridges, flats, or terraces of a particular elevation and occurring in a mosaic with other floodplain communities; canopy generally dominated by a set of species with a narrower range of moisture tolerances, generally predominantly *Quercus* spp.

11. Forest on a brownwater river floodplain; *Quercus pagoda, Fraxinus pennsylvanica,* or *Nyssa aquatica* may be present depending on moisture levels; associated wetter community is Cypress—Gum Swamp (Brownwater Subtype).

12. Forest dominated by combinations of *Quercus michauxii, Quercus pagoda, Quercus laurifolia, Liquidambar styraciflua*, and *Pinus taeda*; occurring on the highest ridges and terraces (short of upland communities)...**Brownwater Bottomland Hardwoods (High Subtype)**

12. Forest dominated by *Quercus laurifolia, Quercus lyrata, Liquidambar styraciflua*, and other species more tolerant of prolonged flooding, but lacking *Quercus michauxii, Quercus pagoda*, and *Pinus taeda*.

13. Forest dominated by *Quercus laurifolia, Quercus lyrata, Liquidambar styraciflua* but without *Nyssa* or *Taxodium*..... **Brownwater Bottomland Hardwoods (Low Subtype)**

13. Forest dominated by a mix of species that includes significant *Nyssa* or *Taxodium*, sometimes also *Fraxinus pennsylvanica* or *Fraxinus profunda*; herb layer often sparse and consisting of the most water-tolerant species similar to those in Cypress—Gum Swamp; occurring at elevations only slightly higher than Cypress—Gum Swamp .... **Brownwater Bottomland Hardwoods (Swamp Transition Subtype)**

11. Forest on a blackwater river floodplain; *Quercus pagoda, Fraxinus pennsylvanica,* and *Nyssq aquatica* generally completely absent; *Quercus michauxii* may be present but is less likely to be.

14. Forest on a young point bar deposit, only newly dominated by trees; canopy generally dominated by *Betula nigra, Planera aquatica, Salix nigra*, or *Salix caroliniana*, with few other species; canopy often somewhat open; species shared with Sand and Mud Bar communities, such as *Coleataenia rigidula,* often present. .....**Blackwater Levee/Bar Forest**

14. Forest not on a young point bar deposit; on floodplain ridges, flats, or shallow sloughs, sometimes on the edge of the channel.

15. Forest containing *Quercus virginiana* or *Chamaecyparis thyoides* as well as *Quercus laurifolia* and *Pinus taeda*; occurring on high ridges and terraces; rare community known only along the Waccamaw River. ...**Blackwater Bottomland Hardwoods (Evergreen Subtype)**

15. Forest not containing *Quercus virginiana* and only rarely containing *Chamaecyparis thyoides*; on the Waccamaw River or not.

16. Forest dominated by combinations of *Quercus laurifolia* with *Pinus taeda, Liquidambar styraciflua*, *Quercus* nigra, and occasionally *Quercus michauxii; Quercus lyrata* and *Carya aquatica* generally absent. ....**Blackwater Bottomland Hardwoods (High Subtype)**

16. Forest dominated by *Quercus laurifolia* in combinations with *Quercus lyrata* and sometimes *Carya aquatica* or *Liquidambar styraciflua,* or more water-tolerant species; *Pinus taeda* and *Quercus michauxii* absent.

17. *Nyssa biflora*, *Taxodium distichum*, or *Taxodium ascendens* codominant or a significant minority in the canopy; herb layer often sparse and consisting of the most water-tolerant species similar to those in Cypress—Gum Swamp; occurring at elevations only slightly higher than Cypress—Gum Swamp..... . ..... **Blackwater Bottomland Hardwoods (Swamp Transition Subtype)**

17. *Nyssa biflora*, *Taxodium distichum*, and *Taxodium ascendens* all absent or rare in the canopy; herb layer dominated by less water-tolerant species; occurring at slightly higher elevations..... **Blackwater Bottomland Hardwoods (Low Subtype)**

1. Community not forested; vegetation may have sparse trees or trees on the edge but is dominated by shrubs, herbs, or open water.

18. Community affected by impounded water, in a beaver pond or an old artificial pond that resembles a beaver pond, or formerly impounded and vegetation not yet resembling an unimpounded community.

19. Community dominated by open water or by floating or submersed aquatic vegetation; emergent herbs, herbs on stumps and snags, shrubs, and trees all minor components. ....**Coastal Plain Semipermanent Impoundment (Open Water Subtype)**

19. Community not dominated by open water; dense to open herbaceous or woody vegetation dominant.

20. Community dominated by live *Taxodium distichum*, *Nyssa biflora,* or *Nyssa aquatica*. ....**Coastal Plain Semipermanent Impoundment (Cypress—Gum Subtype)**

20. Community not dominated by *Taxodium* or *Nyssa*, though sparse individuals may be present; herb layer generally dense

21. Community in the Coastal Plain outside of the Sandhills; pocosin shrubs generally absent though rarely a few may occur; substrate may be sand, clay, or muck; species of richer soils, such as *Persicaria* spp., *Typha latifolia*, *Leersia hexandra*, *Saururus cernuus*, *Cladium jamaicense*, *Sacciolepis striata, Scleria muhlenbergii*, and *Rhynchospora macrostachya*, usually present. .....**Coastal Plain Semipermanent Impoundment (Typic Marsh Subtype)**

21. Community in the Sandhills Region; occurring on small floodplains with substantial seepage and mucky substrates; woody species shared with pocosins are often present; species of richer soils such as those listed above generally absent; species of more acidic, nutrient-poor conditions, such as *Schoenoplectus subterminalis*, *Eriocaulon decangulare*, *Carex glaucescens*, *Carex striata*,

most *Eleocharis* spp., *Schoenoplectus etuberculatus*, *Orontium aquaticum*, and *Sphagnum* spp., present.

22. Community with extensive *Sphagnum*, generally a moderate shrub layer, and a flora of species tolerant of strongly acidic, bog-like conditions. .... **Coastal Plain Semipermanent Impoundment (Sandhills Mire Subtype)**

22. Community with little or no *Sphagnum*; vegetation a dense herbaceous stand of various species. .....**Coastal Plain Semipermanent Impoundment (Sandhills Marsh Subtype)**

18. Community not impounded nor reflecting past impoundment.

23. Community with permanent standing or flowing but not impounded water; in abandoned channel segments or in the river or stream channel itself.

24. Community a mat of plants floating on the water surface in the active river channel or in backwater "coves."

25. Vegetation consisting of free-floating plants, naturally usually dominated by *Hydrocotyle ranunculoides* or *Sacciolepis striata* but now often by *Alternanthera philoxeroides*..... .....**Riverine Floating Mat**

25. Vegetation consisting of dense stands of *Nuphar sagittifolia*; extremely rare community of the Waccamaw River (consider also Tidal Swamp (Narrowleaf Pond-lily Subtype)..... . .....**Sand and Mud Bar (Narrowleaf Pond-lily Subtype)**

24. Community in an oxbow lake, with permanent standing water in an abandoned channel segment not connected to the river channel at normal water levels; center open water with floating or emergent plants; wetland trees, shrubs, and herbs present on the edges but only sparsely in the middle.

26. Oxbow lake on a brownwater river. ..... **Oxbow Lake (Brownwater Subtype)**

26. Oxbow lake on a blackwater river.....**Oxbow Lake (Blackwater Subtype)**

23. Community without permanent standing water; flooded for brief or long periods but exposed at least every few years at low water and vegetated with sparse or dense rooted non-floating plants; occurring along the river channel on point bars or other patches of recently deposited, reworked, or scoured alluvium.

27. Bar on a brownwater river. ..... **Sand and Mud Bar (Brownwater Subtype)**

27. Bar on a blackwater river.

28. Community on regularly exposed bars, generally of coarse sand; vegetation generally containing large herbs, often including *Coleataenia rigidula*; trees or shrubs often present as seedlings, saplings, or sparse larger individuals. ....**Sand and Mud Bar (Blackwater Sand Bar Subtype)**

28. Community on bars exposed only at very low water, generally of fine sand or silt; vegetation of small herbs capable of growing under water or annual species that emerge at drawdown, such as *Juncus repens* or *Eleocharis baldwinii*, sometimes with rare diminutive species such as *Fimbrystylis perpusilla*; rare community known only on the Waccamaw River..... . .....**Sand and Mud Bar (Blackwater Drawdown Bar Subtype)**

BROWNWATER LEVEE FOREST (HIGH LEVEE SUBTYPE)

Concept: Brownwater Levee Forests are forest communities of natural levee deposits along brownwater Coastal Plain rivers, with a significant component of the suite of levee tree species: *Fraxinus pennsylvanica, Celtis laevigata, Platanus occidentalis, Betula nigra, Acer negundo*, and *Ulmus americana*. The High Levee Subtype covers the communities of the highest levees, in the inner to middle Coastal Plain stretches of rivers, where species of rich soils and marginal wetland species are a significant component. *Aesculus sylvatica, Lindera benzoin, Laportea canadensis, Nemophila aphylla (microcalyx)*, and *Corydalis flavula* are examples of such species.

Distinguishing Features: Brownwater Levee Forests usually are easily distinguished by their location adjacent to Coastal Plain Brownwater Rivers. The wide levees on the Roanoke River may extend up to a mile from the river, but those on all other rivers are proportionally smaller. Levee Forests are distinguished from Bottomland Hardwoods communities by having a significant component of the suite of levee species that includes *Fraxinus pennsylvanica, Celtis laevigata, Platanus occidentalis, Betula nigra, Acer negundo*, and *Ulmus americana* in natural condition. (Heavily disturbed Brownwater Bottomland Hardwoods may be invaded by some of these species, particularly *Platanus* and *Betula*. *Liquidambar styraciflua* and various bottomland oaks may occur in Levee Forests but in smaller proportions than in Bottomland Hardwoods. Brownwater Levee Forests, especially this subtype, are similar to Piedmont Levee Forests, sharing much flora but showing differences in dominance and some regional differences. They can be distinguished readily by location. The abiotic dynamics of flooding and sediment deposition are significantly different, but examples in the Fall Zone may be difficult to place.

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

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

Sites: Brownwater Levee Forests occur on natural levee and point bar deposits along channels of rivers draining from the Piedmont. They may occasionally occur on recently abandoned channel segments farther from the active river. The High Subtype is limited to the inner and occasionally middle Coastal Plain.

Soils: Soils are coarse-textured alluvial soils, with little horizon development because of relatively recent deposition. Most levees are mapped as Chewacla (Fluvaquentic Dystrudept) or Congaree (Oxaquic Udifluvent).

Hydrology: The High Levee Subtype is intermittently or seasonally flooded, generally only for short periods. Soils are well drained when not flooded. The high microrelief of these levees leads to substantial variation in hydroperiod, though only very limited areas are very wet. Brownwater rivers, in contrast to blackwater, tend to have periods of sustained high flow, usually in winter and spring, where not controlled by dams. However, floods seldom remain deep enough to submerge higher levees for long periods.

Vegetation: Brownwater Levee Forests are naturally closed forests punctuated by canopy gaps. In the High Levee Subtype, the canopy is a varying mix, with *Celtis laevigata, Fraxinus pennsylvanica, Acer negundo, Platanus occidentalis*, and *Liquidambar styraciflua* most abundant. Other frequent or occasionally abundant canopy species include *Quercus pagoda, Carya cordiformis, Ulmus americana, Quercus laurifolia, Quercus michauxii*, *Pinus taeda, Juglans nigra*, and *Carya ovata*. The understory generally is dominated bv *Acer negundo, Asimina triloba*, and *Carpinus caroliniana*, along with canopy species. *Ilex opaca, Crataegus viridis, Ulmus alata*, *Acer floridanum*, or *Morus rubra* may also be present. The shrub layer is usually well developed and may be dense. Frequent abundant species are *Lindera benzoin, Aesculus sylvatica, Ilex decidua*, and *Arundinaria tecta*. Woody vines are abundant and diverse, with *Muscadinia rotundifolia, Vitis aestivalis, Toxicodendron radicans, Parthenocissus quinquefolia, Smilax rotundifolia*, and *Smilax bona-nox* often abundant. *Berchemia scandens, Bignonia capreolata*, *Campsis radicans, Hydrangea* (*Decumaria*) *barbara*, and *Smilax hispida* may also be abundant. The herb layer is usually dense and often rich. Widespread levee species such as *Boehmeria cylindrica, Leersia oryzoides, Elymus hystrix, Elymus canadensis, Elymus riparius, Chasmanthium latifolium*, *Carex grayi*, *Nemophila aphylla*, and *Viola* spp. are often abundant. Also present are species shared with rich mesic sites, such as *Laportea canadensis, Persicaria virginiana, Asarum canadense, Circaea canadensis,* and *Amphicarpaea bracteata*. Other species found in plot studies (Rice and Peet 1997, Rice et al. 2001, Faestal 2012) at moderate-to-high frequency include *Carex crebriflora*, *Carex abscondita, Carex amphibola, Commelina virginica, Leersia canadensis, Poa cuspidata, Saururus cernuus, Gonolobus suberosus* var. *suberosus*, *Carex louisianica, Sanicula canadensis* var. *canadensis, Arisaema triphyllum, Arisaema dracontium,* and *Dicliptera brachiata*. Invasive exotic species are often abundant in the herb and shrub layers, particularly *Ligustrum sinense, Lonicera japonica, Microstegium vimineum,* and *Stellaria media*. The epiphyte *Tillandsia usneoides* may have high cover, and *Pleopeltis michauxiana* may cover trunks and branches of some trees.

Range and Abundance: Ranked G3G5. The uncertainty in the G-rank may be at least partly because of confusion in the NVC between several associations of Coastal Plain and Piedmont natural levees.

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Associations and Patterns: Brownwater Levee Forest occurs as linear bands along most of the river frontage on the brownwater rivers. The High Subtype predominates along the river in the upper Coastal Plain reaches. It grades to other floodplain communities behind. Well-developed examples of the Medium Levee Subtype may occur if the back slope of the levee is broad, but in other places levees slope rapidly into Cypress–Gum Swamp. Occasional segments of Brownwater Levee Forest may adjoin upland communities along bluffs or may occur along sloughs away from the river channel. Sand and Mud Bar communities may occur below the levee, on the edge of the river channel.

The High Levee Subtype grades downstream to the Medium Levee Subtype as natural levee deposits become lower. It grades upstream to Piedmont Levee Forest.

Variation: No variants are recognized. Examples may vary substantially in composition of the canopy, with any of a substantial pool of species dominating. There are some differences observable among the different brownwater rivers, and these may lead to definition of variants in the future. There are differences in development between large and small rivers. In addition, the Cape Fear River differs from other North Carolina rivers in having a deeply entrenched channel. Communities recognizable as Brownwater Levee Forest occur 30 feet or more above the river but are distinct only in a narrow band.

Dynamics: Flooding is of brief duration but may be energetic enough to scour the soil surface, cause substantial movement of organic debris, or batter trees with floating debris. Alluvial deposition is naturally heaviest in this community; though still generally just a thin layer of sediment in any given flood, it brings in substantial nutrient subsidies.

Canopy gap dynamics typical of most floodplain forests apply, but levee forests may be somewhat more dynamic. They may be subject to more frequent wind disturbance because of their exposure to the open river channel and their low-density soils. They are most exposed to water disturbance as well, including development of new areas on aging point bars, erosion by cut banks, and local scouring by floods. Given the slow migration of channels under present conditions, most examples are long-established, but some patches represent late stages of primary succession.

Comments: The NVC classification of associations have been somewhat confusing, as associations were defined in local studies of different major rivers but not addressed to the intervening areas. The large species pool and variation in canopy dominants potentially allows a large range of associations to be defined, which may not be meaningful.

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

Pinus taeda - Fraxinus pennsylvanica - Ulmus americana - Celtis laevigata Temporarily Flooded Forest [Provisional] (CEGL007559), previously treated as a separate High Pine subtype, is no longer recognized in the 4th approximation or in the NVC. *Pinus taeda* is one tree component that may or may not be present and may sometimes codominate.

There is concern in these communities about excessive sediment deposition caused by anthropogenically-induced erosion in the watersheds over the last several centuries. While this is a concern in all brownwater and Piedmont rivers, it has affected the High Levee Subtype more than others because this is the site of the heaviest sediment deposition. Excess sediment deposition may have raised ground levels, reduced flood frequency and duration, and probably altered plant composition. On the best-studied river in North Carolina, the Roanoke, the flood regime is also altered by dams. This makes determination of the natural state difficult, and our understanding of these communities may need revision in the future.

Rare species: Vascular Plants: *Urtica chamaedryoides, Enemion biterntum, Trillium sessile,* and *Carex jamesii.* Vertebrate animals: *Setophaga cerulea.*

References:

Faestal, M. 2012. Classification and description of alluvial plant communities of the North Carolina Coastal Plain. M.S. thesis, University of North Carolina, Chapel Hill.

Rice, S.K., R.K. Peet, and P. Townsend. 2001. Gradient analysis and classification of the forests of the lower Roanoke River floodplain, North Carolina: a landscape perspective. Unpublished manuscript.

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

BROWNWATER LEVEE FOREST (MEDIUM LEVEE SUBTYPE)

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

Distinguishing Features: Brownwater Levee Forests usually are easily distinguished by their location adjacent to Coastal Plain Brownwater Rivers. Levee Forests are distinguished from Bottomland Hardwoods communities by having a significant component of the suite of levee species that includes *Fraxinus pennsylvanica, Celtis laevigata, Platanus occidentalis, Betula nigra, Acer negundo*, and *Ulmus americana* in natural condition. The Medium Levee Subtype is distinguished from the High Levee Subtype by the absence of characteristic species of rich sites shared with Piedmont levees, such as *Aesculus sylvatica, Lindera benzoin, Laportea canadensis, Nemophila aphylla (microcalyx)*, and *Corydalis flavula.* Species of wetter sites, such as *Carya aquatica, Nyssa aquatica*, *Quercus lyrata*, and *Taxodium distichum,* may be present but only in small numbers or in wetter microsites.

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

Sites: The Medium Levee Subtype occurs along channels and on point bar deposits of brownwater rivers. It may occasionally occur on recently abandoned channel segments farther from the active river. The Medium Levee Subtype most often borders rivers in the middle Coastal Plain but may occur in the inner Coastal Plain where broad levees slope away from the river.

Soils: Soils are coarse-textured alluvial soils, with little horizon development because of relatively recent deposition. Most levees are mapped as Chewacla (Fluvaquentic Dystrudept) or Congaree (Oxaquic Udifluvent). A few are mapped as Chastain or Wehadkee (Fluvaquentic Endoaquepts).

Hydrology: The Medium Levee Subtype is intermittently or seasonally flooded, generally only for short periods but longer than in the High Levee Subtype. Soils are well drained when not flooded but are closer to the water table than in the High Levee Subtype. These levee areas have substantial microrelief, which leads to variation in hydroperiod, though only very limited areas are very wet. Brownwater rivers, in contrast to blackwater, tend to have periods of sustained high flow, usually in winter and spring, where not controlled by dams. However, floods seldom remain deep enough to submerge levees for long periods.

Vegetation: Brownwater Levee Forests are naturally closed forests punctuated by canopy gaps. In the Medium Levee Subtype, the canopy is a varying mix that has *Fraxinus pennsylvanica,*

Ulmus americana, and *Liquidambar styraciflua* as the most frequent dominant species. Plot data (Rice and Peet 2001, Faestal 2012, CVS data) show *Platanus occidentalis, Celtis laevigata, Quercus laurifolia,* and *Acer rubrum* var. *trilobum* also frequent and sometimes dominant, and these data show *Carya aquatica, Carya cordiformis*, *Populus heterophylla, Acer saccharinum*, *Ulmus alata, Diospyros virginiana,* and *Taxodium distichum* as fairly frequent at least on some rivers. The dominant understory species most frequently include *Carpinus caroliniana, Acer negundo*, and less frequently *Ilex opaca, Crataegus viridis*, and *Fraxinus caroliniana*, in addition to various canopy species. *Ilex decidua* is most often the dominant shrub. *Arundinaria tecta* may be fairly frequent but is less abundant than in the High Levee Subtype. Woody vines are also prominent. *Smilax rotundifolia, Toxicodendron radicans, Campsis radicans, Parthenocissus quinquefolia, Berchemia scandens, Smilax bona-nox, Muscadinia rotundifolia*, *Bignonia capreolata*, and *Nekemias arborea* all occur with high frequency and sometimes high cover in plot data. *Thyrsanthella difformis, Smilax hispida, Vitis aestivalis*, and other *Vitis* species also may be fairly frequent. The herb layer is generally dense and fairly diverse. Species at high to moderate frequency, at least on some rivers, include *Commelina virginica, Saururus cernuus, Carex louisianica, Lobelia inflata, Viola sororia*, *Mitchella repens*, *Leersia oryzoides, Leersia virginica, Solidago caesia, Persicaria punctata, Persicaria hydropiperoides, Onoclea sensibilis, Carex grayi, Carex typhina*¸ and a number of other *Carex* species. Species shared with the Piedmont and species shared with rich mesic sites are notably less numerous and less abundant than in the High Levee Subtype, while species of wetter sites are more abundant. Exotic plants, especially *Lonicera japonica* and *Microstegium vimineum*, may be abundant. The epiphyte *Tillandsia usneoides* may have high cover, and *Pleopeltis michauxiana* may cover trunks and branches of some trees.

Range and Abundance: Ranked G4? In North Carolina, the Medium Levee Subtype is locally abundant along the middle Coastal Plain reaches of the several brownwater rivers. It is sometimes present in the upper reaches, where it occurs on the lower edges of high levees. Narrow strips of Brownwater Levee Forest often are left where the rest of the floodplain has been logged. The equivalent NVC association ranges from North Carolina to Alabama.

Associations and Patterns: The Medium Levee Subtype occurs as linear bands along most of the frontage of brownwater rivers in the middle Coastal Plain. In the inner Coastal Plain, it may occur on the lower slope of wide levees away from the river and occasionally along sloughs away from the river. Most examples grade to Cypress–Gum Swamp or Brownwater Bottomland Hardwoods, and they may be bordered by Sand and Mud Bar along the river.

Variation: No variants are recognized. Some differences among different rivers can be seen in existing data and warrant further investigation. *Acer saccharinum* is widespread on the Roanoke River and not present on other rivers. A local area with a disjunct population of *Populus deltoides* occurs only on the Roanoke River. Other differences visible in plot data, such as occurrence of frequent *Quercus laurifolia* only on the Roanoke River, are more likely to be accidents of plot placement.

Dynamics: Dynamics of the Medium Levee Subtype are similar to the High Levee Subtype. Flooding is of somewhat longer duration and frequency but still tends to be brief.

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

Rare species: *Cardamine douglassii, Carya laciniosa,* and *Urtica chamaedryoides*.

References:

Faestal, M. 2012. Classification and description of alluvial plant communities of the North Carolina Coastal Plain. M.S. thesis, University of North Carolina-Chapel Hill.

Rice, S.K., R.K. Peet, and P. Townsend. 2001. Gradient analysis and classification of the forests of the lower Roanoke River floodplain, North Carolina: a landscape perspective. Unpublished manuscript.

BROWNWATER LEVEE FOREST (LOW LEVEE SUBTYPE)

Concept: Brownwater Levee Forests are forest communities of natural levee deposits along brownwater Coastal Plain rivers, with a significant component of the suite of levee tree species. The Low Levee Subtype covers levees on the lower reaches of rivers or on lower parts of upstream levees, where more water-tolerant species such as *Quercus lyrata* and *Carya aquatica* are major components, but where characteristic levee species such as *Fraxinus pennsylvanica* and *Ulmus americana* are still significant. In contrast to other subtypes, the Low Levee Subtype often has little understory or shrub layer and may have a dense herb layers dominated by *Carex* spp. Also included here are communities of relict natural levees in the tidally influenced lower reaches of brownwater rivers, which have similar vegetation.

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

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

Sites: The Low Levee Subtype occurs along channels and on point bar deposits of brownwater rivers. It may occasionally occur on recently abandoned channel segments farther from the active river. The Low Levee Subtype most often borders rivers in the outer Coastal Plain, including tidally influenced stretches, but it may also occur in the inner or middle Coastal Plain where broad levees slope away from the river. It may occasionally occur on backwater streams, blackwater streams that join brownwater rivers and have sediment-laden flood waters pushed up into them from downstream.

Soils: Soils are coarse-textured or medium-textured alluvial soils, with little horizon development because of relatively recent deposition. Examples are mapped as Chewacla (Fluvaquentic Dystrudept), Congaree (Oxaquic Udifluvent), Chastain or Wehadkee (Fluvaquentic Endoaquepts), or Muckalee (Typic Fluvaquent). Some examples are small enough to not be distinguished in mapping.

Hydrology: The Low Levee Subtype is intermittently or occasionally flooded, probably usually for short periods. Though wetter than the Medium Levee Subtype because of finer texture soils,

lower elevation, and higher water table, the lower river reaches where most examples occur have less flood amplitude. It is unclear if the low levees stay flooded longer than those upstream, or even as long. Those along tidal reaches do not usually flood in normal high tides. Examples on lower reaches of rivers are also particularly susceptible to flooding by storm surges and by the gradual effects of rising sea level. In contrast, examples on upstream reaches do stay flooded longer than higher levee communities, and dam control may keep them flooded even longer.

Vegetation: Brownwater Levee Forests are naturally closed forests punctuated by canopy gaps. In the Medium Levee Subtype, the canopy is a varying mix that includes some *Taxodium distichum, Quercus lyrata, Quercus laurifolia,* and *Carya aquatica*, along with more water tolerant of the characteristic natural levee species such a *Fraxinus pennsylvanica* and *Ulmus americana*. Other characteristic species, such as *Acer negundo* and *Celtis laevigata*, may be present but are not abundant. The understory consists primarily of *Carpinus caroliniana* but may include *Crataegus viridis* and other species. The shrub layer is generally not dense. *Ilex decidua* usually dominates, though *Arundinaria tecta* may dominate patches. Vines may be prominent, with *Smilax rotundifolia, Campsis radicans, Toxicodendron radicans, Smilax hispida, Smilax bona-nox, Thyrsanthella difformis, Muscadinia rotundifolia*, and *Berchemia scandens* all occurring with high to moderate frequency in CVS and other plot data (Rice and Peet 1997; Rice et al 2001; Faestal 2012). Herbs range from sparse to dense. Frequent species in plots include *Saururus cernuus, Boehmeria cylindrica, Viola sororia, Symphyotrichum lanceolatum, Carex louisianica, Carex tribuloides, Leersia virginica, Carex corrugate, Carex abscondita, Leersia oryzoides,* and *Mitchella repens*. Species abundant in higher levees, such as *Chasmanthium latifolium* and *Elymus virginicus*, may be present but generally with low cover. Other species, such as *Onoclea sensibilis, Cinna arundinacea, Persicaria punctata, Persicaria hydropiperoides, Persicaria setacea, Pluchea camphorata, Impatiens capensis, Juncus effusus*, and other species of *Carex* are less frequent but indicate the wetness of this subtype compared to the Medium Levee Subtype. Exotic plants, especially *Lonicera japonica* but also *Alternanthera philoxeroides*, may be abundant. Though not presently widespread in North Carolina, *Triadica sebifera* may become more frequent in this community. The epiphyte *Tillandsia usneoides* may have high cover, and *Pleopeltis michauxiana* may cover trunks and branches of some trees.

Range and Abundance: Ranked G3G4. North Carolina's examples are scattered along the brownwater rivers. They are more widely scattered farther inland on lower slopes of large natural levees and on tidal reaches of brownwater rivers. The equivalent NVC association is attributed only to North Carolina and questionably to Virginia. However, similar communities must occur in South Carolina and Georgia. It seems unlikely that it should have a narrower range than the other brownwater levee associations. However, it is possible that the increasing tidal amplitude southward may affect the development of this subtype.

Associations and Patterns: The Low Subtype occurs as linear bands along the frontage of lower brownwater rivers or on the slopes of natural levees farther upstream. It may also border distributary channels or sloughs away from the main river channel. The bands are more often narrow and discontinuous than in the other subtypes. Patches are most often bordered by Cypress–Gum Swamp or Tidal Swamp.

Variation: No variants are recognized. This subtype is less diverse and consequently has a narrower range of variation. Differences among flowing brownwater riverbanks, upstream back levee slopes, and tidal examples should be sought.

Dynamics: Dynamics of the Low Levee Subtype are generally similar to the Medium Levee Subtype. However, flooding dynamics may be different.

Most examples of this subtype occur far downstream, where excessive sedimentation and altered flood regimes created by Piedmont dams have less effect. However, examples on the lower parts of upstream levees are affected by them. Because they lie at a low elevation relative to the river, dam-altered flows that increase the duration of low-level floods may have a particular impact on this community in upstream sites. Hochman (2004) outlined many of the consequences of increased duration of flooding including reduced ability of seedlings to grow before canopies leaf out in spring, slower seedling growth rates, and stress to older trees that established under different flooding conditions.

Comments: The Low Levee Subtype often has a distinctly different aspect than the other subtypes, especially where it does not border the river. Instead of the complex multi-layered structure of the higher levees, the vegetation may be a two-layered forest, with a canopy and sedge-dominated herb layer but little in the intermediate strata.

Rare species: Vascular plants: *Carex socialis, Leersia lenticularis, Oenothera riparia,* and *Stachys tenuifolia*.
Vertebrate animals: *Corynorhinus rafinesquii,* and *Myotis austroriparius*.

References:

Faestal, M. 2012. Classification and description of alluvial plant communities of the North Carolina Coastal Plain. M.S. thesis, University of North Carolina, Chapel Hill.

Hochman, E.R. 2004. Lower Roanoke River hydroperiods: Altered hydrology and implications for forest health and species response. M.S. Thesis, University of North Carolina, Chapel Hill.

Rice, S.K., R.K. Peet, and P. Townsend. 2001. Gradient analysis and classification of the forests of the lower Roanoke River floodplain, North Carolina: a landscape perspective. Unpublished manuscript.

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

BROWNWATER LEVEE FOREST (BAR SUBTYPE)

Concept: The Bar Subtype of Brownwater Levee Forest is a middle stage of primary succession on relatively young point bar deposits. It is intermediate in between other Brownwater Levee Forest communities and Sand and Mud Bar, both temporally and spatially. Similar vegetation occurs in a narrow band along the riverbank in some places but is extensive enough to recognize as a community patch only in larger areas on the inside of point bars.

Distinguishing Features: The Bar Subtype is distinguished by dominance of tree species characteristic of primary succession, particularly *Platanus occidentalis*, *Betula nigra*, *Salix nigra*, *Salix caroliniana*, or *Acer saccharinum*. Most other species of Brownwater Levee Forest are present primarily as seedlings or saplings.

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

Sites: The Bar Subtype occurs on the insides of migrating meanders, where newly deposited material has accumulated high enough and stabilized enough to support trees but has not been stable long enough to have developed into another subtype of Brownwater Levee Forest.

Soils: Soils are recently deposited coarse alluvium that lacks horizon development. Patches are too small to distinguish in soil mapping but would presumably be some kind of Fluvent or Fluvaquent. They are subject to flood scouring and sediment deposition to a greater degree than other subtypes but less so than in Sand and Mud Bar. The substrate may be subject to reworking in floods but is relatively stable.

Hydrology: The Bar Subtype is seasonally to intermittently flooded. Its sites are lower and more frequently flooded than other subtypes of Brownwater Levee Forest but higher and less frequently flooded than most Sand and Mud Bar.

Vegetation: The vegetation of the Bar Subtype may have a closed or open tree canopy. Trees are generally relatively small and young, but a few individuals may be old, or significant tree cover may come from leaning large trees rooted in adjacent forests. Dominant species generally are *Platanus occidentalis, Betula nigra, Salix nigra*, or *Fraxinus pennsylvanica*, less often *Carya aquatica, Celtis laevigata, Acer negundo*, or on the Roanoke River, *Acer saccharinum*. *Carpinus caroliniana* may be present but there is no distinct understory. Other trees species are often present as seedlings or saplings. Shrubs are generally sparse. *Ilex decidua* is the only fairly frequent species in plot data (Peet and Rice 2001, Faestal 2002), but *Hibiscus laevis, Hibiscus moscheutos, Alnus serrulata* or *Cornus amomum* are sometimes observed. Vines are frequent in plots, especially *Toxicodendron radicans, Muscadinia rotundifolia,* and *Vitis cinerea* var. *floridana*, but don't generally have large cover. *Nemexia arborea, Smilax rotundifolia*, and *Campsis radicans* are fairly frequent. Herbs generally are sparse to moderate in density. As in Sand and Mud Bar, they may different greatly in cover from year to year. Frequent species in plot data include *Pluchea camphorata, Boehmeria cylindrica, Echinochloa crus-galli, Leersia virginica*, *Erechtites*

hieracifolia, *Commelina virginica, Coleataenia rigidula, Lindernia dubia,* and on the Roanoke, *Leersia oryzoides, Bidens discoidea, Mollugo verticillata,* and *Oxalis dillenii*. Several species of *Carex* are frequent in plots from the Neuse and Cape Fear but not the Roanoke: *Carex tribuloides, Carex louisianica, Carex lupulina, Carex typhina*. Other fairly frequent species include *Commelina communis, Eclipta prostrata, Bidens bipinnata*, and *Bidens frondosa*. A great diversity of additional species may be present in small numbers or as seedlings. Exotic plants may be present, including *Murdannia keisak* and *Microstegium vimineum*.

Range and Abundance: Ranked G4G5. This subtype is scattered in North Carolina along the brownwater rivers in the upper to middle Coastal Plain but generally is absent downstream. Its overall frequency is not well known, as it often is overlooked in site descriptions. However, its overall extent is small. It may be largely absent on long stretches of rivers that are not actively meandering. Thus, it may be absent from most parts of the Roanoke and Cape Fear. The global range of this subtype also is unclear. The linked NVC association is reported to range to Kentucky, Arkansas, and Texas, but this almost certainly is because it has not been carefully considered and has been defined too broadly. Though the early successional condition may be conceivably be less differentiated than more stable floodplain forests, there is no reason to think it is uniform across such a wide geographic and physiographic range while other associations have much narrower ranges.

Associations and Patterns: The Bar Subtype occurs in small patches on the insides of meanders, generally between a Sand and Mud Bar and another subtype of Brownwater Levee Forest, though potentially adjacent to Cypress–Gum Swamp or Brownwater Bottomland Hardwoods. It is not present on all meanders.

Variation: Variation has not been well defined. The numerous differences in frequent species on different rivers, described above, may represent distinct variants. However, with the exception of a few species with biogeographic limits, such as *Acer saccharinum*, the differences may equally plausibly represent differences in the time of sampling or in types of areas selected for sampling.

Dynamics: The Bar Subtype is a community of middle primary succession on recently deposited landforms, with Sand and Mud Bar (Brownwater Subtype) representing the early stage and the other subtypes of Brownwater Levee Forest the climax stage. Thought this general pattern appears obvious from spatial relationships and vegetation, the details of successional dynamics are not well known. It is driven by migration of meanders. This process is slow but not necessarily uniform. Much of the migration may occur in uncommon very large floods. Creation of bars may vary with rainfall cycles, such as those on a scale of 30 years documented by Stahle et al. (1988). The occurrence of a dry period after a wet period may lead to a temporary abundance of these mid successional communities.

Sand and Mud Bars do not steadily succeed to Brownwater Levee Forest. They appear to be maintained as sparse and young vegetation by scouring and reworking of their substrate and also by long and frequent flooding. Development of the Bar Subtype requires stabilization of the substrate, which appears to come about because of protection by more recently deposited bars. It also requires accretion to a higher elevation above the river, which may result from stabilization or may be a cause of it. The Bar Subtype remains more disturbed than higher parts of the

floodplain, and the vegetation often includes a significant component of ruderal species and of young individuals of herbaceous and woody species. This component can vary substantially from time to time. Eventually, the young individuals mature and the community succeeds to one of the other subtypes.

Upstream dams may have more impact on the dynamics of these communities than on most floodplain communities. Altered flood regimes can affect the dynamics of bar deposition and scouring. An artificially prolonged flood on the Roanoke River in 2003 appears to have resulted in mortality of most established trees on the lower banks and presumably on bars.

Comments: This subtype is less well understood than the other subtypes. It was documented by Rice and Peet (2001) and Faestal (2002) but is little reported in site surveys.

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

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

References:

Faestal, M. 2012. Classification and description of alluvial plant communities of the North Carolina Coastal Plain. M.S. thesis, University of North Carolina, Chapel Hill.

Rice, S.K., R.K. Peet, and P. Townsend. 2001. Gradient analysis and classification of the forests of the lower Roanoke River floodplain, North Carolina: a landscape perspective. Unpublished manuscript.

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BLACKWATER LEVEE/BAR FOREST

Concept: The Blackwater Levee/Bar Forest type consists of forests and woodlands on the interior of point bars and along banks of blackwater rivers, where *Betula nigra* or *Planera aquatica* are a significant component. These communities represent the middle stages of primary succession on point bar deposits along migrating river meanders.

Distinguishing Features: Blackwater Levee/Bar Forest is distinguished from Blackwater Bottomland Hardwoods by the presence of more than very small amounts of *Betula nigra* or (on the lower Lumber and Waccamaw Rivers) *Planera aquatica* in a natural riverbank or sand bar location. It is distinguished from Sand and Mud Bar by having substantial cover of trees rooted in the community. It is distinguished from Brownwater Levee Forest by the absence or near absence of *Platanus occidentalis, Fraxinus pennsylvanica, Acer negundo, Acer saccharinum*, and other characteristic brownwater species.

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

Sites: Blackwater Levee/Bar Forest generally occurs on point bar deposits on the inside of active river meanders. It occurs on surfaces that are fairly recently deposited but which are higher above the river and older than those that support Sand and Mud Bar.

Soils: Soils are sandy and have little or no horizon development. Patches are too small to be distinguished on soil mapping.

Hydrology: Blackwater Levee/Bar Forests are seasonally to frequently flooded. Being close to the river, they may be subject to significant currents during floods. They may be well drained when the river is low.

Vegetation: The vegetation may have a dense or open canopy. *Betula nigra* or, on the Waccamaw and Lumber River, *Planera aquatica* are abundant and usually dominant. *Acer rubrum* var. *trilobum*, *Quercus lyrata, Quercus laurifolia,* or *Taxodium distichum* are often present but primarily as young individuals. *Crataegus* sp. and *Fraxinus caroliniana* also are frequent. Shrubs are generally limited, other than shrub-sized saplings, but *Vaccinium elliottii*, *Cyrilla racemiflora*, *Ilex amelanchier*, or other species of the riverbanks may be present. *Muscadinia rotundifolia, Smilax rotundifolia*, or other vines may dominate patches. Herbs are often patchy, with dense cover in some areas, sparse cover in others. Frequent species include *Boehmeria cylindrica, Persicaria* spp., *Justicia ovata* var. *ovata*, and on the Waccamaw River, *Hymenocallis pygmaea*. Other species may include a number shared with more open sand bars, such as *Phanopyrum gymnocarpon, Coleataenia rigidula*, and *Gratiola neglecta*. As with open bars, many species may be young individuals or be short lived. The exotic species *Murdannia keisak* and *Alternanthera philoxeroides* may be present.

Range and Abundance: Ranked G2G3. In North Carolina, this community is well developed only on the large blackwater rivers such as the Lumber, Waccamaw, Black, and Northeast Cape Fear and is very limited in extent. It also occurs in South Carolina, and the synonymized NVC association is questionably attributed to Georgia.

Associations and Patterns: Blackwater Levee/Bar Forest occurs in small patches that are scattered along meandering portions of rivers. Not every meander has a well-developed patch. Patches tend to be bordered by Sand and Mud Bar on the youngest part of the point bar and to give way to Blackwater Bottomland Hardwoods on older portions. They may also be bordered by Cypress–Gum Swamp in a slough behind them.

Variation: Two variants are recognized, based on range limits of frequent species.
1. Water Elm Variant occurs in areas within the range of *Planera aquatica*. This species tends to be important in the community when it is present, though *Betula nigra* also often is abundant.
2. Northern Variant occurs in areas outside the range of *Planera aquatica*, where *Betula nigra* is the predominant species.

Dynamics: Blackwater Levee/Bar Forests are communities of mid-primary succession, developing when point bar deposits have become high and stable enough to allow trees to establish. *Betula nigra* and *Planera aquatica* are the first tree species to become dominant, and they are eventually supplanted by the oaks of Blackwater Bottomland Hardwoods. It is not well known how long this process takes. It is also unclear whether all sites are on a steady successional trajectory or if some are maintained or periodically reset by flood scouring. While point bars are deposited because current is slow on the inside of meanders, during floods water can flow across them with substantial velocity and new layers of sand may be deposited. While young individuals of the succeeding species are often present, it is not clear if they will mature. Intermediate age individuals often are lacking. Ongoing succession may not be possible until additional deposition raises the surface or until further channel migration and bar deposition leads to greater stability.

As in the Brownwater Levee Forests, frequent sediment deposition presumably provides an important nutrient subsidy, but the low nutrient content of blackwater and the limited nutrient-holding capacity of the sand likely make this a marginal benefit on blackwater rivers.

Comments: Blackwater rivers do not generally have well-developed natural levees of the sort created by overbank flooding on brownwater rivers, because of their low suspended sediment load. While the 3rd Approximation had a Blackwater Subtype of Coastal Plain Levee Forest that was conceived as being analogous to the Brownwater Subtype, none of the communities to which it was applied were very distinctive. Levee species such *Betula nigra* may occur along blackwater rivers outside of point bars, but generally only as scattered individuals rooted in the bank. The narrow band of bank vegetation is too limited in area to be recognized as a distinct community.

Though there are not well-developed natural levees, movement of sand by blackwater rivers does create point bars which are young substrates suitable for this community. This community is analogous to the Bar Subtype of Brownwater Levee Forest.

Rare species: Vascular plants: *Gratiola aurea* and *Hymenocallis pygmaea.*

References:

BROWNWATER BOTTOMLAND HARDWOODS (HIGH SUBTYPE)

Concept: Brownwater Bottomland Hardwoods communities are forests of Coastal Plain floodplain terraces and ridges other than active natural levees, lacking a significant component of levee tree species, and naturally dominated by bottomland oaks, hickories, sweetgum, and locally pine. The High Subtype covers examples that are the farthest above the river. They are thus flooded relatively infrequently and for short periods. They are generally dominated by combinations of *Quercus michauxii, Quercus pagoda, Quercus laurifolia*, and *Liquidambar styraciflua*.

Distinguishing Features: Brownwater Bottomland Hardwoods are distinguished by occurrence on floodplains of brownwater rivers but away from the riverbank or natural levees. These are sites where overbank flooding is, or was in the past, important. The canopy is dominated by wetland oaks and *Liquidambar*, and characteristic levee species such as *Platanus occidentalis, Betula nigra*, and *Celtis laevigata* are generally absent except in disturbed areas. Other levee species such as *Fraxinus pennsylvanica, Acer negundo*, and *Ulmus americana* may be present but in smaller numbers than they have in levee forests. In contrast to Nonriverine Wet Hardwood Forests with similar canopies, Brownwater Bottomland Hardwoods generally lack a significant component of acidic wetland shrubs such as *Lyonia lucida, Ilex glabra*, and *Cyrilla racemiflora*, while species such as *Ilex decidua* are often present.

The High Subtype is distinguished from the Low Subtype and Swamp Transition Subtype by canopy dominance by the more mesophytic bottomland hardwoods such as *Quercus michauxii* and *Quercus pagoda*, with only a small component of wetter site species such as *Quercus lyrata, Carya aquatica*, and *Taxodium distichum*. *Quercus laurifolia* may be abundant in all subtypes and does not readily distinguish among them.

The High Subtype is distinguished from Mesic Mixed Hardwood Forest by the dominance of the species above. *Fagus grandifolia* typically is abundant in Mesic Mixed Hardwoods but scarce or absent in Brownwater Bottomland Hardwoods, while *Liquidambar styraciflua* and *Quercus laurifolia* are scarce or absent in natural Mesic Mixed Hardwoods. *Quercus pagoda* and, more often, *Quercus michauxii* may be in both but is more frequent and more abundant in floodplains. While Mesic Mixed Hardwood Forest near rivers is usually on distinct upland slopes, the highest ridges on river terraces may support patches of it.

Synonyms: *Quercus laurifolia - Quercus michauxii - Liquidambar styraciflua / Carpinus caroliniana* Forest (CEGL004678).
Ecological Systems: Atlantic Coastal Plain Small Brownwater River Floodplain Forest (CES203.250). Southern Atlantic Coastal Plain Large River Floodplain Forest (CES203.066).

Sites: Brownwater Bottomland Hardwoods occur in the interior of brownwater river floodplains, away from the natural levees and from the active river channel. They occur on the higher areas of the floodplain: former natural levees abandoned by channel shifts, ridges in scrollwork ridge-and-swale systems, and potentially on more extensive flats on terraces.

Soils: Brownwater Bottomland Hardwoods generally have sandy or silty soils with high fertility. Examples are mapped with a variety of soils, with no series predominant. Many are alluvial soils

such as Chewacla (Fluvaquentic Dystrudept), Chastain, or Wehadkee (Fluvaquentic Endoaquepts). Many others are mapped as older soils shared with wet uplands, such as Roanoke (Typic Endoaquult), Tarboro (Typic Udipsamment), Altavista (Aquic Hapludult), Wickham (Typic Hapludult), or a number of others. Given the heterogeneity of floodplain soils, many of these may be inclusions or may not be typical of the named soil series. In any case, those mapped with upland soils have vegetation distinct from upland communities.

Hydrology: The High Subtype is intermittently flooded. Flooding probably occurs only in the highest floods and only for relatively brief periods. Nevertheless, the nutrient enrichment brought by flooding likely is important to the distinctive character of these communities. Soils may also sometimes be saturated by floods that don't inundate them. When rivers are not in flood, the sites are well-drained.

Vegetation: The High Subtype is a forest that is typically dominated by a varying mix of *Quercus laurifolia, Quercus michauxii, Quercus pagoda*, and *Liquidambar styraciflua*. A diversity of other trees are often present, have high frequency in CVS and other plot data (Rice and Peet 1997; Rice et al. 2001; Faestal 2012), and may be locally abundant, including *Carya cordiformis, Quercus phellos, Pinus taeda, Fraxinus pennsylvanica, Ulmus americana, Carya ovata, Quercus shumardii, Quercus lyrata*. *Platanus occidentalis, Betula nigra*, or *Celtis laevigata* often are present as small individuals and may grow to the canopy in disturbed areas. On the highest ridges, transitional to Mesic Mixed Hardwood Forest, a few *Fagus grandifolia* or *Quercus alba* may be present. The understory is usually dominated by *Carpinus caroliniana*. *Ilex opaca, Asimina triloba, Acer rubrum, Ulmus alata, Acer negundo*, *Crataegus marshallii*, *Crataegus macrosperma*, *Diospyros virginiana*, and *Nyssa sylvatica* are frequent along at least some rivers and most may dominate some areas. Shrubs are generally moderate to low in density. The only species with very high constancy is *Ilex decidua*. *Arundinaria tecta* often dominates patches. *Lindera benzoin, Euonymus atropurpureus, Euonymus americanus*, and *Viburnum prunifolium* are at least fairly frequent in plots from some rivers. *Vaccinium elliottii, Vaccinium fuscatum, Itea virginica*, *Eubotrys racemosa*, and *Symplocos tinctoria* are less frequent in plots but often noted in site descriptions. Woody vines are notably diverse and many can be locally abundant. Species with high-to-moderate frequency in plots include *Toxicodendron radicans, Bignonia capreolata, Parthenocissus quinquefolius, Muscadinia rotundifolia, Smilax rotundifolia, Smilax bona-nox, Smilax glauca, Smilax hispida, Smilax smallii, Campsis radicans, Nekemias arborea, Thyrsanthella difformis, Berchemia scandens, Hydrangea (Decumaria) barbara*, several species of *Vitis*, and the exotic *Lonicera japonica*. Herbs are generally sparse to moderate in density. None have the frequency in plot data that many of the woody species do. Frequent species at least along some rivers include *Dichanthelium commutatum, Boehmeria cylindrica, Leersia virginica, Mitchella repens, Festuca subverticillata, Cinna arundinacea, Leersia oryzoides, Hypericum walteri, Saururus cernuus*, and many species of *Carex* (*abscondita, typhina, crinita, corrugata, louisianica, crebriflora, radiata, grayi,* and *amphibola* are at least fairly frequent). A great variety of other herbs of rich, mesic, or wet forests may be present, such as *Arisaema triphyllum, Chasmanthium latifolium, Chasmanthium laxum, Osmorhiza longistylis, Polystichum acrostichoides, Geum canadense, Persicaria virginiana, Glyceria striata, Sanicula canadensis, Elymus virginicus*, and *Mikania scandens*. *Tillandsia usneoides* may be abundant on trees.

Range and Abundance: Ranked G3G4. In North Carolina the High Subtype occurs along the inner and middle Coastal Plain portions of all brownwater rivers but becomes scarce in the outer Coastal Plain. This subtype, being drier, has more often been converted to agriculture or pine plantation. It also is the most easily logged. Its original extent has been greatly reduced, and it is one of the rarest floodplain communities. The synonymized NVC association ranges from Virginia to Georgia.

Associations and Patterns: The High Subtype usually occurs in a mosaic with Cypress–Gum Swamp and sometimes with the Low or Swamp Transition Subtype. It may border Brownwater Levee Forest and may border Mesic Mixed Hardwood Forest but more often is separated by wetter communities.

Variation: No variants are recognized at present but the possibility warrants further investigation. A separate High Pine-Oak Subtype was recognized in earlier drafts of the Fourth Approximation and was also provisionally included in the NVC as *Pinus taeda - Quercus (pagoda, michauxii, shumardii)* Temporarily Flooded Forest (CEGL007550). Both were later lumped. *Pinus taeda* patches are generally regarded as successional after natural or human disturbance rather than an enduring distinct community. Consistent differences in sites or associated vegetation have not been identified. However, given the numerous naturally disturbed patches in recent years that have not regenerated in pine, the possibility remains.

Rice et al. (2001) on the Roanoke River recognized a rarely flooded community and a temporarily flooded community, the latter most typical of the High Subtype and the former transitional to Mesic Mixed Hardwood Forest. They also recognize phases within each. It is unclear if these variations are repeated beyond the Roanoke River. Alternatively, differences in the High Subtype among rivers could be great enough to recognize as variants.

The NVC description of *Quercus michauxii - Quercus shumardii - Liquidambar styraciflua / Arundinaria gigantea* Forest (CEGL002099), a floodplain community of states farther west, emphasizes *Quercus shumardii* as an indicator. Given the irregular occurrence of this species in North Carolina's examples, its ecological significance here may be worth investigating.

Dynamics: The dynamics of Brownwater Bottomland Hardwoods are similar to most Coastal Plain Floodplain communities and to many other forests. Flooding does not represent a significant disturbance, but the nutrient enrichment brought by even the infrequent flooding presumably is important.

The presence of occasional patches dominated by *Pinus taeda* in this community suggests questions about its dynamics. Most forests dominated by this species represent successional stands following past agricultural clearing. However, some are in remote locations where it is unclear if farming would have been attractive. A study of pine stands on the Congaree River in South Carolina (Pederson et al. 1997) found that even recent severe hurricane disturbance was not sufficient to allow regeneration of current pine dominance. They concluded that these stands result from undocumented agricultural fields and suggest that *Pinus taeda* probably occurred as scattered individuals or groves before settlement.

Comments: Study of vegetation at Congaree National Park in South Carolina (Landaal et al. 1998) resulted in creation of NVC associations that appear similar or equivalent to the High Subtype as defined here. *Liquidambar styraciflua - Quercus (laurifolia, nigra) - (Pinus taeda) / Arundinaria gigantea / Carex abscondita* Forest (CEGL007732) has been attributed to North Carolina. It seems to overlap with the concept of the High Subtype. A segregation of *Quercus laurifolia* from *Quercus michauxii* and *Quercus pagoda*, implied by the name, does not appear to occur in North Carolina within higher bottomland hardwoods, though *Quercus laurifolia* occurs without the others in wetter subtypes.

Rare species: Vascular plants: *Cardamine douglassii.*
Vertebrate animals: *Dendroica cerulea*.

References:

Faestal, M. 2012. Classification and description of alluvial plant communities of the North Carolina Coastal Plain. M.S. thesis, University of North Carolina, Chapel Hill.

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Rice, S.K., R.K. Peet, and P. Townsend. 2001. Gradient analysis and classification of the forests of the lower Roanoke River floodplain, North Carolina: a landscape perspective. Unpublished manuscript.

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

BROWNWATER BOTTOMLAND HARDWOODS (LOW SUBTYPE)

Concept: Brownwater Bottomland Hardwoods communities are forests of Coastal Plain floodplain terraces and ridges other than active natural levees, lacking a significant component of levee tree species, and naturally dominated by bottomland oaks, hickories, and sweetgum. The Low Subtype covers examples at intermediate elevations above the river on lower ridges, alluvial flats, and edges of higher ridges. They are dominated by more flood-tolerant species such as *Quercus lyrata, Carya aquatica, Ulmus americana*, and *Quercus laurifolia*. While this subtype conceptually lies between the High Subtype and Swamp Transition Subtype, it is not always developed in recognizable form.

Distinguishing Features: Brownwater Bottomland Hardwoods are distinguished by occurrence on floodplains of brownwater rivers, but away from the riverbank or natural levees, and by dominance by bottomland oaks or sweetgum. The Low Subtype is distinguished from the High Subtype by dominance by *Quercus lyrata, Carya aquatica*, or *Quercus laurifolia*, and absence or low numbers of more mesophytic species such as *Quercus michauxii* and *Quercus pagoda*. *Quercus laurifolia* may be abundant in all subtypes and does not readily distinguish among them.

Synonyms: *Quercus lyrata - Carya aquatica* Forest (CEGL007397).
Ecological Systems: Atlantic Coastal Plain Small Brownwater River Floodplain Forest (CES203.250). Southern Atlantic Coastal Plain Large River Floodplain Forest (CES203.066).

Sites: Brownwater Bottomland Hardwoods occur in the interior of brownwater river floodplains, away from the natural levees and from the active river channel. The Low Subtype occurs on low ridges and flats on active floodplains and potentially on lower parts of terraces.

Soils: Soils of the Low Subtype are generally mapped as alluvial soils such as Chewacla (Fluvaquentic Dystrudept), Bibb (Typic Fluvaqent), Chastain, or Wehadkee (Fluvaquentic Endoaquepts). They tend to be silty or sandy and high in fertility.

Hydrology: The Low Subtype is seasonally to intermittently flooded. Its flood regime is intermediate between the High Subtype and higher Brownwater Levee Forests and the Low Subtype and Cypress–Gum Swamp. When not inundated, the water table may still be high and the soil saturated for significant periods.

Vegetation: The Low Subtype is a forest that is typically dominated by varying combinations of *Quercus laurifolia, Quercus lyrata*, and *Carya aquatica*. *Acer rubrum* var. *trilobum*, *Liquidambar styraciflua, Ulmus americana*, and *Quercus phellos* are frequent. The understory is generally dominated by *Carpinus caroliniana*, but *Ulmus alata* is also frequent, and *Crataegus viridis, Fraxinus caroliniana,* and *Acer negundo* may also occur. The shrub layer generally is sparse to moderate in density; *Ilex decidua* is the only frequent species. Woody vines are diverse and sometimes extensive, though less so than in the High Subtype. *Smilax rotundifolia, Toxicodendron radicans, Campsis radicans, Nekemias arborea, Parthenocissus quinquefolia, Muscadinia rotundifolia, Smilax bona-nox, Thyrsanthella difformis*, and *Berchemia scandens* are at least fairly frequent, and *Gelsemium sempervirens, Smilax glauca*, *Smilax walteri*, and several species of *Vitis* are also encountered. The herb layer is usually sparse to moderate but is fairly low in diversity.

Boehmeria cylindrica is the most constant species; it and *Carex* spp. (*ludoviciana, typhinia, tribuloides, lupulina, radiata, abscondita, gigantea, intumescens*, or others) may be abundant. Frequent herbs on at least some rivers include *Saururus cernuus, Mitchella repens, Viola sororia, Leersia virginica,* and *Leersia oryzoides*. *Tillandsia usneoides* may be abundant on trees.

Range and Abundance: Ranked G4? In North Carolina, the Low Subtype occurs along all of the brownwater rivers and may be in any part of the Coastal Plain. It appears to be rarer than the High Subtype or Swamp Transition Subtype, occupying less area in floodplain community mosaics and less often being present as well-developed examples. The synonymized NVC association ranges to Kentucky and Texas but this probably is a result of uneven treatment and may reflect more limited knowledge and attention. There does not appear to be any reason to expect this wetter bottomland hardwood community to be more widespread than drier ones which are more finely divided and separated by region.

Associations and Patterns: The Low Subtype usually occurs in a mosaic with Cypress–Gum Swamp and sometimes with the High or Swamp Transition Subtype. It may border Brownwater Levee Forest and may border Mesic Mixed Hardwood Forest but more often is separated by wetter communities.

Variation: No variants are recognized at present. This subtype appears to be narrowly defined. However, the distinction between those with *Carya aquatica* and *Quercus lyrata* and those without them warrants investigation.

Dynamics: The dynamics of Brownwater Bottomland Hardwoods are similar to most Coastal Plain Floodplain communities and to many other forests. Flooding does not represent a significant disturbance, but the nutrient enrichment brought by even the infrequent flooding presumably is important.

Some areas of the Low Subtype are susceptible to flooding by beaver ponds, turning them into Coastal Plain Semipermanent Impoundment communities. See the discussion under Coastal Plain Semipermanent Impoundment. Because the trees in this subtype are not tolerant of permanent flooding, the pond will generally develop the Coastal Plain Marsh or Open Water Subtype, even if deeper parts of the pond are the Cypress–Gum Subtype. When a beaver pond is abandoned and drained, it may take some years for the community to return to Bottomland Hardwoods. In addition, deposition of clay in the pond may potentially change the site.

Comments: In North Carolina, this subtype is less common than the other two, and often in smaller patches. As defined, it presumably occupies a narrower segment of the wetness gradient. The vegetation description is less precise and detailed than that for the High Subtype because there are fewer plots and the attribution of them to this subtype is less reliable. Nevertheless, vegetation units that seem equivalent to it were distinguished by both Faestal (2012) and Rice et al. (2001).

Rare species:

References:

Faestal, M. 2012. Classification and description of alluvial plant communities of the North Carolina Coastal Plain. M.S. thesis, University of North Carolina, Chapel Hill.

Rice, S.K., R.K. Peet, and P. Townsend. 2001. Gradient analysis and classification of the forests of the lower Roanoke River floodplain, North Carolina: a landscape perspective. Unpublished manuscript.

BROWNWATER BOTTOMLAND HARDWOODS (SWAMP TRANSITION SUBTYPE)

Concept: Brownwater Bottomland Hardwoods communities are forests of Coastal Plain floodplain terraces and ridges other than active natural levees, lacking a significant component of levee tree species, and naturally dominated by bottomland oaks, hickories, and sweetgum. The Swamp Transition Subtype encompasses communities that are transitional to Cypress–Gum Swamp, having a mix of oaks with *Taxodium* or *Nyssa* in the canopy and having lower strata that are similarly intermediate.

Distinguishing Features: Brownwater Bottomland Hardwoods are distinguished by occurrence on floodplains of brownwater rivers but away from the riverbank or natural levees, and by dominance by bottomland oaks or sweetgum. The Swamp Transition Subtype is distinguished from other subtypes by the absence of the less water-tolerant species and by vegetation transitional to Cypress–Gum Swamp. It has significant *Taxodium, Nyssa*, or *Fraxinus*, and the shrub and herb layers are more similar to Cypress–Gum Swamp than to other subtypes of this type. Oaks are less strongly dominant, though *Quercus lyrata* or *Quercus laurifolia* are generally abundant. Though this subtype has a significant component of Cypress–Gum Swamp species, and the abundance of *Fraxinus pennsylvanica* may give it affinities with Levee Forest, it lacks the strong dominance of species typical of those communities.

The Swamp Transition Subtype may resemble the Oak-Gum Slough subtype of Nonriverine Wet Hardwood Forest but occurs on brownwater river floodplains rather than on nonriverine wet flats. The distinction could become difficult on remote high river terraces that no longer flood, but no extant examples of such ambiguous situations are known. The Swamp Transition Subtype may also resemble Tidal Swamp but may be distinguished by a substantial oak component.

Synonyms: *Taxodium distichum - Fraxinus pennsylvanica - Quercus laurifolia / Acer rubrum / Saururus cernuus* Forest (CEGL007719).
Ecological Systems: Atlantic Coastal Plain Small Brownwater River Floodplain Forest (CES203.250). Southern Atlantic Coastal Plain Large River Floodplain Forest (CES203.066).

Sites: Brownwater Bottomland Hardwoods occur in the interior of brownwater river floodplains, away from the natural levees and from the active river channel. The Swamp Transition Subtype may occur on the lowest ridges or alluvial flats, on the edge of higher ridges, or, not infrequently, in sloughs on higher floodplains or terraces. Relict ridges in the tidal reaches of brownwater rivers, but above the level of tidal flooding, may also support this community.

Soils: Soils of the Low Subtype are generally mapped as alluvial soils such as Chewacla (Fluvaquentic Dystrudept), Bibb (Typic Fluvaqent), Chastain, or Wehadkee (Fluvaquentic Endoaquept). They tend to be silty or sandy and high in fertility. Given the heterogeneity of floodplain soils, many of these may be inclusions or may not be typical of the named soil series.

Hydrology: The Swamp Transition Subtype is seasonally flooded. Its flood regime is intermediate between the Low Subtype and Cypress–Gum Swamp, and it may be inundated well into the growing season. When not inundated, the water table may still be high and the soil saturated for

significant periods. Patches in sloughs may carry flowing water with enough current to cause some local scouring.

Vegetation: The Swamp Transition Subtype is a forest dominated by a mix of trees that includes both *Quercus laurifolia, Quercus lyrata*, or *Carya aquatica*, and *Taxodium distichum, Nyssa aquatica*, or *Nyssa biflora*. *Populus heterophylla, Liquidambar styraciflua, Fraxinus pennsylvanica*, *Fraxinus profunda*, *Acer rubrum* var. *trilobum*, or *Ulmus americana* may also be present in the canopy. Trees of drier bottomland hardwoods, such as *Quercus pagoda* or *Quercus michauxii* are present only in small numbers if at all. The understory may be dominated by *Carpinus caroliniana*, *Fraxinus caroliniana*, or one of the species in the canopy. Other understory species sometimes present include *Crataegus marshallii* and young individuals of species shared with the levees, such as *Celtis laevigata* or *Platanus occidentalis*. The shrub layer is generally sparse. *Ilex decidua* is most frequent species, but *Itea virginica, Eubotrys racemosa,* or *Cephalanthus occidentalis* may be present. The herb layer is usually patchy, with some dense areas and some areas nearly devoid of cover. *Saururus cernuus* and various species of *Carex* (*louisianica, crinita, lurida, gigantea, lupulina, radiata*, or others) are most often dominant, but *Boehmeria cylindrica*, *Leersia oryzoides, Persicaria punctata, Persicaria hydropiperoides*, *Juncus effusus, Justicia ovata, Pilea pumila*, or *Pluchea camphorata* may dominate patches. Other characteristic species include *Lobelia inflata, Mecardonia inflata, Hypericum walteri*, *Glyceria septentrionalis,* and *Peltandra virginica*. *Tillandsia usneoides* may be abundant on trees.

Range and Abundance: Ranked G3G4. In North Carolina, the Low Subtype occurs along all of the brownwater rivers and may be in any part of the Coastal Plain. This subtype tends to become more prominent in the downstream portions of rivers. However, it may also be abundant in the lowest parts of upstream floodplains that are high enough to have little Cypress–Gum Swamp. The synonymized association is attributed to South Carolina, Mississippi, and questionably to Louisiana. As with the Low Subtype, this broad range suggests it may be too broadly defined. At the same time, the disjunct distribution suggests that something like it may be going unrecognized in the intermediate states.

Associations and Patterns: The Swamp Transition Subtype occurs in a mosaic with potentially any other brownwater floodplain communities. It often grades to Cypress–Gum Swamp and to the Low or High Subtype, sometimes to Brownwater Levee Forest. Conceptually, this subtype occurs on the slopes of ridges, but often it is not recognizable there unless there is a broad area at the right elevation. In higher floodplains, it may occupy the lowest parts of the mosaic, with Cypress–Gum Swamp absent.

Variation: No variants are recognized at present. This subtype appears to be narrowly defined. However, the distinction between those with *Quercus lyrata* or *Carya aquatica* and those with *Quercus laurifolia* as the only oak warrants investigation.

Dynamics: The dynamics of the Swamp Transition Subtype are similar to most Coastal Plain Floodplain communities and to many other forests. The influx of nutrients brought by flooding likely is a significant influence on them. Flooding is not generally a disturbance, but examples in sloughs that carry current may be subject to local scouring. Because they are low but not as flood-

tolerant as Cypress–Gum Swamps, the Swamp Transition Subtype may potentially be affected by dam-caused alterations that increase the duration of low-level floods.

The Swamp Transition Subtype may be particularly susceptible to impoundment by beaver ponds, converting them into Coastal Plain Semipermanent Impoundment communities. See the discussion under Coastal Plain Semipermanent Impoundment. Because some of the trees in the Swamp Transition Subtype are tolerant of prolonged flooding, they may survive as a partial canopy in beaver ponds. The initial density of *Taxodium* and *Nyssa* may thus determine whether the Coastal Plain Semipermanent Impoundment community is the Cypress–Gum Subtype or the Coastal Plain Marsh Subtype. When a beaver pond is abandoned and drained, it may take some years for the community to return to Bottomland Hardwoods. In addition, deposition of clay in the pond may potentially change the site. The natural abundance of beavers, how long their ponds lasted, and how much of the floodplain their ponds affected under natural conditions is not known. Within large floodplains, sites where dams can impound significant areas and escape destruction by flood flows are probably limited.

Comments: This subtype is compositionally intermediate between Bottomland Hardwoods and Cypress–Gum Swamp. Vegetation structure resembles a Cypress–Gum Swamp, with a low-diversity herb layer containing species such as *Saururus cernuus* or sedges. The boundaries between this community and adjacent ones do not seem to be placed in the same place in different studies, and attribution of CVS plots is somewhat uncertain. Nevertheless, a vegetation group comparable to this is apparent in both Rice et al. (2001) and Faestal (2012).

Rare species: Vascular plants: *Cardamine douglassii*.

References:

Faestal, M. 2012. Classification and description of alluvial plant communities of the North Carolina Coastal Plain. M.S. thesis, University of North Carolina, Chapel Hill.

Rice, S.K., R.K. Peet, and P. Townsend. 2001. Gradient analysis and classification of the forests of the lower Roanoke River floodplain, North Carolina: a landscape perspective. Unpublished manuscript.

BLACKWATER BOTTOMLAND HARDWOODS (HIGH SUBTYPE)

Concept: Blackwater Bottomland Hardwoods are forests of blackwater river terraces and floodplain ridges, generally dominated by wetland oaks and lacking a significant component of *Betula nigra* or *Planera aquatica*. The High Subtype covers higher examples which lack significant *Quercus lyrata* and which often have a significant component of *Pinus taeda* along with bottomland oaks.

Distinguishing Features: Blackwater Bottomland Hardwoods are distinguished by dominance or codominance by bottomland oaks on blackwater river floodplains, in sites where overbank flooding is, or has been, a significant ecological influence. They are distinguished from Brownwater Bottomland Hardwoods by more acid-tolerant composition and absence of brownwater species such as *Quercus pagoda, Fraxinus pennsylvanica*, *Acer negundo*, and *Asimina triloba*. Most of the plants typical of Blackwater Bottomland Hardwoods are also present in Brownwater Bottomland Hardwoods, but the more acid-tolerant species, such as *Persea palustris, Magnolia virginiana, Lyonia lucida*, and *Cyrilla racemiflora*, are not, and *Clethra alnifolia* is more likely to be in the blackwater type. Nonriverine Wet Hardwood Forests may share some of these acid-tolerant undergrowth plants but generally are dominated by *Quercus pagoda, Quercus michauxii*, or *Liquidambar styraciflua*. Blackwater Bottomland Hardwoods are distinguished from Blackwater Levee/Bar Forest by lacking appreciable numbers of *Betula nigra* or *Planera aquatica*.

The High Subtype is distinguished from the Low Subtype and Swamp Transition Subtype by the absence or limited abundance of *Quercus lyrata, Nyssa biflora*, and *Taxodium distichum*. It is distinguished from the Evergreen Subtype by the absence of *Quercus virginiana* and the absence or near absence of *Chamaecyparis thyoides*.

Synonyms: *Pinus taeda - Quercus laurifolia / Vaccinium elliottii - Arundinaria gigantea* Forest (CEGL004736).
Ecological Systems: Atlantic Coastal Plain Small Blackwater River Floodplain Forest (CES203.249).

Sites: Blackwater Bottomland Hardwoods occur on large blackwater river floodplains. The High Subtype occurs on the highest portions of the floodplain, on terraces and on the highest ridges in scrollwork ridge-and-swale systems. In contrast to brownwater rivers, where levee forests separate bottomland hardwoods from the river, Blackwater Bottomland Hardwoods often border the channel.

Soils: Blackwater Bottomland Hardwoods generally have sandy alluvial soils. Johnston (Cumulic Humaquept) is the only frequently mapped soil series, but Bibb (Typic Fluvaquent), Pactolus, or Chipley (Aquic Quartzipsamment) are sometimes mapped.

Hydrology: The High Subtype is intermittently flooded. Flooding probably occurs only in the highest floods and only for relatively brief periods. Soils may also sometimes be saturated by floods that don't inundate them. When rivers are not in flood, the sites are well drained.

Vegetation: The High Subtype is a forest typically dominated by *Quercus laurifolia*. *Pinus taeda* is frequent and may codominate locally. *Liquidambar styraciflua, Acer rubrum* (var. *trilobum*?), *Quercus nigra*, and, less frequently, *Quercus michauxii* are often present. The understory is usually dominated by *Ilex opaca, Carpinus caroliniana*, or *Persea palustris*, along with canopy species. *Magnolia virginiana* and *Diospyros virginiana* are also fairly frequent. The shrub layer is usually moderate to fairly dense. *Vaccinium elliottii* or *Arundinaria tecta* dominate patches. Other shrubs may include *Cyrilla racemiflora, Clethra alnifolia, Eubotrys racemosa*, or *Hypericum hypericoides*. Woody vines are frequent and maybe be locally abundant, especially *Smilax rotundifolia, Muscadinia rotundifolia*, and *Toxicodendron radicans*, but also fairly frequently *Gelsemium sempervirens, Campsis radicans, Smilax laurifolia*, and other *Smilax* spp. The herb layer usually is sparse. *Mitchella repens* or *Chasmanthium laxum* may dominate patches, and *Lorinseria areolata, Osmunda spectabilis, Osmundastrum cinnamomeum, Dichanthelium* spp., and *Elephantopus nudatus* may be scattered. *Tillandsia usneoides* and *Phoradendron serotinum* may be abundant as epiphytes. In a few places, blackwater bottomlands on riverbanks, where they are well drained when the river is low, may support some upland species in combination with the floodplain species. *Vaccinium arboreum* is the most frequent of these, but occasionally *Pteridium aquilinum, Carya pallida* or *Quercus stellata* may occur.

Range and Abundance: Ranked G3G4. In North Carolina, this community is well developed only on the large blackwater rivers such as the Lumber, Black, and Northeast Cape Fear. It was once extensive in these areas, but as the driest of floodplain communities it is the most frequently altered by logging. On the Waccamaw River, it is largely replaced by the Evergreen Subtype. The community also occurs in South Carolina. The synonymized NVC association occurs in Georgia and potentially in Virginia and Florida.

Associations and Patterns: The High Subtype occurs as part of a floodplain mosaic with other subtypes and with Cypress–Gum Swamp.

Variation: No variants are recognized. Variation within a site often is greater than among sites. The presence of *Quercus michauxii* is infrequent and may be worth investigating as indicative of different ecological conditions.

Dynamics: Dynamics are similar to other floodplain forests. While nutrient input from blackwater flooding is small compared to brownwater, it presumably is an important subsidy and contributes to making the community more productive than other forests of sandy soils.

The High Subtype is dry enough of the time that fire is a possibility, and pines, when present, would provide flammable litter. However, individual patches are small and are separated by vegetation that is less flammable. The lack of a continuous flammable landscape presumably makes natural fire a rare event.

The mechanism for coexistence of shade-intolerant pines with more shade-tolerant oaks in the High Subtype and Evergreen Subtype, as in maritime forests and a few other communities, is not well known.

Comments: Plot data for this subtype are scarce or are not recognized as this community. Most of the above vegetation description is based on site reports.

Rare species: Vascular plants: *Ditrysinia fruticosa*.
Vertebrate animals: *Myotis rafinesquii* and other bats may use these forests.

References:

BLACKWATER BOTTOMLAND HARDWOODS (LOW SUBTYPE)

Concept: Blackwater Bottomland Hardwoods are forests of blackwater river terraces and floodplain ridges, generally dominated by wetland oaks and lacking a significant component of *Betula nigra* or *Planera aquatica*. The Low Subtype encompasses examples at intermediate local elevations, which have a significant component of *Quercus lyrata* and generally lack a significant component of either *Pinus taeda*, *Taxodium distichum,* or *Nyssa biflora*.

Distinguishing Features: Blackwater Bottomland Hardwoods are distinguished by dominance or codominance by bottomland oaks on blackwater river floodplains, in sites where overbank flooding is, or has been, a significant ecological influence. The Low Subtype is distinguished from the High Subtype and the Evergreen Subtype by having abundant *Quercus lyrata* or occasionally by being almost pure *Quercus laurifolia* without plants indicative of drier sites. It is distinguished from the Swamp Transition Subtype by having little or no *Nyssa biflora* and *Taxodium distichum*, by having an herb layer dominated by more mesophytic species than *Saururus cernuus*, and generally by a well-developed shrub layer. It is distinguished from Blackwater Levee/Bar Forest, which may contain *Quercus lyrata*, by lacking appreciable numbers of *Betula nigra* or *Planera aquatica*.

Synonyms: *Quercus laurifolia - Quercus lyrata / Carpinus caroliniana - Persea palustris / Vaccinium elliottii* Forest (CEGL004737).
Ecological Systems: Atlantic Coastal Plain Small Blackwater River Floodplain Forest (CES203.249).

Sites: Blackwater Bottomland Hardwoods occur on large blackwater river floodplains. The Low Subtype occurs at intermediate elevations relative to the river, on lower ridges or in lower parts of terraces. In contrast to brownwater rivers, where levee forests separate bottomland hardwoods from the river, Blackwater Bottomland Hardwoods often border the channel.

Soils: The Low Subtype generally has wet sandy alluvial soil that may be organic-rich. Johnston (Cumulic Humaquept) is the most frequently mapped soil series, but many examples are mapped as Muckalee (Typic Fluvaquent).

Hydrology: The Low Subtype is seasonally to frequently flooded. Flooding may last for significant periods but seldom through much of a growing season. Soils may also sometimes be saturated by floods that don't inundate them.

Vegetation: The Low Subtype is a forest dominated by *Quercus laurifolia* or *Quercus lyrata*, usually by both. *Acer rubrum* var. *trilobum* and *Liquidambar styraciflua* are frequent. Less frequent but characteristic species include *Carya aquatica* and *Ulmus americana*. The understory is frequently dominated by *Carpinus caroliniana* or *Acer rubrum* var. *trilobum*. *Ilex opaca* is frequently present but not usually dominant. *Persea palustris*, understory size *Cyrilla racemiflora, Crataegus* spp., *Diospyros virginiana*, or *Magnolia virginiana* may sometimes be abundant. The shrub layer is generally moderate or fairly dense. *Vaccinium elliottii* or *Ilex decidua* usually dominate. Other shrubs may include *Cyrilla racemiflora, Eubotrys racemosa*, *Vaccinium fuscatum*, *Sabal minor*, and on the Lumber River, *Ditrysinia fruticosa*. Vines may be locally

abundant. *Muscadinia rotundifolia, Smilax rotundifolia, Smilax walteri, Smilax glauca, Campsis radicans, Berchemia scandens, Bignonia capreolata,* and *Thyrsanthella difformis* are all at least fairly frequent, and *Smilax laurifolia, Wisteria frutescens*, and *Gelsemium rankinii* sometimes occur. The herb layer is generally sparse. *Mitchella repens* or *Chasmanthium laxum* may dominate patches. *Boehmeria cylindrica, Mikania scandens,* and *Hypoxis curtisii* are fairly frequent, as are the epiphytes *Tillandsia usneoides* and *Pleopeltis michauxiana*. The latter sometimes forms extensive mats on spreading branches of oak trees in this community near the river, and these are occasionally habitat for the rare *Epidendrum conopseum*. *Dichanthelium yadkinense*, other *Dichanthelium* spp., *Centella asiatica*, *Pluchea camphorata*, *Hymenocallis crassifolia*, and, on the Waccamaw River, *Hymenocallis pygmaea* are other characteristic species, and species of wetter areas such as *Saururus cernuus* and various *Carex* species may be present in small numbers.

Range and Abundance: Ranked G4? but possibly rarer. In North Carolina, the Low Subtype occurs on all the large blackwater rivers and is an important part of the floodplain mosaic of communities. It occurs in South Carolina, but the synonymized NVC association has not been attributed to any other states.

Associations and Patterns: The Low Subtype occurs as part of a floodplain mosaic with other subtypes and with Cypress–Gum Swamp. Conceptually it falls between the High or Evergreen Subtype and the Swamp Transition Subtype but well-developed patches of these are often not present adjacent to it.

Variation: No variants are recognized. Variation within a site often is greater than among sites. More systematic differences should be sought between the occurrences on the Waccamaw River and those on the other rivers.

Dynamics: Dynamics are similar to other floodplain forests.

Comments: *Quercus laurifolia* / *Carpinus caroliniana* / *Justicia ovata* Forest (CEGL07348) is an association of low blackwater bottomland hardwoods that has been attributed to North Carolina. It appears to be more similar to the Swamp Transition Subtype.

Rare species: Vascular plants: *Ditrysinia fruticosa, Hymenocallis pygmaea,* and *Rhynchyospora decurrens*.
Vertebrate animals: *Corynorhinus rafinesquii macrotis* and other bats.

References:

BLACKWATER BOTTOMLAND HARDWOODS (EVERGREEN SUBTYPE)

Concept: Blackwater Bottomland Hardwoods are forests of blackwater river terraces and floodplain ridges, generally dominated by wetland oaks. The Evergreen Subtype covers examples on high to medium-height ridges and terraces that have a substantial component of *Quercus virginiana* or *Chamaecyparis thyoides*. This subtype is known to occur in North Carolina only on the Waccamaw River and its tributary Juniper Creek.

Distinguishing Features: Blackwater Bottomland Hardwoods are distinguished by dominance or codominance by bottomland oaks on blackwater river floodplains, in sites where overbank flooding is, or has been, a significant ecological influence. The Evergreen Subtype is distinguished from all other subtypes by having *Quercus virginiana* or *Chamaecyparis thyoides* present. The Evergreen Subtype is distinguished from Coastal Fringe Evergreen Forest and Swamp Island Evergreen Forest by having floodplain species such as *Quercus laurifolia* and *Vaccinium elliottii*, by having acidic wetland species such as *Chamaecyparis thyoides*, and by generally lacking the drier upland species such as *Quercus hemispherica* and *Quercus geminata*. It can usually be distinguished by its topographic setting, but the Swamp Island Evergreen Forest occurs on some higher ridges on terraces along the Waccamaw River in close proximity to Blackwater Bottomland Hardwoods.

Synonyms: *Pinus taeda - Quercus laurifolia - Chamaecyparis thyoides - (Quercus virginiana) / Vaccinium elliottii* Forest (CEGL007548).
Ecological Systems: Atlantic Coastal Plain Small Blackwater River Floodplain Forest (CES203.249).

Sites: Blackwater Bottomland Hardwoods occur on larger blackwater river floodplains. The Evergreen Subtype occurs primarily on terraces but may occur on higher ridges in the active meander belt.

Soils: The Evergreen Subtype occurs on sandy alluvial soils. Most are mapped as Muckalee (Typic Fluvaquent).

Hydrology: The Evergreen Subtype is intermittently flooded. Flooding probably occurs only in the highest floods and only for relatively brief periods. Soils may also sometimes be saturated by floods that don't inundate them. When the river is not in flood, the sites are well drained.

Vegetation: The Evergreen Subtype is a forest typically dominated by *Quercus laurifolia*. *Pinus taeda* is usually present and sometimes codominates. *Chamaecyparis thyoides* or *Quercus virginiana*, often both, are widely distributed in stands. They seldom occur together in the limited number of plots but can be observed in close proximity. Other canopy species that are frequent and sometimes abundant are *Acer rubrum*, *Liquidambar styraciflua*, and somewhat less frequently, *Quercus nigra, Taxodium ascendens*, and *Nyssa biflora*. The understory is usually dominated by *Quercus laurifolia*, but *Ilex opaca, Persea palustris*, *Magnolia virginiana,* or tall *Cyrilla racemiflora* may have high cover. The shrub layer is often moderate to fairly dense. *Vaccinium elliottii* is most often dominant. Other frequent species, sometimes locally abundant, include *Clethra alnifolia, Lyonia lucida, Eubotrys racemosus*, *Hypericum hypericoides,* and *Ilex*

myrtifolia. Drier areas may have some *Vaccinium arboreum* or *Symplocos tinctoria*. Less frequent but notable species include *Sabal minor, Vaccinium formosum*, *Ilex decidua*, and *Diospyros virginiana*. Vines are common, though they are less prominent and less diverse than in wetter subtypes. Frequent species includer *Smilax laurifolia, Smilax rotundifolia, Smilax walteri, Smilax glauca, Muscadinia rotundifolia*, *Gelsemium sempervirens*, and *Toxicodendron radicans*. The herb layer is generally sparse. The only species with high constancy in CVS plot data are *Mitchella repens* and epiphytic *Tillandsia usneoides*. Fairly frequent in plots or observations are *Osmunda spectabilis, Lorinseria areolata*, *Anchistea virginica*, *Centella asiatica*, and *Zephyranthes atamasca*. *Sphagnum* is often present in scattered clumps. Other hers that are less frequent but may be characteristic include epiphytic *Pleopeltis michauxiana*, *Chasmanthium laxum, Dichanthelium dichotomum* var. *dichotomum*, *Carex glaucescens, Carex verrucosa, Carex debilis*, *Rhynchospora perplexa*, and other species of *Carex* and *Rhynchospora*.

Range and Abundance: Ranked G2?, but the question mark probably is not needed. As far as is known, this community occurs only along the Waccamaw River and Juniper Creek, in North and South Carolina. The well-drained sites are suitable for loblolly pine plantation, and many examples have been converted.

Associations and Patterns: The Evergreen Subtype occurs as part of a floodplain mosaic of communities on the Waccamaw River, along with the Low and Swamp Transition Subtype and Cypress–Gum Swamp. It seems to take the place of the High Subtype along other rivers. Conceptually it grades to the Low Subtype.

Variation: Two variants are recognized, based on wetness.
1. Live Oak Variant occurs on the higher areas. *Quercus virginiana* is present but *Chamaecyparis thyoides* may be present or absent.
2. Atlantic White Cedar Variant occurs on somewhat lower areas. *Chamaecyparis thyoides* is common and *Quercus virginiana* is usually absent. *Taxodium ascendens* may also be present in these communities, though they occur at higher elevations than the Swamp Transition Subtype. While this variant is interpreted as part of the Evergreen Subtype, it may be more like the Low Subtype in wetness. It may warrant recognition as a new subtype that is analogous to the Low Subtype in the same way that the Evergreen Subtype is analogous to the High Subtype.

Dynamics: Dynamics of the Evergreen Subtype are probably largely similar to other floodplain communities, especially to the High Subtype. As with the High Subtype, it is dry enough of the time that fire is a possibility, and pines, when present, would provide flammable litter. However, individual patches are small and are separated by vegetation that is less flammable. The lack of a continuous flammable landscape presumably makes natural fire a rare event.

The factors that lead to the formation of this subtype on the Waccamaw River and not on other rivers are not known. Possible causes include the specific flood regime of the Waccamaw River, the elevation of the terraces relative to the river, the large size of the terraces, or something related to the nature of the alluvium. A number of species are shared with nonriverine wetlands, more than in other blackwater floodplain communities. This may suggest a reduced influence of flooding, though the community's affinities are still more with floodplains than any other setting. At the same time, the mix of species includes ones with an unusually wide range of moisture tolerances,

including a number that suggest wetter conditions than would be expected given the elevation above the river and the sandy soil.

The southerly location may also be important. *Quercus virginiana* is largely confined to maritime settings in North Carolina and does not range this far inland farther north. Nevertheless, while *Quercus virginiana* is common along rivers in states farther south, communities with this composition are not known. The occurrence of *Chamaecyparis* is notable. Populations of this species to the north are in nonriverine wetlands with organic soils. Populations to the south are along small streams with mucky soils. The occurrence on sandy mineral soils on the large floodplain of the Waccamaw River is unlike either.

The mechanism for coexistence of shade-intolerant pines with more shade-tolerant oaks in the High Subtype and Evergreen Subtype, as in maritime forests and a few other communities, is not well known. The question is more complex for the Evergreen Subtype, where the dynamics of the generally short-lived *Chamaecyparis* and means for its coexistence need explanation.

Comments: Though *Quercus laurifolia* is indicated as the dominant oak species, the identity of the laurel oaks on the Waccamaw River is somewhat uncertain. They seem different from the species elsewhere, with smaller and narrower leaves. A few observers have interpreted them as *Quercus hemispherica*, and many have noted their unusual character.

Rare species: Vascular plants: *Hymenocallis pygmaea* and *Rhynchospora decurrens.*

References:

BLACKWATER BOTTOMLAND HARDWOODS (SWAMP TRANSITION SUBTYPE)

Concept: Blackwater Bottomland Hardwoods are forests of blackwater river terraces and floodplain ridges, generally dominated by wetland oaks and lacking a significant component of *Betula nigra* or *Planera aquatica*. The Swamp Transition Subtype encompasses communities that are transitional to Cypress–Gum Swamp, having a mix of oaks with *Taxodium* or *Nyssa* in the canopy and having lower strata that are intermediate or are more similar to Cypress–Gum Swamp.

Distinguishing Features: Blackwater Bottomland Hardwoods are distinguished by dominance or codominance by bottomland oaks on blackwater river floodplains, in sites where overbank flooding is, or has been, a significant ecological influence. The Swamp Transition Subtype is distinguished from other subtypes by having a significant component of *Taxodium* and *Nyssa*, by lacking most herbs less water tolerant that *Saururus cernuus*, and usually by the absence of a well-developed shrub layer. It is distinguished from Cypress–Gum Swamp by having a substantial component of oaks.

The Swamp Transition Subtype may resemble the Oak-Gum Slough subtype of Nonriverine Wet Hardwood Forest but occurs on blackwater river floodplains rather than on nonriverine wet flats.

Synonyms: *Quercus lyrata - Quercus laurifolia - Taxodium distichum / Saururus cernuus* Forest (CEGL004735).
Ecological Systems: Atlantic Coastal Plain Small Blackwater River Floodplain Forest (CES203.249).

Sites: Blackwater Bottomland Hardwoods occur on large blackwater river floodplains. The Low Subtype occurs at elevations just above those that support Cypress–Gum Swamp, on lower ridges or in shallow sloughs. In some upstream areas, Cypress–Gum Swamp may be limited and the Swamp Transition Subtype may occupy the lowest areas.

Soils: The Swamp Transition Subtype has wet sandy alluvial soil that may be organic-rich. Johnston (Cumulic Humaquept) is the most frequently mapped soil series, but many examples are mapped as Muckalee (Typic Fluvaquent).

Hydrology: The Swamp Transition Subtype is seasonally flooded. Its flood regime is intermediate between the Low Subtype and Cypress–Gum Swamp, and it may be inundated well into the growing season. When not inundated, the water table may still be high and the soil saturated for significant periods. Patches in sloughs may carry flowing water with enough current to cause some local scouring.

Vegetation: The Swamp Transition Subtype is a forest dominated by combinations of *Quercus laurifolia* and *Quercus lyrata* with *Nyssa biflora* and *Taxodium distichum. Acer rubrum* var. *trilobum* or *Liquidambar styraciflua* are usually present and may be abundant. Small numbers of *Ulmus americana* or other species may be present in the canopy. The understory usually is dominated by *Fraxinus caroliniana, Carpinus caroliniana*, or *Acer rubrum* var. *trilobum*. *Persea palustris, Ilex opaca*, or large *Cyrilla racemiflora* may also be present. The shrub layer is usually sparse. Species may include *Ilex decidua, Vaccinium elliottii, Ilex laevigata, Eubotrys racemosus*,

and *Alnus serrulata*. Vines are often prominent. High frequency species include *Muscadinia rotundifolia*, *Toxicodendron radicans, Smilax rotundifolia, Smilax walteri, Berchemia scandens, Bignonia capreolata, Campsis radicans, Parthenocissus quinquefolia*, *Smilax bona-nox*, and *Smilax glauca*. The herb layer generally is sparse, with the predominant species shared with Cypress–Gum Swamp as much as with other Bottomland Hardwoods subtypes. Frequent species include *Saururus cernuus, Boehmeria cylindrica, Hypericum walteri, Lorinseria areolata, Mikania scandens, Mitchella repens, Persicaria* spp., *Carex intumescens, Carex bromoides*, and other *Carex* spp. Other characteristic species include *Hypoxis curtisii, Lycopus virginicus, Osmunda spectabilis*, *Peltandra virginica, Apios americana, Tillandsia usneoides, Phoradendron leucarpum*, and *Pleopeltis michauxiana*.

Range and Abundance: Ranked G3G5, but probably more truly G3. In North Carolina, the Low Subtype occurs on all the large blackwater rivers and may be an important part of the floodplain mosaic where it remains intact. However, the presence of this subtype often is not apparent in site descriptions, making it difficult to be certain how much remains. This community occurs in South Carolina but the synonymized NVC association has not been attributed to any other states.

Associations and Patterns: The Swamp Transition Subtype occurs as part of a floodplain mosaic with other subtypes and with Cypress–Gum Swamp. Conceptually it falls between the Low Subtype and Cypress–Gum Swamp, but well-developed patches of these are often not present adjacent to it.

Variation: No variants are recognized. Variation within a site often is greater than among sites.

Dynamics: Dynamics are similar to other floodplain forests.

Comments: The vegetation description for this subtype has less detail than for other subtypes. Plot data are scarce or are not recognized as this community. This subtype is also often not recognizable in many site descriptions. It is, however, readily recognizable in the field.

Quercus laurifolia / *Carpinus caroliniana* / *Justicia ovata* Forest (CEGL07348) is an NVC association of low blackwater bottomland hardwoods defined in South Carolina and attributed to North Carolina. It appears to overlap the concept of this subtype but does not seem distinct enough to warrant recognition as a separate element. Areas with abundant *Justicia ovata* are present on the Black River.

Rare species: Vascular plants: *Hymenocallis pygmaea* and *Sagittaria weatherbiana.*
Vertebrate animals: *Corynorhinus rafinesquii macrotis* and other bats.

References:

CYPRESS–GUM SWAMP (BROWNWATER SUBTYPE)

Concept: Cypress–Gum Swamps are wet forests dominated by combinations of *Nyssa* and *Taxodium*, flooded for long periods by overbank flow from rivers or streams. The Brownwater Subtype encompasses examples along large brownwater (alluvial) rivers which receive clay-rich floodwaters and have *Nyssa aquatica* as the primary canopy hardwood species.

Distinguishing Features: The Cypress–Gum Swamp type is distinguished by canopy dominance of combinations of *Taxodium* and *Nyssa* in a nontidal river floodplain setting that is not impounded. The distinction from Tidal Swamp (Cypress–Gum Subtype) can be subtle on the edges of tidal influence and where tidal flooding is primarily from irregular wind tides. However, *Morella cerifera, Juniperus silicicola,* and many herbs associated with Tidal Freshwater Marsh communities are good indicators of tidal conditions. Tidal swamps usually have a more open canopy created by stress from rising sea level, but this is not always the case.

Nonriverine Swamp Forests may also resemble Cypress–Gum Swamps, and the distinction may occasionally be subtle. Nonriverine conditions are marked by a substantial component of acid-loving understory and shrub species typical of pocosins, such as *Persea palustris, Magnolia virginiana, Lyonia lucida, Leucothoe axillaris*, and *Clethra alnifolia*.

Coastal Plain Semipermanent Impoundment (Cypress–Gum Subtype) is distinguished from Cypress–Gum Swamp by the presence of impounded water that does not drain with the fall of floods. This is generally marked by the loss of all but the most water-tolerant species, or by their confinement to elevated microsites such as tree bases. Floating aquatic plants often are present. The canopy generally is somewhat open in Semipermanent Impoundments.

The Brownwater Subtype is distinguished from the other subtypes by its association with brownwater rivers and by the strong dominance of *Nyssa aquatica* with only minor *Nyssa biflora* in the canopy. Backwater creeks, Coastal Plain tributaries that receive muddy water backing up from brownwater rivers as they flood, should be treated as the Brownwater Subtype if *Nyssa aquatica* is the primary hardwood.

Synonyms: *Taxodium distichum - Nyssa aquatica / Fraxinus caroliniana* Forest (CEGL007431). Ecological Systems: Atlantic Coastal Plain Small Brownwater River Floodplain Forest (CES203.250). Southern Atlantic Coastal Plain Large River Floodplain Forest (CES203.066).

Sites: Cypress–Gum Swamps occur in the lowest parts of floodplains, in sloughs, abandoned channel segments, overflow channels, swales, and backswamp basins. They may be present in sloughs on river terraces if they are low enough to flood frequently.

Soils: The Brownwater Subtype occurs on wet alluvial soils. Most have a higher clay content than those in the other brownwater communities, but those in overflow channels may be sandy. Most occurrences are mapped as Wehadkee (Fluvaquentic Endoaquept), Bibb (Typic Fluvaquent), Chewacla (Fluvaquentic Dystrudept), or Chastain (Typic Fluvaquent). A few areas, generally downstream, have organic soils and are mapped as Dorovan (Typic Haplosaprist).

Hydrology: Cypress–Gum Swamps are seasonally to frequently flooded. They may stay flooded well into the growing season and may be flooded again during the growing season by major storms or wet periods. While water may flow rapidly down the floodplain in major floods, in most Cypress–Gum Swamps the flood waters are stagnant for long periods. In the Brownwater Subtype, natural levees slow drainage when the river falls and prolong floods. Clay deposited in the still waters leads to impermeable soils that may perch water at the surface.

Vegetation: The Brownwater Subtype is dominated by varying combinations of *Nyssa aquatica* and *Taxodium distichum*. Most examples have at least a small amount of both, but a few may be exclusively one or the other. *Populus heterophylla* is fairly frequent and may occasionally be abundant. Other trees, such as *Acer rubrum* var. *trilobum*, *Fraxinus pennsylvanica*, and *Ulmus americana*, are present only in small numbers or in transitions to drier communities. The understory usually is dominated by *Fraxinus caroliniana*, but *Acer rubrum* var. *trilobum* may be abundant and *Acer negundo* is fairly frequent. Shrubs are sparse. *Ilex decidua, Itea virginica*, and *Cephalanthus occidentalis* are fairly frequent in plots data (Rice et al. 2001, Faestal 2012, CVS data). Woody vines are diverse and may have high cover locally but their density is fairly low. Constant or fairly frequent species are *Toxicodendron radicans, Campsis radicans, Smilax rotundifolia, Muscadinia rotundifolia, Berchemia scandens,* and *Nekemias arborea*. *Smilax walteria* is recorded less frequently but is often observed. The herb layer ranges from largely absent to locally dense in patches. *Boehmeria cylindrica* and *Saururus cernuus* are highly constant and often dominant in patches. *Carex* species, most frequently *ludoviciana, lupulina, typhina, tribuloides*, but also often *gigantea* or *crinita*, may also dominate patches. Other fairly frequent herbs in plots include *Bidens discoida, Leersia oryzoides, Commelina virginiana, Ludwigia palustris*, and the exotic *Murdannia keisak*. Less frequent but characteristic species include *Lobelia inflata, Gradiola virginiana, Leersia virginica, Persicaria hydropiperoides*, *Viola* sp., and *Pluchea camphorata*. The epiphyte *Tillandsia usneoides* may have high cover, and *Pleopeltis michauxiana* may cover trunks and branches of some trees.

Range and Abundance: Ranked G5?. Examples are abundant along all of North Carolina's brownwater rivers and can cover large areas in the middle and outer Coastal Plain portions. Because wetness prevents conversion of these forests to agriculture or pine plantation and makes logging more difficult, more examples remain in relatively natural condition than is the case for most communities.

The synonymized NVC association ranges throughout the Southeast, from Virginia to Texas, making it one of the most wide-ranging communities in the NVC. The low species richness imposed by extreme wetness limits variation, but whether the community is sufficiently uniform through such a large range, more uniform than most other communities in the region, is unclear.

Associations and Patterns: Cypress–Gum Swamps occur in mosaics with other floodplain forests. In downstream parts of rivers, they may form large patches that occupy much of the area. In the middle and inner Coastal Plain, patches may be large in backswamp basins on large rivers but otherwise are linear bands along sloughs or swales. The Brownwater Subtype usually grades to Brownwater Bottomland Hardwoods or Brownwater Levee Forest. While the Swamp Transition Subtype and the Low Levee Subtype, respectively, are conceptually the adjacent communities along the moisture gradient, they are not always recognizable. In practice, any brownwater

community may be found bordering them. Coastal Plain Semipermanent Impoundment or Oxbow Lake communities may also be interspersed. Cypress–Gum Swamp may grade downstream to Tidal Swamp.

Variation: With limited diversity of plants, examples vary primarily in the relative amounts of *Taxodium* and *Nyssa*, which may be natural or may be a result of past logging. Vegetation may vary among examples in backswamp basins, sloughs, and sandy overflow channels

Dynamics: While the dynamics of Cypress–Gum Swamps are similar to other floodplain communities, several aspects are different. Mattoon (1915) suggests reproduction is episodic and infrequent well beyond areas of permanent inundation. His observations in virgin stands found a patchy age structure, with even-aged groups making up a multi-aged stand. He reported some patches with concentric, progressively younger tree zones toward the middle. This suggests trees establishing as a basin was filled in, but he did not suggest this was the predominant means of regeneration. Any abandoned channel segments or isolated depressions in brownwater floodplains will be filled in by ongoing sediment deposition fairly quickly. Shankman (1991, 1993) suggested that all cypress regeneration was tied to channel migration in the Interior rivers he studied. This is not obviously so in North Carolina, but Stahle et al. (2012) confirmed the patchy age structure in the Blackwater Subtype in the Black River Swamp and it likely applies to the Brownwater Subtype as well. The uncommon conditions that can lead to establishment of patches of cypress in the absence of geologically-created new habitat are not well known. Both dominant trees in this community are very tolerant of wind, and wind-thrown *Taxodium* are virtually never observed. *Nyssa aquatica* too is very tolerant of wind, but canopy gaps created by the most severe storms may be important for *Taxodium* regeneration.

Taxodium distichum is highly tolerant of water and can survive even permanent flooding, but it cannot survive if its leaves are submersed. Thus, prolonged flooding prevents regeneration. In the wettest areas, seedlings may be able to establish only in unusually dry periods. In other situations, wet periods that reduce competition from other trees may be necessary.

It has been widely noted that cypress often failed to regenerate after early logging. It appears that the amount of *Taxodium* in most examples is now much less than in the past, though it is difficult to know how abundant it was and how it was distributed in the past. Broadwell (2000) emphasized that swamps logged after 1959 had good regeneration on the Roanoke River while stands logged before that did not, regardless of the logging technique or intensity. He suggested that the altered flood regime caused by dams constructed around that time is responsible, perhaps by causing longer low-level flooding that is stressful for competing trees.

Despite the wet habitat, Stahle et al. (1988) found that tree ring growth in *Taxodium* was positively related to rainfall. Stahle et al. (2012) suggested that flowing water brings oxygen and nutrients that enhance tree growth. They also noted the ability of *Taxodium* to adapt to changing water levels by producing new fine roots from trunks, knees, and upper roots at levels with good oxygenation. These fine roots can readily be seen at low water levels. They noted that this adaptation is effective enough that the tree rings are a poor indicator of longer-term water level changes even as they are a good indicator of short-term rainfall patterns.

As the lowest elevation communities in the floodplain, Cypress–Gum Swamps along downstream parts of rivers are the first to be affected by the inland spread of tidal influence with rising sea level. While the canopy initially remains the same, as saturation becomes permanent and flooding becomes more frequent, the lower strata change to those characteristic of Tidal Swamp. Over time, increasing stress leads to thinning of crowns and eventually increasing tree mortality. In the Brownwater Subtype, sediment deposition may raise the floodplain surface enough to partly offset slow sea level rise, but this is not well known.

Cypress–Gum Swamps are the most susceptible brownwater floodplain communities to impoundment by beavers. Beaver dams on sloughs can flood narrow bands or larger backswamp basins. See the discussion under Coastal Plain Semipermanent Impoundment. Because *Taxodium* and *Nyssa aquatica* can tolerate permanent flooding, the swamp canopy often survives to become the canopy of the Cypress–Gum Subtype of Coastal Plain Semipermanent Impoundment. When the beaver pond is abandoned and drains, the canopy remains, and the community quickly reverts to typical Cypress–Gum Swamp. However, the speed at which the characteristic understory and herbs return is not well known.

Comments: *Nyssa aquatica* Forest (CEGL002419), which was recognized provisionally as a Tupelo subtype in earlier 4th approximation draft, has been dropped. There is no clear way to distinguish swamps that naturally lack *Taxodium* from those that have lost it because of early logging. Virtually all examples are dominated by *Nyssa*, with *Taxodium* occurring as a minority. It is unclear if any swamp forests that naturally lacked *Taxodium* occurred in North Carolina.

Rare species: Vascular plants: *Carex crus-corvi, Ranunculus flabellaris,* and *Sagittaria weatherbiana.*
Vertebrate animals: *Ictinia mississippiensis*. *Necturus lewisii,* and *Noturus furiosus* and other fishes can inhabit Cypress–Gum Swamps during flood periods.

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CYPRESS–GUM SWAMP (INTERMEDIATE SUBTYPE)

Concept: Cypress–Gum Swamps are wet forests dominated by combinations of *Nyssa* and *Taxodium*, flooded for long periods by overbank flow from rivers or streams. The Intermediate Subtype covers examples where *Nyssa aquatica* and *Nyssa biflora* are both important components of the canopy or where *Nyssa aquatica* dominates along rivers or streams that are not brownwater rivers. They occur on rivers or creeks that have mineral sediment and pH levels between those of the Brownwater Subtype and Blackwater Subtype. This concept was included in the Blackwater Subtype of the Third Approximation but has been split out, narrowing the concept of the Blackwater Subtype.

Distinguishing Features: The Cypress–Gum Swamp type is distinguished by canopy dominance of combinations of *Taxodium* and *Nyssa* in a nontidal river floodplain setting that is not impounded. The Intermediate Subtype is distinguished from other subtypes by a canopy containing substantial amounts of both *Nyssa aquatica* and *Nyssa biflora* in a setting with some mineral sediment input. The distinction from Tidal Swamp (Cypress–Gum Subtype) can be subtle on the edges of tidal influence and where tidal flooding is primarily from irregular wind tides. However, *Morella cerifera, Juniperus silicicola,* and many herbs associated with Tidal Freshwater Marsh communities are good indicators of tidal conditions. Tidal swamps usually have a more open canopy created by stress from rising sea level, but this is not always the case.

The Intermediate Subtype is distinguished from Coastal Plain Small Stream Swamp, where occurring on small stream floodplains, by the strong canopy dominance by *Nyssa* or *Taxodium* throughout the community (sometimes *Acer rubrum* in successional condition). Coastal Plain Small Stream Swamp is reserved for floodplain communities having a more mixed forest composition driven by more microsite heterogeneity or by shorter hydroperiod. The 3rd Approximation was ambiguous about how to treat the uniformly wet small stream floodplains, but they should be classified as Cypress–Gum Swamp.

Synonyms: *Taxodium distichum - Nyssa aquatica - Nyssa biflora / Fraxinus caroliniana / Itea virginica* Forest (CEGL007432).
Ecological Systems: Atlantic Coastal Plain Small Brownwater River Floodplain Forest (CES203.250).

Sites: The Intermediate Subtype occurs on rivers or creeks that originate in the Coastal Plain but that have characteristics between those of brownwater and blackwater streams. This subtype is most typically along streams that drain clay-rich areas, but it may occur where limestone increases water pH. It may also occur locally along backwater creeks, where blackwater and brownwater mix. It may occupy the full width of uniformly wet small to medium floodplains or may occur in mosaics on floodplains with more topographic variation.

Soils: Most Intermediate Subtype occurrences have organic soils, usually mapped as Dorovan (Typic Haplosaprist). Some are mapped as Johnston (Cumulic Humaquept) and a few as the alluvial soils of brownwater floodplains.

Hydrology: The Intermediate Subtype is seasonally to frequently flooded, with hydroperiods comparable to other Cypress–Gum Swamp subtypes. It may stay flooded well into the growing season and may be flooded again during the growing season by major storms or wet periods. In most settings the water flows slowly or may become stagnant.

Vegetation: The Intermediate Subtype is either dominated by a mix of *Nyssa aquatica, Nyssa biflora*, and varying amounts of *Taxodium distichum* or by *Nyssa aquatica* with or without *Taxodium*. Other trees are scarce or absent from the canopy. The understory may include *Fraxinus caroliniana, Acer rubrum* var. *trilobum*, *Fraxinus profunda, Persea palustris, Carpinus caroliniana*, or *Ilex opaca*. Shrubs are generally sparse. *Eubotrys racemosa, Itea virginica, Viburnum nudum, Alnus serrulata, Ilex verticillata, Arundinaria tecta*, or other species may be present in small numbers. Woody vines are often abundant, including *Toxicodendron radicans*, *Smilax rotundifolia, Smilax walteri, Muscadinia rotundifolia, Berchemia scandens, Smilax glauca, Bignonia capreolata*, and *Campsis radicans*. Herbs range from nearly absent to moderate in density. *Boehmeria cylindrica* and *Saururus cernuus* are the most constant. Other herbs include *Hydrocotyle prolifera, Persicaria punctata,* other *Persicaria* species, *Hypericum walteri, Lorinseria areolata, Osmunda spectabilis, Bidens discoidea, Pilea pumila, Carex gigantea*, other *Carex* species, and, at least on the Waccamaw River, *Rhynchospora corniculata* and *Hymenocallis pygmaea*.

Range and Abundance: Ranked G3G4. In North Carolina, the Intermediate Subtype is most widespread in the northern part of the Coastal Plain and is scattered elsewhere. Many examples are on short streams that drain to estuaries, suggesting its abundance may decline with rising sea level. The synonymized NVC association ranges from Virginia to Florida. It apparently is more abundant than the Blackwater Subtype in states to the south.

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Associations and Patterns: The Intermediate Subtype most often occurs as large patches, filling featureless small to medium size floodplains. Many grade downstream to Tidal Swamp. A few occur in mosaics with other floodplain forests, which may be either blackwater or brownwater in character.

Variation: Too little is known to recognize variants. Differences between those on small floodplains and larger examples should be investigated. The large example on the upper Waccamaw River may be different from other examples.

Dynamics: The dynamics of this subtype are not specifically well known. The distinctive dynamics of *Taxodium distichum*, as discussed for the Brownwater and Blackwater subtypes, presumably apply to this subtype.

Because most examples of the Intermediate Subtype grade downstream to Tidal Swamp, their lower ends are subject to rising sea level and the inland extension of tidal influence. While the canopy initially remains the same, as saturation becomes permanent and flooding becomes more frequent, the lower strata change to those characteristic of Tidal Swamp. Over time, increasing stress leads to thinning of crowns and eventually increasing tree mortality.

Comments: The Intermediate Subtype is relatively recently recognized and needs further clarification. Plot data are not reliably attributed to it and many known sites are not well described, leaving only sparse vegetation data. Beyond the mix of canopy dominants, its vegetation seems more generally to be intermediate between the Blackwater and Brownwater subtypes, with a varying mix of the plants of both.

Nyssa aquatica - *Nyssa biflora* Forest (CEGL007429) is an association that has been created for mixed *Nyssa* swamps on the edges of brownwater floodplains. Scarcity of *Taxodium* is believed to be natural in this situation. It has been questionably attributed to North Carolina but no examples are known. It is unclear if it would be recognizable from the Intermediate Subtype described here, although the setting is different.

Rare species: Vascular plants: *Sagittaria weatherbiana.*

References:

CYPRESS--GUM SWAMP (BLACKWATER SUBTYPE)

Concept: Cypress–Gum Swamps are wet forests dominated by combinations of *Nyssa* and *Taxodium*, flooded for long periods by overbank flow from rivers or streams. The Blackwater Subtype covers examples on Coastal Plain floodplains which lack clay sediment, where *Nyssa aquatica* is not a significant component of the canopy. They occur commonly both in sloughs of large blackwater rivers and filling the entire floodplain of many small streams.

The concept of the Blackwater Subtype has been narrowed from that in the 3rd Approximation, where it was defined to cover all streams with headwaters in the Coastal Plain. Here it includes only the most acidic and clay-free streams, most of which occur in the southern half of the state.

Distinguishing Features: The Cypress–Gum Swamp type is distinguished by canopy dominance by combinations of *Taxodium* and *Nyssa* in a nontidal river floodplain setting that is not impounded. The distinction from Tidal Swamp (Cypress–Gum Subtype) can be subtle on the edges of tidal influence and where tidal flooding is primarily from irregular wind tides. However, *Morella cerifera, Juniperus silicicola,* and many herbs associated with Tidal Freshwater Marsh communities are good indicators of tidal conditions. Tidal swamps usually have a more open canopy created by stress from rising sea level, but this is not always the case.

The Blackwater Subtype is distinguished from the Intermediate and Brownwater subtypes by the absence of *Nyssa aquatica* as a significant canopy component, and by a more acid-tolerant flora in general. It is distinguished from the Blackwater Cove Subtype by a lack of the distinctive open canopy, large buttresses, and deep flooding of that subtype, and corresponding lack of abundant *Cephalanthus occidentalis* and *Planera aquatica*. The Blackwater Subtype is distinguished from Coastal Plain Small Stream Swamp, where occurring on small stream floodplains, by the strong canopy dominance by *Nyssa* or *Taxodium* throughout the community (sometimes *Acer rubrum* in successional condition). Coastal Plain Small Stream Swamp is reserved for floodplain communities having a more mixed forest composition driven by more microsite heterogeneity or by shorter hydroperiod. The 3rd Approximation was ambiguous about how to treat the uniformly wet small stream floodplains, but they should be classified as Cypress–Gum Swamp.

Nonriverine Swamp Forest resembles the Blackwater Subtype more than other subtypes. Its setting is usually clearly not associated with a flowing river, but in ambiguous settings it may be distinguished by a more strongly acid-tolerant flora and dominant plants. While species such as *Lyonia lucida, Ilex glabra, Clethra alnifolia,* and *Smilax laurifolia* may occur in either community, they are usually moderate to dense in Nonriverine Swamp Forest.

Synonyms: *Taxodium distichum - Nyssa biflora / Fraxinus caroliniana / Lyonia lucida* Forest (CEGL004733).
Ecological Systems: Atlantic Coastal Plain Small Blackwater River Floodplain Forest (CES203.249).

Sites: The Blackwater Subtype occurs along rivers and streams that originate in sandy parts of the Coastal Plain and carry very little clay or silt. Blackwater floodplains vary substantially in their microrelief. Some larger rivers have well-developed ridge-and-swale systems, numerous sloughs,

terraces, and other evidence of widespread channel migration, though they have little natural levee development. In these complex floodplains, Cypress–Gum Swamp occurs in the lower portions, in sloughs and overflow channels. Small streams may sometimes have complex microtopography but may instead have flat featureless, floodplains which support Cypress–Gum Swamp throughout their width.

Soils: Soils in the Blackwater Subtype are typically a mix of sand and organic matter, but some are deep organic material. Many are mapped as alluvial soils such as Muckaelee or Bibb (Typic Fluvaqents) but many others are mapped as Johnson (Cumulic Humaquept) or Dorovan (Typic Haplosaprist).

Hydrology: Like other Cypress–Gum Swamps, the Blackwater Subtype is seasonally to frequently flooded, with water often lasting well into the growing season and potentially rising again at any season. The blackwater rivers that flood this subtype are tannin-stained but not turbid and usually are very acidic. Blackwater rivers tend to have more variable water levels than the larger brownwater rivers, so floods may be more frequent but have shorter duration.

Vegetation: The Blackwater Subtype is dominated by *Nyssa biflora*, generally along with *Taxodium distichum* or *Taxodium ascendens*. Other trees are scarce or absent from the canopy. The understory may be dominated by *Fraxinus caroliniana,* by *Acer rubrum* var. *trilobum*, *Persea palustris,* or rarely by tree-size *Cyrilla racemiflora*. It may contain small numbers of *Carpinus caroliniana, Fraxinus profunda, Liquidambar styraciflua*, *Quercus laurifolia*, or *Ilex opaca*. Shrubs may be sparse to moderate in density. Most constant in CVS plot data and field observations are *Cyrilla racemiflora* and *Eubotrys racemosus*. Also fairly frequent in plots are *Itea virginica, Clethra alnifolia*, and *Ilex myrtifolia*, while *Lyonia lucida, Vaccinium formosum, Cephalanthus occidentalis*, or *Alnus serrulata* may be present. Woody vines are often abundant. *Toxicodendron radicans*, *Smilax rotundifolia, Smilax walteri,* and *Smilax laurifolia* are most constant in plot data, while *Muscadinia rotundifolia, Smilax glauca, Bignonia capreolata*, and *Campsis radicans* are frequently observed in plots or in site reports. Herbs range from nearly absent to moderate in density. *Boehmeria cylindrica* is the most constant species. *Mitchella repens, Lorinseria areolata,* and *Osmunda spectabilis*, are frequent in plots. *Carex* spp. are collectively frequent; they include species shared with the Brownwater Subtype, such as *Carex louisianica, tribuloides, lupulina,* and *gigantea*, but also include species more typical of acidic wetlands such as *Carex glaucescens* and *radiata*. Other herbs may include *Ludwigia palustris, Biden discoidea, Dulichium arundinaceum, Hypericum walteri, Mikania scandens, Pilea pumila*, *Persicaria hydropiperoides*, and other *Persicaria* species. *Hymenocallis crassifolia* or, on the Waccamaw River, *Hymenocallis pygmaea* may be locally abundant.

Range and Abundance: Ranked G3G4. This community is present on all of North Carolina's blackwater rivers and many of its smaller streams. The synonymized NVC association is attributed only to North Carolina and South Carolina. The conditions that give rise to the extreme development of blackwater become less prevalent farther south, and Coastal Plain rivers there are more closely related to the Intermediate Subtype.

Associations and Patterns: The Blackwater Subtype may occur as large patches, filling a featureless small to medium size floodplain. These may have a distinct channel, a network of

anastomosing channels, or have no visible channel at all. On larger rivers, it occurs as part of a floodplain mosaic with various subtypes of Blackwater Bottomland Hardwoods and other floodplain communities. In the downstream parts of large floodplains it may again dominate large featureless flats that fill most or all of the floodplain. It may grade downstream to Tidal Swamp.

Variation: Two variants are presently defined, but several other kinds of variation warrant investigation.

1. Typic Variant includes most examples on large rivers and small streams.
2. Waccamaw Variant includes swamps on the Waccamaw River as well as Juniper Creek and potentially other tributaries. These have *Cyrilla racemiflora, Lyonia lucida*, and *Ilex myrtifolia* as prominent components and lack *Fraxinus caroliniana*. Their vegetation suggests a transition from blackwater to nonriverine conditions, though they do not fit Nonriverine Swamp Forest better in their vegetation or environment. *Hymenocallis pygmaea*, an endemic species to the system, often is an abundant herbaceous component.

Within the Typic Variant, examples on large floodplains and those on smaller ones likely have somewhat different dynamics and may have differences in biota driven by them. Examples also vary in the relative amounts of *Taxodium* and *Nyssa*, which may be natural or may be a result of past logging. The occurrence of *Taxodium distichum* and *Taxodium ascendens* needs further clarification and may suggest variants.

Dynamics: As discussed for the Brownwater Subtype, the population dynamics of *Taxodium distichum* are distinctive. Stahle et al. (2012) confirmed the patchy age structure suggested by Mattoon (1915) as general for cypress. Reproduction thus appears to occur in uncommon episodes in different patches. Stahle et al. (1988) and Stahle et al. (2012) clarified the extreme longevity of *Taxodium distichum*. Under natural conditions, reproduction would not need to be very frequent to maintain its dominance. The conditions required for it are not known. Blackwater rivers and streams may undergo substantial channel migration, shifting microhabitats and creating new open areas where *Taxodium* could establish. However, it is not apparent that most patches in North Carolina are of such geologic origin. It is possible that the cycles of wetter or drier weather on the scale of 30 years documented by Stahle (1988) could affect it. *Taxodium* is more tolerant of inundation than other trees, including *Nyssa biflora*.

As in other Cypress–Gum Swamps, *Taxodium* often failed to regenerate after early logging, leaving most examples depleted in it. Regeneration appears limited in recently logged areas as well.

As in the other subtypes, downstream parts of the Blackwater Subtype are being affected by rising sea level and are developing into Tidal Swamp. Without substantial new sediment deposition to raise ground levels as sea level rises, tidal influence often extends farther up backwater rivers than brownwater.

Comments: Stahle et al. (2012) (and ongoing work) have documented the extreme age of cypress trees in this subtype along the Black River. Trees exceeding 2600 years old have been found, some of the oldest nonclonal plants in the world.

Nyssa biflora - *(Taxodium distichum)* Semi-natural Forest (CEGL004640) was defined as an association for modified versions of this subtype, where *Taxodium* has been removed by logging. It is now inactive and not treated as a standard association. It is generally impossible to determine how much *Taxodium* was present before early logging. Remnants of decay-resistant stumps suggest it was a patchy minority component even long ago, but it is not clear if this reflects conditions before the first logging. For conservation purposes, all examples should be regarded as the same subtype, in varying conditions.

Rare species: Vascular plants: *Acmella repens, Bacopa caroliniana, Ditrysinia fruticosa, Hymenocallis pygmaea, Ponthieva racemosa, Rhynchospora decurrens, Sabatia kennedyana, Sagittaria filiformis,* and *Sagittaria weatherbiana*.
Vertebrate animals: *Anhinga anhinga, Mycteria americana*. *Elassoma boehlkii, Enneacanthus obeisus* and other rare fish of blackwater rivers use Cypress–Gum Swamps when they rare flooded.

References:

Mattoon, W.R. 1915. The Southern Cypress. Bulletin of the U.S. Department of Agriculture ; no. 272.

Stahle, D.W., D.J. Burnette, J. Villanueva, J. Cerano, F.K. Fye, R.D. Griffin, M.K. Cleaveland, D.K. Stahle, J.R. Edmondson, K.P. Wolff . 2012. Tree-ring analysis of ancient baldcypress trees and subfossil wood. Quaternary Science Review 34: 1-15.

Stahle, D.W., M.K. Cleaveland, and J.G. Hehr. 1988. North Carolina climate changes reconstructed from tree rings A.D. 372 to 1985. Science 240: 1517-1519.

CYPRESS–GUM SWAMP (BLACKWATER COVE SUBTYPE)

Concept: Cypress–Gum Swamps are wet forests dominated by combinations of *Nyssa* and *Taxodium*, flooded for long periods by overbank flow from rivers or streams. The Blackwater Cove Subtype encompasses distinctive examples in deeply flooded and somewhat lake-like abandoned channel segments that are connected to blackwater rivers (commonly named coves or backwaters). The vegetation has an open to closed canopy of *Taxodium ascendens* and a substantial understory of *Fraxinus caroliniana*, *Cephalanthus occidentalis*, or *Planera aquatica*. The well-developed examples in North Carolina are on the Waccamaw River.

Distinguishing Features: The distinctive vegetation and environment distinguishes the Blackwater Cove Subtype from the Blackwater Subtype. The canopy may be open to nearly closed, but the deep flooding and abundance of *Cephalanthus occidentalis* or *Planera aquatica* are distinct. Canopy trees are almost exclusively *Taxodium*, which have disproportionately broad and tall buttresses. Either *Taxodium ascendens* and *Taxodium distichum* may dominate. Some Oxbow Lake (Blackwater Subtype) occurrences may have zones of similar vegetation, but they are distinguished by lack of connection to the river (except in flood).

Synonyms: *Taxodium ascendens / Fraxinus caroliniana - Cephalanthus occidentalis - (Planera aquatica)* Woodland (CEGL004289). Backwater (Schafale, Marty, and LeGrand 1985 - Waccamaw River study).
Ecological Systems: Atlantic Coastal Plain Small Blackwater River Floodplain Forest (CES203.249).

Sites: The blackwater Cove Subtype occurs in elongate, triangular, or round low areas that project upstream from the river channel; they are exposed only at very low water. This community may fill the cove, or it may form a rim around treeless open water.

Soils: Soils in the Blackwater Cove Subtype are often mucky but may be sandy if current flows through them at high water. Most are not specifically distinguished in soil mapping.

Hydrology: The Blackwater Cove Subtype is frequently flooded for long periods. Standing water may last for the entire growing season in wetter years. The flooding is often deeper than in other Cypress–Gum Swamps, with 2 meters of water not uncommon.

Vegetation: The Blackwater Cove Subtype canopy is dominated by either *Taxodium distichum* or *Taxodium ascendens*. The trees usually have a distinctive look, with very large, tall-buttressed bases, small trunks, and narrow crowns that produce limited shade. A well-developed understory is present, dominated by *Fraxinus caroliniana, Cephalanthus occidentalis*, or *Planera aquatica*. *Crataegus* sp. or *Ilex amelanchier* may also be present. When the water is down, herbaceous species typical of drawdown areas may be seen. *Eragrostis hypnoides, Eleocharis baldwinii,* or *Juncus repens* usually dominate. *Lindernia anagallidea*, *Hydrocotyle prolifera* (*verticillata* var. *triradiate*), and rare species such as *Sabatia kennedyana* or *Fimbristylis perpusilla* may be present.

Range and Abundance: Ranked G2G3 but likely rarer. The abundance and range of this community in North Carolina needs further clarification. Backwater cove sites are present on the

Black, Lumber, and Northeast Cape Fear rivers but are numerous and well developed only on the Waccamaw. It may be that distinctive examples of this community depend on the distinctive hydrological character of this river. This community was only recently recognized and was usually not distinguished in earlier site descriptions. Plot data too are limited because times when the water is low enough for sampling are uncommon. The synonymized NVC association also occurs in South Carolina and is questionably attributed to Georgia and Florida.

Associations and Patterns: The Blackwater Cove Subtype is a small patch community, with suitable sites scattered. It borders the river on one side. It often grades into the Blackwater Subtype in a slough upstream from the cove, where the canopy is dense, *Nyssa biflora* may be a major canopy component, and *Cephalanthus* and *Planera* are less abundant. It usually is bordered by Blackwater Bottomland Hardwoods, potentially any subtype, along the sides.

Variation: No variants have been recognized.

Dynamics: The specific dynamics of this subtype are not known. Given the inability of *Taxodium* seedlings and saplings to survive inundation of their crowns, tree regeneration must be a rare event dependent on prolonged drought. Most of the stands appear to be even-aged or two-aged. The distinctive herbaceous vegetation may grow vegetatively beneath the water or may persist as a seed bank until a dry year. Though current may flow through some of these areas during deeper floods, still water prevails.

Comments:

Rare species: Vascular plants: *Fimbristylis perpusilla*.

References:

SANDHILL STREAMHEAD SWAMP

Concept: The Sandhill Streamhead Swamp type covers very wet forests along mucky small streams in sandy terrain, which are dominated by combinations of *Nyssa biflora, Acer rubrum*, *Liriodendron tulipifera, Persea palustris*, and *Magnolia virginiana*, and have undergrowth of pocosin species. Either *Pinus taeda* or *Pinus serotina* may be present but are not dominant. These communities are conceptually intermediate between Cypress–Gum Swamp or Coastal Plain Small Stream Swamp, and Streamhead Pocosin, with the shrub and herb layers more related to the latter and the canopy more like the former.

Distinguishing Features: Sandhill Streamhead Swamps are distinguished from the closely associated Streamhead Pocosins by having canopy dominance by hardwoods, particularly including *Nyssa biflora*, rather than by *Pinus serotina*. The lower strata are often very similar.

Sandhill Streamhead Swamps are distinguished from Cypress–Gum Swamps by a more mixed canopy, which usually includes *Liriodendron tulipifera* and *Pinus serotina* as well as *Nyssa biflora*. *Taxodium ascendens* may be present in either but is rare in Sandhill Streamhead Swamp. Coastal Plain Small Stream Swamps have a mixed canopy that may contain many of they same species but usually contain additional species such as oaks. The well-developed shrub layer of Sandhill Streamhead Swamp, dominated by *Cyrilla racemiflora, Lyonia lucida, Ilex coriacea*, *Ilex glabra*, and other species shared with Streamhead Pocosin type, is quite different from the open and more mixed shrub layer of Coastal Plain Small Stream Swamp and the sparse, more flood-tolerant shrub layer of Cypress–Gum Swamp.

Nonriverine Swamp Forests also have a substantial component of pocosin species but differ floristically. They are easily distinguishable by occurring in flat areas that lack seepage or overland flooding.

Synonyms: *Nyssa biflora - Liriodendron tulipifera - Pinus (serotina, taeda) / Lyonia lucida - Ilex glabra* Forest (CEGL004734).
Ecological Systems: Atlantic Coastal Plain Blackwater Stream Floodplain Forest (CES203.247).

Sites: Sandhill Streamhead Swamps occur along small to medium drainages in the Sandhills region, where seepage sustains saturated conditions. Because of their distinctive regime of steady flow, floodplain development is limited and fluvial landforms are not present. The sites are flat or may extend slightly up the bordering slopes, but they have little microtopography.

Soils: Soils are mucky sands or loams. They are usually mapped as Johnston (Cumulic Humaquept).

Hydrology: The hydrologic regime of streams in the Sandhills is distinctive because the porous substrate leads to almost complete infiltration of rainfall and little surface runoff. Groundwater seepage maintains saturated conditions and supports steady stream flow. Overbank flooding is rare and sediment movement appears to be nonexistent away from the sandy channel itself.

Vegetation: Sandhill Streamhead Swamps may be closed or open forests. The canopy is a mix that includes *Nyssa biflora* in combination with *Liriodendron tulipifera, Acer rubrum* var. *trilobum*, *Pinus serotina, Pinus taeda*, *Persea palustris, Magnolia virginiana*, *Chamaecyparis thyoides*, and occasionally, *Liquidambar styraciflua* or *Taxodium ascendens*. The understory consists primarily of the same species but may also include *Ilex opaca* or *Oxydendrum arboreum*. The shrub layer is generally dense and is dominated by species shared with pocosins: *Cyrilla racemiflora, Lyonia lucida, Ilex coriacea, Ilex glabra,* and shrub-sized *Persea palustris* and *Magnolia virginiana*. Less abundant but fairly frequent shrubs include *Aronia arbutifolia, Morella caroliniana, Vaccinium formosum, Rhododendron viscosum*, and *Arundinaria tecta*. *Xanthorhiza simplicissima* often is present near the channel. *Smilax laurifolia* may form tangles, and *Smilax rotundifolia, Smilax glauca*, or less commonly *Muscadinia rotundifolia* may be present. The herb layer usually is sparse, though it may be locally denser in open areas. *Lorinseria areolata*, *Osmundastrum cinnamomeum, Osmunda spectabilis*, and *Sphagnum* spp. are the most constant and usually most abundant species. Other herbs may include *Juncus effusus, Chasmanthium laxum, Viola primulifolia Carex intumescens, Carex folliculata, Carex communis,* and other *Carex* spp.

Range and Abundance: Ranked G4?. Sandhills Streamhead Swamps are known only in the Sandhills region, though it is possible that similar conditions could exist locally elsewhere in the Coastal Plain. They are fairly abundant in the region in North Carolina. They also occur in South Carolina and possibly Georgia.

Associations and Patterns: Sandhill Streamhead Swamps are usually bordered by Pine/Scrub Oak Sandhill on adjacent upland slopes. Along drainages, Streamhead Pocosin usually occurs upstream. However, along a given drainage, Sandhill Streamhead Swamp, Streamhead Pocosin, Streamhead Atlantic White Cedar Forest, Streamhead Canebrake, and Coastal Plain Semipermanent Impoundment may occur in any order.

Variation: Examples vary in the amount of the various canopy trees, but it is unclear how much of this variation is natural and how much results from logging history or effects of fire exclusion.

Dynamics: The dynamics of Sandhill Streamhead Swamps appear to differ from most floodplain communities. Flooding is of marginal importance. Given the low nutrient status of soils and water, what flooding there is probably provides little nutrient subsidy. Because they occur along small streams that are closely bordered by longleaf pine communities, Sandhill Streamhead Swamps are frequently exposed to fire. The dense shrub layer makes them susceptible to burning, at least under some circumstances. Many examples show evidence of fire. Without a large component of pine with its flammable litter, they probably burn less intensely and less frequently than Streamhead Pocosins, but fire presumably is an important natural process in them.

The factors that lead to the occurrence of this community rather than others that may occur along Sandhills drainages are not entirely clear. Streamhead Pocosins probably occur where fire is more frequent, and Streamhead Canebrakes where it is most frequent. Streamhead Atlantic White Cedar Forests presumably need less frequent but occasional fire. It is possible these communities represent a shifting mosaic, where one may change into another over time. However, given that all may occur in the same present-day landscape with similar management regimes, such shifts must be uncommon. Given the limited mobility of *Arundinaria tecta* and *Chamaecyparis thyoides*, it

seems unlikely that communities dominated by them could shift around very frequently. However, the presence of *Arundinaria* in many Sandhill Streamhead Swamps may allow for rapid develop of canebrakes if fire frequency becomes high. It is also plausible that these different communities represent alternative stable states, where the flammability of the vegetation perpetuates a fire regime that allows it to persist after a rare establishing event. A further possibility is that unrecognized site differences affect the tendency to burn and lead to a stable mosaic of communities under natural conditions.

The dynamics of beaver ponds similarly are uncertain. If beavers create dams at random or systematically, their ponds and recovering vegetation may create a shifting mosaic under natural conditions. Alternatively, beavers may have had preferred pond sites while other streamhead areas never saw impoundment. It is possible that the Sandhill Streamhead Swamp community would establish itself more readily than other communities in drained beaver ponds, so that past impoundment is the key to present occurrence of this community.

Comments: Sandhill Streamhead Swamp is newly recognized with the Fourth Approximation. Occurrences of it were variously treated as Cypress–Gum Swamp (Blackwater Subtype) and Coastal Plain Small Stream Swamp (Blackwater Subtype) in the 3rd Approximation. They resemble the latter in the intermittent flooding regime, location along small streams, and common admixture of pines in the canopy. They resemble the former in usual dominance by *Nyssa biflora* and long hydroperiod. They are distinct from either in being closely related to Streamhead Pocosins, floristically and spatially. Almost all of the understory, shrub, vine, and herb layer plants are shared with Streamhead Pocosin communities; only the canopy differs.

Rare species: Vascular plants: *Eupatorium resinosum* and *Schoenoplectus etuberculatus.*
Vertebrate animals: *Hyla andersonii.*

References:

COASTAL PLAIN SMALL STREAM SWAMP

Concept: Coastal Plain Small Stream Swamp communities are forests of small floodplains that have microtopography such as ridges and sloughs on a scale too small to differentiate distinct communities. They usually support a mix of species with different moisture tolerances from very wet to mesic, because of fine-scale elevational variation. Uniformly wet small floodplains may support Cypress–Gum Swamp instead.

Distinguishing Features: Coastal Plain Small Stream Swamps are distinguished from all other floodplain communities by having a mixed composition of plants with very different flooding tolerance growing in close association along a stream with only small fluvial landforms. The canopy will usually include substantial *Nyssa* or *Taxodium* along with substantial bottomland oaks and other bottomland hardwoods. Pines are often present. They are distinguished from Cypress–Gum Swamps in smaller floodplains by having a greater diversity in the canopy, generally in all strata. They are distinguished from Mesic Mixed Hardwood Forests by having a significant component of wetland species and by occurring on a floodplain. They are distinguished from Sandhill Streamhead Swamps, which occur on similar size floodplains and also have a mixed composition, by having a broader mix of plants that is not limited to the most acid-tolerant "pocosin" species. Species such as *Quercus laurifolia, Quercus michauxii, Carpinus caroliniana*, and most of the vines and herbs described below are not found in Sandhill Streamhead Swamps, while *Pinus serotina* is not found in Coastal Plain Small Stream Swamps.

Synonyms: *Nyssa biflora - Quercus nigra - Quercus laurifolia - Pinus taeda / Ilex opaca - Carpinus caroliniana* Forest (CEGL007350).
Ecological Systems: Atlantic Coastal Plain Blackwater Stream Floodplain Forest (CES203.247).

Sites: Coastal Plain Small Stream Swamps occur in the floodplains of small-to-medium size streams. They generally have microtopography created by sediment deposition and channel migration, such as slough, ridges, and small natural levees. These create a diversity of site conditions at a scale too small to support recognizable patches of Bottomland Hardwoods or Cypress–Gum Swamps.

Soils: Coastal Plain Small Stream Swamp soils are heterogeneous in drainage, texture, and organic content, both among sites and potentially at a fine scale within sites. A diversity of soil series are mapped, most frequently Muckalee and Bibb (Typic Fluvaquents), but also Johnston (Cumulic Humaquept). A significant minority are mapped as organic soils such as Dorovan (Typic Haplosaprist) or Croatan (Terric Haplosaprist).

Hydrology: Coastal Plain Small Stream Swamps are generally seasonally flooded but some may flood more or less often. Floods are usually of shorter duration than in larger floodplains, rising and falling more quickly because of the smaller watersheds. Many of the creeks have enough current during floods to scour local areas. While they carry little sediment compared to brownwater rivers, those in watersheds with clayey or loamy soils may carry some sediment. Wetness when not in flood is heterogeneous. Low areas may remain saturated for long periods, and local areas may receive seepage from adjacent uplands.

Vegetation: Coastal Plain Small Stream Swamps are forests with extremely variable composition and generally a mix of species with different moisture tolerances. Generally no single species dominates. Highly constant species in CVS plot data and which may codominate locally include *Liquidambar styraciflua, Quercus nigra, Quercus laurifolia, Acer rubrum* var. *trilobum*, *Pinus taeda, Liriodendron tulipifera,* and *Nyssa biflora*. Also fairly frequent are *Quercus michauxii, Taxodium distichum, Quercus alba*, *Carya cordiformis*, and *Fagus grandifolia*. The understory may be dominated by *Carpinus caroliniana, Ilex opaca, Persea palustris*, or *Magnolia virginiana*, as well as canopy species. The shrub layer is usually moderate in density. The most constant shrubs include *Arundinaria tecta, Euonymus americanus, Cyrilla racemiflora*, and *Viburnum nudum*. Also fairly frequent are *Clethra alnifolia, Eubotrys racemosa, Morella cerifera, Lyonia lucida, Leucothoe axillaris*, and *Cornus stricta*. Less frequent in plots but sometimes notable are *Sabal minor, Vaccinium fuscatum, Vaccinium formosum, Hamamelis virginiana*, and *Lindera benzoin*. A wide range of woody vines may occur, including *Toxicodendron radicans, Smilax rotundifolia, Bignonia capreolata, Hydrangea (Decumaria) barbara*, *Muscadinia rotundifolia, Parthenocissus quinquefolia, Smilax glauca, Smilax bona-nox, Smilax walteri, Campsis radicans, Gelsemium sempervirens*, and *Berchemia scandens*. The herb layer may range from sparse to dense and may be quite variable among microsites within the community. The most constant species in plot data are *Mitchella repens, Lorinseria areolata*, and *Osmunda spectabilis*, but additional species that are fairly frequent include *Boehmeria cylindrica, Osmundastrum cinnamomeum, Athyrium asplenioides, Dioscorea villosa, Carex debilis, Carex gigantea, Leersia virginica, Chasmanthium laxum, Dichanthelium boscii, Hypericum walteri, Hexastylis arifolia, Impatiens capensis*, and *Lycopus virginicus*. Clumps of *Sphagnum* spp. may be present locally.

Range and Abundance: Ranked G4? Coastal Plain Small Stream Swamps are common throughout the parts of the Coastal Plain beyond tidal influence. They are often left in recognizable condition even when the surrounding uplands have been heavily altered. The synonymized NVC association is attributed to states from North Carolina to Alabama, including Florida.

Associations and Patterns: Coastal Plain Small Stream Swamps are a regular part of the landscape mosaic in dissected areas other than the Sandhills region. Some are bordered by Mesic Mixed Hardwood Forest, Dry-Mesic Oak–Hickory Forest, or Basic Mesic Forest on steep bluffs. Those in less steep terrain are naturally bordered by longleaf pine communities. Those near enough to the coast may grade to Tidal Swamps downstream, while others will end at a large blackwater or brownwater river floodplain.

Variation: Coastal Plain Small Stream Swamp is one of the most variable communities in the Fourth Approximation. Recognition of variants or subtypes may be appropriate; however, the variation has not been sorted out enough to do so. Several associations in NVC appear to overlap this concept, but they do not fit the occurrences in North Carolina well and do not appear to represent a good division of subtypes for North Carolina occurrences. Instead, there may be variation between those in sandy areas and those in loamy or clay-rich areas, analogous to the difference between the Blackwater and Intermediate subtypes of Cypress–Gum Swamp. There may be differences based on stream gradient.

Dynamics: Most of the dynamics of Coastal Plain Small Stream Swamps are similar to those of blackwater floodplain communities. Flooding brings little sediment but likely provides some nutrient subsidy.

The role of fire is not well known but likely is limited under natural conditions. Those at the bottom of steeper slopes or bordered by mesophytic vegetation are naturally sheltered from fire. Those bordered by longleaf pine communities were naturally exposed to fire frequently. However, the predominantly forb and fern herb layers are not highly flammable during the growing season and wetness limits fire penetration in much of the winter. Floods which redistribute litter also reduce the ability of these communities to carry fire.

More than most other floodplain communities, Coastal Plain Small Stream Swamps are subject to the dynamics of beaver behavior. Beaver dams may turn them quickly into Coastal Plain Semipermanent Impoundment communities. Once ponds drain, it may take many years for the typical forest to return. It is not known how much of the landscape's small stream floodplains were impounded by beavers under more natural conditions, or whether ponds shifted frequently or were relatively stable. In the last two to three decades, beavers have impounded many of the small streams in some parts of the Coastal Plain.

Comments: This community type has been narrowed from the definition in the 3rd Approximation. Pocosin-like small stream bottoms in sandhill terrain have been put into the Sandhill Streamhead Swamp type, and those strongly dominated by *Nyssa* or *Taxodium* have been put into Cypress–Gum Swamp. Coastal Plain Small Stream Swamp remains for small streams that have highly mixed vegetation due to variable flooding regime and microtopography. The Brownwater Subtype in the 3rd Approximation has been dropped, as no well-developed examples were found.

This community has had relatively little study. Bledsoe (1993) described the microsite variability of vegetation along one stream, including an interesting mix of species typical of blackwater and brownwater rivers in different microsites. A moderate number of CVS plots have been collected.

Rare species: Vascular plants: *Carex lupuliformis, Chasmanthium nitidum, Eupatorium resinosum, Gelsemium rankinii, Hottonia inflata, Lindera subcoriacea, Luziola fluitans, Ponthieva racemosa,* and *Trillium pusillum* var. *pusillum*.
Nonvascular plants: *Fissidens hallii.*
Invertebrate animals: *Ptichodis bistrigata*.

References:

Bledsoe, B.P. 1993. Vegetation along hydrologic and edaphic gradients in a North Carolina Coastal Plain creek bottom. M.S. thesis, North Carolina State University.

OXBOW LAKE (BROWNWATER SUBTYPE)

Concept: Oxbow Lakes are permanently flooded open water depressions in large floodplains, isolated from the river by channel shifts. Most are largely unvegetated, but they may contain sparse vegetation or patches of woody or herbaceous wetland plants of various kinds. The Brownwater Subtype covers those along brownwater rivers, which receive substantial mineral sediment input. They typically have an edge zone containing *Taxodium distichum, Nyssa aquatica*, *Platanus occidentalis,* or *Betula nigra*.

Distinguishing Features: Oxbow Lake communities are distinguished from Cypress–Gum Swamps by being wet enough to lack a closed tree canopy. They are distinguished from Semipermanent Impoundment communities by occurring in closed, undammed basins created by an abandoned river channel. This setting produces an aquatic community that is isolated from both the river and from stream input except in floods.

The Brownwater Subtype can usually easily be distinguished by the character of the river and the occurrence of brownwater communities adjacent to it. It typically has an edge zone containing brownwater species such as *Platanus occidentalis* or *Fraxinus pennsylvanica* as well as the more widespread *Taxodium distichum* and *Betula nigra*.

Synonyms: Not covered in NVC.
Ecological Systems: Atlantic Coastal Plain Small Brownwater River Floodplain Forest (CES203.250).

Sites: Oxbow Lake communities occur in large floodplains in segments of former river channels that have become isolated from the river by channel shifts. Deposition along the new river course has closed them off, turning them into basins that hold permanent water and are not connected to the river except during floods.

Soils: Oxbow Lake soils are treated as inclusions or mapped as water in soil surveys. The substrate is alluvial material. The bed presumably is initially sandy, but over time clay is deposited.

Hydrology: Oxbow Lakes are permanently flooded, drying, if ever, only in extreme drought. Except during floods, the water is stagnant and any suspended clay can settle out. In the Brownwater Subtype floods bring pulses of sediment-laden water.

Vegetation: The interior of Oxbow Lake communities is open water, generally without any emergent vegetation. The aquatic vegetation is poorly known. The edges generally are lined with trees, which most often include *Platanus occidentalis, Salix nigra, Taxodium distichum, Nyssa aquatica,* or *Nyssa biflora,* less often *Populus heterophylla, Ulmus americana, Quercus lyrata, Carya aquatica*, or other species of brownwater floodplains. *Cephalanthus occidentalis* or *Swida (Cornus) stricta* may form a shrubby edge in places. Herbs on the edges may include *Persicaria* spp., *Echinodorus cordifolius, Carex* spp. (*lurida, typhina, gigantea,* and potentially many other species), *Boehmeria cylindrica, Proserpinaca pectinata, Sagittaria latifolia, Hydrocotyle prolifera*, *Onoclea sensibilis, Bidens frondosa,* and *Pluchea camphorata*.

Range and Abundance: No G-rank is assigned. In North Carolina, the Brownwater Subtype is extremely rare, with only a handful of examples known. Oxbow Lakes are not recognized in the NVC but they potentially could occur throughout the Southeast.

Associations and Patterns: Oxbow Lakes are small patch communities. They may occur as isolated lakes or several may occur in close proximity. They are embedded in the floodplain community mosaic of Cypress–Gum Swamp, Brownwater Bottomland Hardwoods, and Brownwater Levee Forest of various subtypes.

Variation: No patterns of variation have been identified. Each of the handful of examples is different in its bordering vegetation.

Dynamics: Oxbow Lakes are geologically driven communities. They are created by channel shifts, which appear to be rare events in North Carolina's floodplains. When a meander is cut off, it initially remains connected to the river as a backwater, but sediment deposition on the riverbank fairly quickly isolates it from the river. It will then gradually fill with sediment carried in by floods. It is unclear how long this process takes, but the rarity of oxbow lakes on brownwater rivers suggests they are not geologically long-lived.

Vegetation dynamics may resemble a form of primary succession. The trees on the edge include species that readily establish on newly deposited material, such as *Salix nigra*, species common on riverbanks, such as *Platanus occidentalis*, and species of very wet areas, such as *Taxodium distichum* and *Nyssa aquatica*. As the water becomes shallower with ongoing sediment deposition, these species may spread toward the center. Ultimately the open water will be eliminated, and the depression will succeed to Cypress–Gum Swamp, with the long-lived dominants of that community accumulating over time. A similar process of primary succession was described by Shankman (1991, 1993) for rivers in western Tennessee.

Comments: These communities are not well known. The vegetated portions of them, if any, somewhat resemble the primary successional communities of bars or backwaters along the rivers. The aquatic animal and planktonic communities can be expected to be more distinctive, because they offer an environment that is free from interaction with the river community for long periods. These communities are substantially aquatic rather than terrestrial but are part of the Palustrine System of Cowardin because of their small size.

Rare species: Vascular plants: *Didiplis diandra* and *Hottonia inflata.*

References:

Shankman, D. 1993. Channel migration and vegetation patterns in the Southeastern Coastal Plain. Conservation Biology 7: 176-183.

Shankman, D. 1991. Forest regeneration on abandoned meanders of a Coastal Plain stream in western Tennessee. Castanea 56: 157-167.

OXBOW LAKE (BLACKWATER SUBTYPE)

Concept: Oxbow Lakes are permanently flooded open water depressions in large floodplains, isolated from the river by channel shifts. Most are largely unvegetated, but they may contain sparse vegetation or patches of woody or herbaceous wetland plants of various kinds. The Blackwater Subtype covers examples on blackwater rivers. They typically have an edge zone containing *Taxodium distichum, Nyssa biflora, Liquidambar styraciflua, Planera aquatica*, or *Cephalanthus occidentalis*.

Distinguishing Features: Oxbow Lake communities are distinguished from Cypress–Gum Swamps by being wet enough to lack a closed tree canopy. They are distinguished from Semipermanent Impoundment communities by occurring in closed, undammed basins created by an abandoned river channel. This setting produces an aquatic community that is isolated from both the river and from stream input except in floods. The Blackwater Subtype can usually easily be distinguished by the character of the river and the occurrence of blackwater communities adjacent to it. The edge zone will lack brownwater species such as *Platanus occidentalis* and will probably contain only more broadly tolerant species such as *Taxodium distichum* and *Betula nigra*. On the Waccamaw and Lumber Rivers, as well as in states to the south, *Planera aquatica* may be abundant.

Synonyms: Not covered in NVC.
Ecological Systems: Atlantic Coastal Plain Small Blackwater River Floodplain Forest (CES203.249).

Sites: Oxbow Lake communities occur in large floodplains in segments of former river channels that have become isolated from the river by channel shifts. Deposition along the new river course has closed them off, turning them into basins that hold permanent water and are not connected to the river except during floods.

Soils: Oxbow Lake soils are treated as inclusions or mapped as water in soil surveys. The substrate is alluvial material. The bed presumably is initially sandy, but over time clay is deposited.

Hydrology: Oxbow Lakes are permanently flooded, drying, if ever, only in extreme drought. Except during floods, the water is stagnant. In the Blackwater Subtype, floods bring little in the way of sediment or nutrients.

Vegetation: The interior of Oxbow Lake communities is open water, generally without any emergent vegetation. The aquatic vegetation is poorly known. The edges generally are lined with trees, which in the Blackwater Subtype most often are *Taxodium distichum, Taxodium ascendens*, and on the Waccamaw River, *Planera aquatica*. *Quercus lyrata, Quercus laurifolia*, or *Liquidambar styraciflua* may line them where the edges are steeper. Most descriptions do not note any emergent herbs.

Range and Abundance: No G-rank is assigned. In North Carolina, the Blackwater Subtype is known on all the large blackwater rivers but only the Waccamaw River has more than one or two.

They are more abundant in South Carolina. Oxbow Lakes are not recognized in the NVC but they potentially could occur wherever there are blackwater rivers.

Associations and Patterns: Oxbow Lakes are small patch communities. They may occur as isolated lakes or several may occur in close proximity. They are embedded in the floodplain community mosaic of Cypress–Gum Swamp and Blackwater Bottomland Hardwoods of various subtypes.

Variation: No patterns of variation have been identified.

Dynamics: Oxbow Lakes are geologically driven communities. They are created by channel shifts, which appear to be rare events in North Carolina's floodplains. When a meander is cut off, it initially remains connected to the river as a backwater. It becomes an oxbow lake only if sediment deposition blocks the connection. The abundance of backwaters, greater than of oxbow lakes, suggests that is not inevitable. On blackwater rivers, the lack of fine sediment means that lakes do not fill as rapidly as on brownwater rivers and they may persist until much slower deposition of organic matter fills them.

Comments: These communities are not well known. The vegetated portions of them, if any, resemble the primary successional communities of bars or backwaters along the rivers. The aquatic animal and planktonic communities can be expected to be more distinctive, because they offer an environment that is free from interaction with the river community for long periods. These communities are substantially aquatic rather than terrestrial but are part of the Palustrine System because of their small size.

Rare species:

References:

SAND AND MUD BAR (BROWNWATER SUBTYPE)

Concept: Sand and Mud Bars are communities of soft sediment deposits along rivers, nonforested because of recent deposition, frequent reworking, or frequent scouring. Vegetation generally is sparse or patchy. The Brownwater Subtype occurs along brownwater rivers, where clay deposition and circumneutral water chemistry influence the community.

Distinguishing Features: The Sand and Mud Bar type is distinguished by the combination of occurrence on soft sediments along a river shoreline and lack of a well-developed tree canopy. Vegetation ranges from herbs to shrubs, often at low density, and tree cover is low to nonexistent. Sand and Mud Bar should be recognized only where the patch is wider than the narrow band of shrubs present on most riverbanks. The Brownwater Subtype is distinguished by occurring on brownwater rivers. It contains species typical of brownwater systems that don't occur on blackwater rivers, such as *Platanus occidentalis, Acer negundo*, and *Fraxinus pennsylvanica*.

Synonyms: No NVC association appears to cover this community.
Ecological Systems: Atlantic Coastal Plain Small Brownwater River Floodplain Forest (CES203.250).

Sites: Sand and Mud Bar (Brownwater Subtype) communities occur wherever well-developed bars are present along brownwater rivers. Most are point bars on the insides of meanders, but they may occur on bars along straight reaches as well. Bars vary in slope and in elevation above the river but all are lower than the river banks.

Soils: No well-developed soil is present on the bars. The substrate consists of newly deposited or reworked sand, silt, or clay, sometimes with layers of leaf litter or debris buried by later sediment deposition. Often in the Brownwater Subtype the bulk of the bar appears to consist of sand but there is a thin layer of silt and clay deposited as the most recent flood flow waned. These layers may be removed by rain over time.

Hydrology: Sand and Mud Bars are frequently flooded. Natural flood regimes on brownwater rivers tend to include long duration floods and some very low flows. On rivers controlled by dams, the very high flows and the low flows are eliminated, but low-level floods may often last longer. This may have effects on the morphology of bars as well as on the vegetation. Though bars are deposited where the river current is the slowest along its course, during high flows currents are sometimes swift enough to scour or rework the surface. Sediment deposition may be heavy enough in some parts to be an important disturbance to the vegetation.

Vegetation: Sand and Mud Bar communities have sparse to moderately dense herbaceous vegetation with variable cover of small woody plants. In the Brownwater Subtype the typical woody species are young *Salix nigra, Betula nigra, Fraxinus pennsylvanica, Platanus occidentalis*, and on the Roanoke River, often *Acer saccharinum*. *Hibiscus laevis* or *Hibiscus moscheutos* often is present though rarely very dense. The herbs are tremendously variable. *Coleataenia rigidula* and *Echinochloa crusgalli* are perhaps the most frequent species. On the Roanoke River, *Leersia oryzoides* is frequent (Rice et al. 2001). On the Neuse River, species at least fairly frequent include *Carex louisianica, Carex tribuloides, Carex typhina, Leersia*

virginica, Rumex conglomeratus, Erectites hieracifolia, Mikania scandens, Comellina virginica, Comellina communis, Eclipta prostrata, Elymus virginicus, Persicaria punctata, Persicaria hydropiperoides, Persicaria sagittate, Rumex crispus, Peltandra virginica, Viola spp., and the exotic species *Murdannia keisak, Microstegium vimineum, Alternanthera philoxeroides*, and *Humulus japonicus* (Faestal 2012).

Range and Abundance: No G-rank has been assigned. The Brownwater Subtype appears to be irregularly distributed among brownwater rivers. Faestal (2012) noted that there were few bars on the Cape Fear River and the author's experience suggest there are few on the Roanoke. Both of these rivers meander relatively little. Bars are more numerous on the Neuse River and perhaps on the Tar. Similar bar communities presumably occur along brownwater rivers throughout the Southeast, though it is uncertain how widely they would be regarded as the same NVC association.

Associations and Patterns: Sand and Mud Bars occur along river channels, generally on the inside of active meanders. They generally grade to Brownwater Levee Forest of some subtype on the landward side.

Variation: Variation in communities has not been clarified but may be sufficient to recognize a different variant for the Roanoke than for North Carolina's other brownwater rivers. Extreme heterogeneity at fine scales within patches, along with potential for drastic changes in vegetation with time makes recognition of consistent variants difficult. There presumably are significant differences between areas that have stabilized and are undergoing directional succession compared to those that are regularly reworked or scoured.

Dynamics: Sand and Mud Bars are among the most dynamic natural communities in North Carolina. Their location is tied to river channel patterns and is predictable but the vegetation and even the configuration of the site may potentially be changed drastically by a single flood. Slower changes, over periods of years or dozens of years, also occur as river meanders migrate and older portions of bars become more sheltered or stabilize. Long-lived plant species may be present but much of the vegetation is newly established and much may be ruderal or short-lived. Regular input of propagules collected over a large area may be an important determinant of plants present. The species present and their abundance may be very different at different times.

Though not well known, it is likely that bar configuration and vegetation are in short-term equilibrium with river behavior but that they respond to changes in river flood regimes caused by climatic cycles. The cycles of wetter or drier weather on the scale of 30 years documented by Stahle et al. (1988) may be important to them. The changes caused by upstream dams may also affect them in ways that are not widely recognized.

Comments: Study of this community is limited. Though both Faestal (2012) and Rice (et al. 2001) included it in their classifications, the number of plots was limited. Site observations are extremely limited.

Rare species: None are known.

References:

Faestal, M. 2012. Classification and description of alluvial plant communities of the North Carolina Coastal Plain. M.S. thesis, University of North Carolina, Chapel Hill.

Rice, S.K., R.K. Peet, and P. Townsend. 2001. Gradient analysis and classification of the forests of the lower Roanoke River floodplain, North Carolina: a landscape perspective. Unpublished manuscript.

Stahle, D.W., M.K. Cleaveland, and J.G. Hehr. 1988. North Carolina climate changes reconstructed from tree rings A.D. 372 to 1985. Science 240: 1517-1519.

SAND AND MUD BAR (BLACKWATER SAND BAR SUBTYPE)

Concept: Sand and Mud Bars are communities of soft sediment deposits along rivers, nonforested because of recent deposition, frequent reworking, or frequent scouring. Vegetation generally is sparse or patchy. The Blackwater Sand Bar Subtype covers examples on higher sandy bars along blackwater rivers.

Distinguishing Features: The Sand and Mud Bar type is distinguished by the combination of occurrence on soft sediments along a river shoreline and lack of a well-developed tree canopy. Vegetation ranges from herbs to shrubs, often at low density, and tree cover is low to nonexistent. Sand and Mud Bar should be recognized only where the patch is wider than the narrow band of shrubs present on most riverbanks. The Blackwater Sand Bar Subtype is distinguished from the Blackwater Drawdown Bar Subtype by being higher, generally exposed when the river is not in flood. It usually has a clean sand substrate, though piles or layers of organic debris may be present. The vegetation may be sparse or locally dense but usually includes abundant medium to tall forbs and grasses, such as *Coleataenia rigidula* ssp. *rigidula*. Tree seedlings may be present, as may a number of native or invasive ruderal herbaceous species.

Synonyms: *Panicum rigidulum - Hibiscus moscheutos* Herbaceous Vegetation (CEGL004273). Ecological Systems: Atlantic Coastal Plain Small Blackwater River Floodplain Forest (CES203.249).

Sites: Sand and Mud Bar (Blackwater Subtype) communities occur wherever well-developed bars are present along blackwater rivers. Most examples are on point bars on the insides of meanders but they may occur on bars along straight reaches as well. Bars vary in slope and in elevation above the river, but all are lower than the river banks. The substrate is well-sorted sand in most parts.

Soils: No well-developed soil is present on the bars. The substrate consists of newly deposited or reworked sand, sometimes with layers of leaf litter or debris buried by later sediment deposition.

Hydrology: Sand and Mud Bars are frequently flooded. Natural flood regimes on blackwater rivers tend to be variable, with flooding caused by storms possible at any time of year. Though bars are deposited where the river current is the slowest along its course, during high flows currents are sometimes swift enough to scour or rework the surface. Sediment deposition may be heavy enough in some parts to be an important disturbance to the vegetation. When the river is low, the sand substrate of these bars may lead to excess drainage and dry conditions.

Vegetation: Sand and Mud Bar communities have sparse to moderately dense herbaceous vegetation with variable cover of small woody plants. The most typical woody species in the Blackwater Subtype are *Betula nigra, Salix nigra, Taxodium distichum*, and on the Waccamaw and Lumber River, *Planera aquatica*, occurring as seedlings or as stunted individuals. Frequent herbs are *Coleataenia rigidula*, *Lindernia dubia, Hydrocotyle prolifera, Hydrocotyle verticillata, Lindernia dubia, Pluchea camphorata, Persicaria punctata*, other *Persicaria* spp., *Boehmeria cylindrica*, *Cyperus polystachyos, Mikania scandens, Lobelia elongata,* and various *Dichanthelium* spp. Less frequent but apparently characteristic species include *Fimbristylis autumnalis, Eupatorium capillifolium, Ludwigia alternifolia, Hypericum mutilum, Chasmanthium*

laxum, Erianthus sp., *Leersia oryzoides, Agrostis perennans*, and on the Waccamaw River, *Sabatia kennedyana, Hymenocallis pygmaea*, and *Helenium flexuosum*.

Range and Abundance: Ranked G2G3 but more likely G3. This community is present in numerous patches on the upper and middle reaches of the larger blackwater rivers in North Carolina, though the aggregate acreage is small. It occurs in South Carolina and possibly Georgia, but the NVC association is not attributed more widely.

Associations and Patterns: Sand and Mud Bars occur along river channels, generally on the inside of active meanders. They generally grade to Blackwater Levee/Bar Forest, Blackwater Bottomland Hardwoods, or Cypress–Gum Swamp away from the river.

Variation: Two variants are recognized:
1. Typic Variant occurs on most blackwater rivers.
2. Waccamaw Variant occurs on the Waccamaw River and potentially on lower Juniper Creek. It is marked by distinctive floristic elements, such as *Sabatia kennedyana*. The distinctive hydrologic regime of the Waccamaw River may be important to its distinctive character.

Extreme heterogeneity at fine scales within patches, along with potential for drastic changes in vegetation with time, makes recognition of consistent variants difficult. There presumably also are significant differences between areas that have stabilized and are undergoing directional succession compared to those that are regularly reworked or scoured.

Dynamics: Sand and Mud Bars are among the most dynamic natural communities in North Carolina. Their location is tied to river channel patterns and is predictable but the vegetation and even the configuration of the site may potentially be changed drastically by a single flood. Slower changes, over periods of years or dozens of years, also occur as river meanders migrate and older portions of bars become more sheltered or stabilize. The relatively pure sand of most blackwater bars makes them more easily eroded than brownwater bars and may contribute to less stability. At the same time, the lack of clay and silt deposition leads to lower soil fertility and greater potential for dry conditions.

Comments: Study of this community is limited. Plot data are limited or absent. Examples have been described for multiple sites on the Waccamaw and Lumber River but there is little description for the Black, Northeast Cape Fear, or other rivers.

Rare species: Vascular plants: *Hymenocallis pygmaea* and *Sabatia kennedyana.*

References:

SAND AND MUD BAR (BLACKWATER DRAWDOWN BAR SUBTYPE)

Concept: Sand and Mud Bars are communities of soft sediment deposits along rivers, nonforested because of recent deposition, frequent reworking, or frequent scouring. Vegetation generally is sparse or patchy. The Blackwater Drawdown Bar Subtype covers examples on lower shorelines of blackwater rivers, typically dominated by small plants tolerant of prolonged flooding such as *Eragrostis hypnoides, Micranthemum umbrosum, Juncus repens*, or *Lipocarpha micrantha*.

Distinguishing Features: The Sand and Mud Bar type is distinguished by the combination of occurrence on soft sediments along a river shoreline and lack of a well-developed tree canopy. The Blackwater Drawdown Bar Subtype is distinguished from the Blackwater Sand Bar Subtype by being lower, generally exposed only at very low river levels. The substrate often is finer textured, with appreciable silt or organic matter as well as sand. The vegetation may be sparse but may also consist of dense mats of herbs.

Synonyms: *Eragrostis hypnoides - Micranthemum umbrosum - Lipocarpha micrantha - (Juncus repens)* Herbaceous Vegetation (CEGL004341).
Ecological Systems: Atlantic Coastal Plain Small Blackwater River Floodplain Forest (CES203.249).

Sites: The Blackwater Drawdown Bar Subtype occurs on lower riverbank areas that are exposed only at the lowest water levels. It is well developed only intermittently along the river, where a wide bench or flat exists at the appropriate level. It is not necessarily associated with point bars. It may also occur in backwaters.

Soils: No well-developed soil is present on the bars. The substrate consists of newly deposited or reworked sand or silt.

Hydrology: The Blackwater Drawdown Bar Subtype is intermittently exposed. It may be flooded for long periods during the growing season and may not be exposed at all in wetter years.

Vegetation: The vegetation may be sparse but often is a dense bed of small herbs, many of them annual. Abundant and frequent species include *Eragrostis hypnoides, Lipocarpha micrantha, Fimbristylis autumnalis, Micranthemum umbrosum, Lindernia dubia, Juncus repens*, *Eleocharis baldwinii*, and on the Waccamaw River, *Sabatia kennedyana*. Other characteristic species include *Fimbristylis perpusilla*, *Helenium flexuosum, Gratiola aurea*, *Helanthium tenellum (Echinodorus parvulus*), *Oldenlandia boscii*, and *Edrastema (Oldenlandia) uniflora*. Species of the Blackwater Sand Bar Subtype, such as *Cyperus polystachyos, Hypericum walteri, Persicaria* spp., *Pluchea camphorata, Hypericum mutilum,* and *Hydrocotyle verticillata*, and ruderal species such as *Erechtites hieracifolia* and *Digitaria sanguinalis* may be present in small numbers. A wide variety of other species may be present with low frequency.

Range and Abundance: Ranked G2. The abundance of this community is not well known. In North Carolina, well-developed examples are documented only on the Waccamaw River, but the community may be present on other rivers. The synonymized NVC association occurs in Virginia, South Carolina, and possibly Georgia.

Associations and Patterns: The Blackwater Drawdown Bar Subtype occurs as small patches within the banks of the river. It may be bordered by the Blackwater Sand Bar Subtype but otherwise is bordered by Blackwater Bottomland Hardwoods or Cypress–Gum Swamp.

Variation: Variation is not well studied. Patches are heterogeneous at a fine scale and vary substantially from time to time.

Dynamics: The dynamics of the Blackwater Drawdown Bar Subtype are not well known. The large number of annual plants may only geminate when the water is low, and they presumably persist in a seed bank the rest of the time. Being located beneath the river, these areas are subject to the river's current and may be affected by scouring and deposition of new sediment. However, they appear to occur in low-energy flow regimes.

Comments: The boundary between the concept of this subtype, the Blackwater Sand Bar Subtype, and Cypress–Gum Swamp (Blackwater Cove Subtype) needs further clarification.

Rare species: Vascular plants: *Fimbristylis perpusilla, Gratiola aurea, Helanthium tenellum (Echinodorus parvulus*), *Oldenlandia boscii,* and *Sabatia kennedyana*.

References:

SAND AND MUD BAR (NARROWLEAF POND-LILY SUBTYPE)

Concept: The Narrowleaf Pond-Lily Subtype of Sand and Mud Bar encompasses areas on edges of blackwater river channels that are dominated by *Nuphar sagittifolia*. These areas are permanently or nearly permanently flooded.

Distinguishing Features: This community is distinguished from all others by dominance of *Nuphar sagittifolia* in a nontidal, blackwater river setting. The Narrowleaf Pond-Lily Subtype of Tidal Freshwater Marsh may occur in downstream portions of blackwater rivers and is similar except for having tidal water level fluctuations. *Zizaniopsis miliacea* or other species of Tidal Freshwater Marsh may be present in it.

Synonyms: *Nuphar sagittifolia* Herbaceous Vegetation (CEGL004328).
Ecological Systems: Atlantic Coastal Plain Small Blackwater River Floodplain Forest (CES203.249).

Sites: The Narrowleaf Pond-Lily Subtype occurs on edges of river channels with minimal current or in backwaters.

Soils: Soils are soft sediment, probably of silt or muck.

Hydrology: The Narrowleaf Pond-Lily Subtype is essentially permanently flooded.

Vegetation: The vegetation consists of a dense-to-moderate bed of *Nuphar sagittifolia*. Usually no other vascular plants are present.

Range and Abundance: Ranked G3? but perhaps rarer. In North Carolina it is known in well-developed form only on the Waccamaw River. Though still rare, Tidal Freshwater Marsh (Narrowleaf Pond-Lily), on tidally influenced rivers, is more abundant. The association is also attributed to South Carolina, where it may occur only on the Waccamaw River.

Associations and Patterns: This community occurs in the river channel. It may border Cypress–Gum Swamp or Blackwater Bottomland Hardwoods.

Variation: Nothing is known of variation.

Dynamics: Nothing specific is known about the dynamics of this community.

Comments: The existence of three very similar communities dominated by *Nuphar sagittifolia* is perhaps only marginally acceptable, but the distinctive hydrologic environment of each appears to justify it. All three occur in South Carolina, in the narrow range of this species. A comparable *Nuphar advena* subtype may also exist on other blackwater rivers outside of the range of *Nuphar sagittifolia* but has not been documented.

Rare species: Though not documented, rare aquatic species of the Waccamaw River such as *Procambarus braswelli* and *Enneacanthus chaetodon* may occur in this community.

References:

RIVERINE FLOATING MAT

Concept: Riverine Floating Mats are beds of free-floating vegetation in still waters on the edges of rivers. This community is currently defined conceptually to include any vegetation of large free-floating plants along Coastal Plain flowing or tidal rivers but examples are known only along blackwater rivers in the lower flowing reaches and upper tidal reaches. They are typically dominated or codominated by *Hydrocotyle ranunculoides* or the exotic *Alternanthera philoxeroides* but may be dominated by other native species. Beds consisting solely of diminutive floating plants such as *Lemna* spp. are not included.

Distinguishing Features: The Riverine Floating Mat community is distinguished by floating vegetation of *Hydrocotyle ranunculoides* or similar plants in river channels or waters connected to a river. Beds consisting solely of exotic species such as *Alternanthera philoxeroides* or floating *Murdannia keisak* should not be treated as this community unless there is evidence they once were dominated by native floating species. However, beds with native species that are overgrown by these exotic species should be treated as degraded examples. Beds dominated by rooted floating-leaf plants such as *Nuphar advena* or *Nuphar sagittifolia* are treated as Sand and Mud Bar. Water with only diminutive floating plants such as *Lemna*, *Wolffia*, *Wolffiella*, or *Azolla* is treated as an unclassified aquatic community.

Synonyms: *Hydrocotyle ranunculoides* - (*Sacciolepis striata*) Floating Herbaceous Vegetation (CEGL004305).
Ecological Systems: Atlantic Coastal Plain Small Blackwater River Floodplain Forest (CES203.249).

Sites: Riverine Floating Mats occur in backwaters or still edges of channels in the lower flowing reaches or upper tidal reaches of rivers. Water is generally several feet deep but may be shallower.

Soils: No soil is present. The mat does not typically interact with the river bed, but forms a dense mat of interlaced stems, rhizomes, and fibrous roots.

Hydrology: The sites of Riverine Floating Mats are permanently flooded. The vegetation floats on the surface of the water.

Vegetation: Riverine Floating Mats are most typically dominated by *Hydrocotyle ranunculoides* in its natural condition, but the exotic *Alternanthera philoxeroides* has often become dominant or codominant. In the center of mats, *Sacciolepis striata* will often dominate. Small numbers of other plants such as *Limnobium spongia, Pontederia cordata, Dichanthelium scabriusculum, Decodon verticillatus*, or *Iris virginica* may be present. Diminutive floating plants such as *Lemna* spp., *Wolffia* spp., *or Wolffiella gladiata* may be present in small openings with uncovered water. Unusual examples dominated by different species, such as *Hymenachne (Panicum) hemitomon, Ludwigia repens*, or *Eleocharis* sp. are known.

Range and Abundance: Ranked G3G4. The abundance of this community is not well known. It is present on many blackwater and upper tidal rivers throughout the lower Coastal Plain in North

Carolina but the overall acreage is small. Few examples remain that are not heavily altered by exotic plants. This community also occurs in South Carolina. The synonymized NVC association is questionably attributed to Georgia, Florida, and Alabama, and attributed without question to Misssissippi.

Associations and Patterns: River Floating Mats occur as small patches within river channels. They may be attached to the shore or separated by a few meters from it. In tidal rivers, they may occur in close proximity to Tidal Freshwater Marsh (Narrowleaf Pond-Lily, Broadleaf Pond-Lily, or Southern Wild Rice subtypes). They usually border Cypress–Gum Swamp or Tidal Swamp, less often Blackwater Bottomland Hardwoods.

Variation: Variation has not been well defined. Several examples appear to have unique composition. It is not always clear if they are enduring communities or if they should be considered Riverine Floating Mat communities at all. If they are, several variants or subtypes could be defined.

Dynamics: The dynamics of these communities likely are unique, but they are not well known. The stability and long-term nature of them is not known. The mats are somewhat fragile and can be disturbed by unusual flood flows or storm surges. Mats may occasionally break loose and drift to new locations, and fragments of plants may lodge to start new mats. Mat dynamics may be altered by alterations in flow regimes, and they may also be affected by water pollution. It is possible that mats have become more extensive or vigorous because of nutrient enrichment. They may also have been altered by powered boats, with frequent wakes disturbing them in areas with heavy traffic.

Mats often appear zoned in a way the suggests succession, with *Hydrocotyle* dominant around the edges and extending outward but with *Sacciolepis* overtopping it in the middle of a mat. Additional species, if present at all, will generally be in the center of mats, in areas that appear to be the oldest, thickest, and most stable. There appears to be a seasonal succession, with *Hydrocotyle* active and dominant in the spring, *Alternanthera* overtopping it in summer, and *Sacciolepis* overtopping both later in the summer.

The widespread invasion of *Alternanthera philoxeroides* has severely altered most examples. In a few places, *Murdannia keisak*, usually a rooted or draping invasive plant of swamps, extends outward from shore as floating mats and can overrun natural Riverine Floating Mats.

Comments: These communities are intermittent along most larger blackwater rivers. It is unclear whether well-developed examples occur along any brownwater rivers. They seldom occur on smaller streams.

Hydrocotyle ranunculoides was considered uncommon several decades ago. It is unclear it this suggests floating mats have become more common or if survey of rivers was limited.

Rare species: Vascular plants: *Acmella repens*.

References:

COASTAL PLAIN SEMIPERMANENT IMPOUNDMENT (OPEN WATER SUBTYPE)

Concept: Coastal Plain Semipermanent Impoundment communities are ponded wetlands produced by beaver dams or by long-established man-made dams that produce similar ponds. They include drained impoundments whose vegetation remains distinct from other floodplain communities. The Open Water Subtype covers the deeper portions of pond complexes, dominated by open water or by submersed, floating, or floating-leaved aquatic plants, with limited emergent vegetation. It is generally a zonal community, occurring in a complex with other subtypes.

Distinguishing Features: Coastal Plain Semipermanent Impoundment communities are distinguished by occurrence in the Coastal Plain in active or recently drained beaver ponds or in artificial ponds that have a similar environment and vegetation. Good mimics are usually old mill ponds that have long been unused. Larger reservoirs and smaller farm ponds do not seem to develop similar communities and have no natural community analogue. Other permanently or semipermanently flooded communities such as Oxbow Lake and the various Coastal Plain Depression Communities are generally readily distinguishable by occurring in closed basins without dams. Their vegetation usually is quite different, though recently formed Oxbow Lakes may look similar.

The Open Water Subtype is distinguished by the absence of substantial emergent vegetation or tree cover. Some examples have no significant vascular plant cover. *Nymphaea odorata* is the most typical plant, but *Utricularia* spp., *Lemna* spp., *Myriophyllum* spp., and others may dominate instead.

Synonyms: *Nuphar advena* - *Nymphaea odorata* Herbaceous Vegetation (CEGL002386); Atlantic Coastal Plain Small Brownwater River Floodplain Forest (CES203.250).
Ecological Systems: Atlantic Coastal Plain Small Blackwater River Floodplain Forest (CES203.249). Atlantic Coastal Plain Brownwater Stream Floodplain Forest (CES203.248). Atlantic Coastal Plain Blackwater Stream Floodplain Forest (CES203.247).

Nelumbo lutea Herbaceous Vegetation (CEGL004323) might potentially describe some of our examples. The NVC associations do not distinguish natural and pseudo-natural impoundments from artificial lakes and from other natural basins, apparently even from tidal rivers; hence the correspondence is only partial.

Sites: Coastal Plain Semipermanent Impoundments occur on the floodplains of blackwater or brownwater streams or rivers, rarely on tidal creeks. Beavers prefer second order streams (Snodgrass 1997), but they can use smaller or larger streams. On large river floodplains, beavers dam sloughs, tributary streams, or drainages from backswamps. Old mill ponds that mimic beaver ponds tend to be on relatively small streams. While beavers strongly prefer low gradient streams, very few streams in the Coastal Plain have high enough gradients to deter them.

Soils: Coastal Plain Semipermanent Impoundments can occur on any floodplain soil, though impoundment presumably modifies the preexisting soil if the pond lasts very long. Besides water saturation, depletion of oxygen, and development of a strongly reducing chemical environment, the still water of ponds traps sediment. It may allow clay or muck deposition where it would not

otherwise occur. An accumulated clay layer may persist even after the pond drains and is revegetated. 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 in floodplains might remain in place for centuries.

Hydrology: The Open Water Subtype has deeper water than the other subtypes and is permanently flooded as long as the dam is maintained. Brief dam breaches may occur, but if they are not repaired, the Open Water Subtype quickly develops into other subtypes.

Vegetation: The vegetation of the Open Water Subtype consists of aquatic plants. Dominant plants may include free-floating plants such as *Lemna* spp., *Wolffia*, *Wolffiella gladiata*, or *Azolla caroliniana*; floating leaf aquatics such as *Nymphaea odorata*, *Nuphar advena*, or *Brasenia schreberi*; or submersed aquatic plants such as *Potamogeton* spp., *Cabomba caroliniana*, or *Utricularia* spp. Mat-forming floating plants such as *Hydrocotyle ranunculoides* or the introduced *Alternanthera philoxeroides* can occur but are less typical. Other, less common plants may include *Hottonia inflata*. Nonaquatic plants may be present as minor components, with a number of species potentially inhabiting any remaining stumps, logs, tree bases, or old tip-up mounds. Sparse *Taxodium distichum*, *Nyssa aquatica*, *Nyssa biflora*, *Acer rubrum* var. *trilobum*, or *Fraxinus pennsylvanica* may persist. A diverse community of animals may use the ponds, including frogs and toads, lizards, turtles, snakes, and birds which are not common in the surrounding forest (Metts et al. 2001).

Range and Abundance: Ranked G5. This community may be found wherever streams or rivers occur on the Coastal Plain. Beaver ponds are abundant in the Sandhills region, which has a high stream density, but is also the site of first reintroduction of beavers. They are scarce in the outer Coastal Plain. Similar communities may occur in all the Coastal Plain states.

Associations and Patterns: The Open Water Subtype usually occurs with other subtypes, though sometimes it may occupy most of a given impoundment. It is usually occurs in the middle of the impoundment and near the dam, where water tends to be the deepest. In shallow ponds, it may occur as a narrow sinuous body following the stream channel. On large river floodplains, such as the Roanoke River, beavers tend to build ponds in sloughs or in backswamps (Townsend and Butler 1996). In these settings, the middle of impoundments may be the Cypress–Gum Subtype, the trees persisting from a previous Cypress–Gum Swamp. There, the outer portions of the slough or backswamp, having been occupied by the less flood-tolerant trees of Bottomland Hardwoods communities, may be the location of the Open Water Subtype.

Coastal Plain Semipermanent Impoundments in general are bordered by floodplain communities. In the Sandhills, Streamhead Pocosin or Streamhead Canebrake may occur adjacent to them. A variety of upland communities may border them on the edges, though the Open Water Subtype more often grades to other Coastal Plain Semipermanent Impoundment communities.

Variation: The vegetation is extremely variable among examples and can be patchy and heterogeneous within individual ponds. The dominant plants may occur in any combination, and vegetation density can range from dense to sparse or nearly absent.

Differences between brownwater and blackwater examples should be examined; none have been identified to date, but detailed data are lacking. There must necessarily be differences among those of small and large stream systems, given the differences in flood regime.

Krues and Bason (2015) described a physical typology of beaver ponds that may be useful in describing their variation. The main pond forms, 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) may be helpful, though additional types for sloughs and for backswamps in large floodplains would need to be added to these categories. The cluster configuration types they described also appear useful: pioneer (single pond), disjunct serial (several ponds nearby), and stair step serial (ponds running together).

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 occurring on 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 nonoverlapping. 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 can form rapidly when beavers build a dam large and high enough to impound deep water. Most trees die quickly, though ponds in Cypress–Gum Swamps may retain their tree canopy and not become the Open Water Subtype quickly, or at all. 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 nonaquatic plants as well as for animals.

Colonization by aquatic plants takes some time, though it is not known 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 as well. More mature ponds are generally believed to be more diverse, as aquatic species accumulate over time. Many old mill ponds predate the reintroduction of beavers, and their more diverse aquatic communities are believed to represent the vegetation that once would have occurred in the more persistent beaver ponds.

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. While drained ponds in the North may persist as wet meadows for 50 years or more (Wright et al. 2002), forest return generally appears 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, Rossell, et al. 2014). 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. 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 and 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 how much populations naturally were controlled by predation, and how this affected the life span of colonies.

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. While the situation is usually portrayed as random colonization 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 frequently, and some areas unsuitable and rarely or never ponded. In the Roanoke River floodplain, Townsend and Butler (1996) found that most ponds were created in sloughs, and a fair number on the edges of backswamps next to natural levees (where woody food other than the undesired *Taxodium* and *Nyssa* were available). However, ponds in backswamps were larger, and amounted to slightly larger acreage. 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 that 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 the period. Rather than a shifting mosaic, the landscape appeared to consist of sites that were repeatedly reoccupied long before succession occurred, and 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.

Crucial parameters that remain unknown are how much of a natural landscape would be occupied by which stages of beaver ponds at a given time, and how much of the landscape would ever be affected by them. 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 cases, 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.

In the modern landscape, beavers sometimes take advantage of man-made structures such as road fills, bridges, and culverts. This probably is caused simply by these structure constricting flow and increasing current, trigging the beavers' instinct to place dams there, but at such constrictions, a small dam can create a large and deep pond. Thus, some beaver ponds may be larger than individual ponds in the past, even while ponds overall are less extensive.

Comments: Beaver ponds are potentially important in larger landscapes. They have been called "ecosystem engineers," because they cause physical habitat change and create habitat that would not otherwise be present (Wright et al. 2002). Though the open water and marshy vegetation they create often contrasts less with the other Coastal Plain vegetation than it does with Piedmont and Mountain forests, they provide distinctive habitat that allows different animals and plants to persist in the landscape. Several studies have noted that, though species richness of plants is lower in beaver ponds than in the forests they replace, the presence of beaver ponds increases the species richness of the landscape as a whole (Bartel 2008, Bonner 2005, Metts, et al. 2001, Wright, et al. 2002). Modeling exercises in some of these studies have calculated what abundance of beaver ponds should provide maximum diversity. There is no reason to believe that this particular abundance is what would specifically be present naturally, but the presence of multiple species that depend on beaver pond habitat or artificial analogues shows that it was present in important amounts.

Beaver ponds also apparently provide important ecosystem services and may be important to local geomorphologic processes. They may help buffer stream flows, enhance ground water recharge, and reduce stream velocity. Snodgrass (1997), working in the Savanna River Plant of South Carolina, found that ponds on intermittent streams caused perennial flow in them downstream of the dam. Most importantly, they trap sediment. Kroes and Bason (2015) reported sediment accumulations of 15-20 mm/year in Piedmont streams, compared to 1.6-5.4 mm in unponded streams. Coastal Plain ponds trapped shallower sediment, but the larger surface area of the ponds led to similar total amounts. They noted that, while sediment trapped in channels is often lost quickly when a dam breaks, that deposited in the floodplain can persist. Even in the mountainous landscape of Glacier National Park, Butler and Malanson (2005) found that most ponds that catastrophically drained in severe thunderstorms lost little of their sediment before grass and shrubs stabilized the exposed pond bed.

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COASTAL PLAIN SEMIPERMANENT IMPOUNDMENT (TYPIC MARSH SUBTYPE)

Concept: Coastal Plain Semipermanent Impoundment communities are ponded wetlands produced by beaver dams or by long-established man-made dams that produce similar ponds. They include drained impoundments whose vegetation remains distinct from other floodplain communities. The Typic Marsh Subtype encompasses shallow water and saturated portions of ponds dominated by emergent herbaceous marsh vegetation in the Coastal Plain outside of the Sandhills. It is both a zonal community in active ponds and a successional community in drained ponds.

Distinguishing Features: Coastal Plain Semipermanent Impoundment communities are distinguished by occurrence in the Coastal Plain in active or recently drained beaver ponds or in artificial ponds that have a similar environment and vegetation. Drained beaver ponds are treated as Semipermanent Impoundments until they become more similar to another floodplain community. Young shrub and sapling stands are treated as the Typic Marsh Subtype until they form a recognizable forested community.

The Typic Marsh Subtype is distinguished from other subtypes by the dominance of emergent herbaceous or shrub vegetation and the lack of a substantial tree canopy. *Salix* or other early successional small trees may be present, and *Taxodium distichum, Nyssa biflora*, or *Nyssa aquatica* may be present as scattered trees. The Typic Marsh Subtype is distinguished from the Sandhills Marsh Subtype by substantial floristic differences that correlate with nutrient richness and mineral or boggy character. Species indicative of the Typic Marsh Subtype and not typical in the Sandhills Marsh Subtype include most *Persicaria* spp., *Typha latifolia*, *Leersia hexandra*, *Saururus cernuus*, *Cladium jamaicense*, *Sacciolepis striata, Scleria muhlenbergii*, and *Rhynchospora macrostachya*. Species indicative of the Sandhills Marsh Subtype include *Schoenoplectus subterminalis*, *Eriocaulon decangulare*, *Carex glaucescens*, *Carex striata*, most *Eleocharis* spp., *Schoenoplectus etuberculatus*, *Orontium aquaticum*, and *Sphagnum* spp.

Synonyms: *Polygonum (hydropiperoides, punctatum)* - *Leersia* spp. Herbaceous Vegetation (CEGL004290).

Ecological Systems: Atlantic Coastal Plain Small Brownwater River Floodplain Forest (CES203.250). Atlantic Coastal Plain Small Blackwater River Floodplain Forest (CES203.249). Atlantic Coastal Plain Brownwater Stream Floodplain Forest (CES203.248). Atlantic Coastal Plain Blackwater Stream Floodplain Forest (CES203.247).

NVC associations that could partially overlap this subtype include *Cephalanthus occidentalis / Carex* spp. - *Lemna* spp. Southern Shrubland (CEGL002191); *Alnus serrulata* Saturated Southern Shrubland (CEGL003912); *Juncus effusus* Seasonally Flooded Herbaceous Vegetation (CEGL004112); *Scirpus cyperinus* Seasonally Flooded Southern Herbaceous Vegetation (CEGL003866); *Zizaniopsis miliacea* Coastal Plain Slough Herbaceous Vegetation (CEGL004139); *Typha (angustifolia, latifolia)* - *(Schoenoplectus* spp.) Eastern Herbaceous Vegetation (CEGL006153) (unlikely to be in NC, mainly a northern association). The NVC associations do not distinguish natural and pseudo-natural impoundments from artificial lakes and

from other natural basins, apparently even from tidal rivers; hence the correspondence is only partial.

Sites: The Typic Marsh Subtype occurs on floodplains of blackwater or brownwater streams or rivers, rarely on tidal creeks. Beavers prefer second order streams (Snodgrass 1997), but they can use smaller or larger streams. On larger river floodplains, beavers dam sloughs or outlets of backswamps. While they strongly prefer low gradient streams, very few streams in the Coastal Plain have high enough gradients to deter them. The Typic Marsh Subtype usually occurs on the edges of beaver ponds or in beds of recently drained ponds, but it may occasionally occupy most of an active pond.

Soils: Coastal Plain Semipermanent Impoundments can occur on any floodplain soil, though impoundment presumably modifies the preexisting soil if the pond lasts very long. Kroes and Bason (2015) noted that ponds could be significant repositories for carbon storage, and that, though sediments in channels tended to wash out quickly if the dam was breached, sediment stored in floodplains might remain in place for centuries. If enough sediment accumulates, the soil left behind when the pond drains may be higher and drier than what existed on the site before.

Hydrology: The Typic Marsh Subtype may be permanently or nearly permanently flooded to shallow depths, may draw down during dry seasons, or may be unflooded but permanently saturated. Drained or partially drained ponds may have no standing water.

Vegetation: The vegetation of the Typic Marsh Subtype is dominated by emergent herbaceous plants. The species composition is extremely variable and is not well documented. Species that have been noted as patch dominants or as abundant in some sites include *Sparganium americanum*, *Persicaria hydropiperoides*, *Persicaria densiflora*, *Persicaria punctata*, *Persicaria sagittata*, *Leersia hexandra*, *Panicum hemitomon*, *Saururus cernuus, Typha latifolia*, *Rhynchospora macrostachya*, *Scleria muehlenbergii*, *Sacciolepis striata*, *Cladium jamaicense*, and the exotic species *Murdannia keisak* and *Microstegium vimineum*. Other species noted as present in as many as three of the 11 recorded species lists in Natural Heritage Program files include *Peltandra virginica*, *Juncus effusus*, *Typha latifolia*, *Persicaria sagittata*, *Boehmeria cylindrica*, *Saururus cernuus*, and *Decodon verticillatus*. Other herbaceous species include *Hypericum walteri*, *Impatiens capensis*, *Glyceria striata*, *Persicaria hastata*, *Lycopus virginicus*, *Carex gynandra*, *Rhexia virginica*, *Rhynchospora scirpoides*, *Galium aparine*, *Dulichium arundinaceum*, and *Ludwigia leptocarpa*. Aquatic species such as *Nymphaea odorata* may be present in small numbers amid the emergent vegetation or in small pools. Woody plants may be absent, may consist of sparse trees and shrubs remaining from before impoundment, or may consist of sparse-to-dense young individuals invading the marsh. They usually are generalist species of open wetlands, such as *Alnus serrulata, Cornus stricta*, *Cephalanthus occidentalis, Salix nigra*, *Salix caroliniana*, and *Rosa palustris*, or water-tolerant trees such as *Acer rubrum* var. *trilobum* and *Nyssa biflora*.

Range and Abundance: Ranked G4?. This community may be found wherever streams or rivers occur in the Coastal Plain, though they are scarce or absent in the Sandhills Region. Similar communities may occur in all the southeastern states. Beaver ponds are scarce in the outer Coastal Plain and are more abundant in the northern inner and middle Coastal Plain. This may be simply related to stream density but could also reflect locations of reintroduction and recent spread.

Associations and Patterns: The Typic Marsh Subtype usually occurs with other subtypes, as an edge or upper end zone. In channel ponds (see Krues and Bason 2015), open water may be limited and marsh may make up most of the pond. Coastal Plain Semipermanent Impoundments in general are bordered by floodplain communities. The Typic Marsh Subtype often also borders upland communities of various types.

Variation: This subtype, as currently defined, is one of the most variable in the state, both in differences among sites and in heterogeneity within sites. However, patterns have not been identified in the vegetational variation. Vegetation often appears to consist of patches or zones dominated by a single species, but other areas may have the same species intermixed. True monocultures are not common, and most are not a large proportion of the marsh area. Two variants are tentatively recognized based on presumed functional differences:

1. Active Pond Variant occurs in ponds where beavers are present and maintaining the dam.
2. Successional Pond Variant occurs in abandoned ponds that have drained. Vegetation often is newly established in what was the Open Water Subtype or, in older examples, invading shrub and tree saplings are present. Other vegetational differences between these variants are not well known, but *Leersia virginica*, *Kellochloa* (*Panicum*) *verrucosa*, *Persicaria sagittata*, and the exotic species are some that are more likely to be abundant in successional examples.

Other likely sources of variation that could lead to variants or subtypes include blackwater versus brownwater, small versus large floodplains, association with organic soils, and distance from the coast. Water depth or wetness clearly is an important driver of local variation in vegetation but does not appear to be a useful basis for division given its wide range within sites. However, deeper water patches associated with old channels tend to be dominated by *Sparganium americanum*.

The physical typology of beaver ponds and pond clusters described by Krues and Bason (2015) and summarized under the Open Water Subtype may be useful.

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

These communities can form fairly rapidly when a pond is built, but they may be slower to develop than the Open Water Subtype because the shallower water may take longer to kill the existing trees. Some live trees, generally showing signs of stress, are present for some time, before they eventually succumb to the flooding or are girdled or cut by the beavers. Snags may be abundant for several years. The role of stumps and fallen logs in providing microsites for plants of drier sites is even more important in this subtype than in the deeper water. Establishment of some herbaceous vegetation can be rapid, but the community continues to develop and change in composition and diversity with time. There may be a distinct successional trajectory in the development of these communities, but it has not been described. It is unknown how much of the tremendous variability observed is related to duration of impoundment in addition to variation in flooding conditions.

The Typic Marsh Subtype may also rapidly spread into deeper parts of the pond when the dam is abandoned. While drained ponds in the North 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. However, if part of the dam remains, it may retain enough water to prevent woody invasion and to allow the marsh to persist for some years.

In addition to limited knowledge of the natural abundance and duration of beaver ponds in North Carolina, and in general, there is limited knowledge of the number of examples, extent, and duration of the different subtypes. Most drained ponds probably go through a stage of marsh vegetation, but it may be short-lived. In long-lasting ponds, the marsh may be a stable zone, or may slowly succeed to the Cypress–Gum Subtype.

Comments: See the discussion on ecosystem services and landscape roles of beaver ponds, under the Open Water Subtype.

The vegetation of all Coastal Plain Semipermenent Impoundment subtypes is not well studied. Very few CVS plots exist. Sites descriptions often do not document their vegetation in great detail. In addition, many examples are relatively new and were not present at the time of older site descriptions.

The Typic Marsh Subtgype is very heterogeneous. It may need to be split into several subtypes, but these communities are not well enough known to create a useful division at present. The NVC presently has a number of wide-ranging associations described only as being dominated by single species that often occur within this subtype, as well as in other habitats. Occurrences of this subtype could therefore be treated as a fine-scale mosaic of patch or zonal subtypes, some of which would correspond to NVC associations, while many new associations would need to be defined for other patch dominant species. A better solution is likely to be a small set of subtypes/associations of mixed composition, ones that incorporate the patches but reflect broader scale differences among impoundments. Variations correlating with size of impounded stream, amount of mineral sediment vs. muck, presence of seepage, and biogeography may be a good basis for classifying these communities but are virtually unknown. Even within a region and stream type, beaver ponds vary substantially. An additional axis of variation is the cycle from new creation to maturity to abandonment and succession back to prevailing community types.

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COASTAL PLAIN SEMIPERMANENT IMPOUNDMENT (SANDHILLS MARSH SUBTYPE)

Concept: Coastal Plain Semipermanent Impoundment communities are ponded wetlands produced by beaver dams or by long-established man-made dams that produce similar ponds. They include drained impoundments whose vegetation remains distinct from other floodplain communities. The Sandhills Marsh Subtype covers herbaceous-dominated zones or ponds of the Sandhills Region, where sediment input is minimal and muck substrate predominates. It includes both shallow water edges of active ponds and marshy vegetation in drained ponds.

Distinguishing Features: Coastal Plain Semipermanent Impoundment communities are distinguished by occurrence in the Coastal Plain in active or recently drained beaver ponds or in artificial ponds that have a similar environment and vegetation. Drained beaver ponds are treated as Semipermanent Impoundments until they become more similar to another floodplain or streamhead community.

The Sandhills Marsh Subtype is distinguished from the Cypress–Gum Subtype by dominance of emergent herbaceous vegetation and by the lack of a substantial tree or shrub canopy. However, *Nyssa biflora* trees remaining from before impoundment may be present with limited cover, and shrubs generally establish around the edges. The Typic Marsh Subtype is distinguished from the Sandhills Marsh Subtype by substantial floristic differences that correlate with nutrient richness and mineral or boggy character. Species indicative of the Typic Marsh Subtype and not known in the Sandhills Marsh include most *Persicaria* spp., *Typha latifolia*, *Leersia hexandra*, *Saururus cernuus*, *Cladium jamaicense*, *Sacciolepis striata, Scleria muhlenbergii*, and *Rhynchospora macrostachya*. Species indicative of the Sandhills Marsh Subtype include *Schoenoplectus subterminalis*, *Eriocaulon decangulare*, *Carex glaucescens*, *Carex striata*, most *Eleocharis* spp., *Schoenoplectus etuberculatus*, *Orontium aquaticum*, and *Sphagnum* spp.

The Sandhills Marsh Subtype is distinguished from the Sandhills Mire Subtype by having only a limited woody component. The Sandhills Mire Subtype has a well-developed shrub layer and often trees. However, the differences in herbaceous flora that once were thought to distinguish the two do not appear to work well. Of the species listed in earlier versions of the 4th Approximation as characterizing the Sandhills Mire Subtype — *Carex mitchelliana*, *Carex howei, Carex stricta, Glyceria obtusa, Leersia oryzoides, Dichanthelium scabriusculum, Peltandra virginica*, *Dichanthelium dichotomum*, *Dulichium arundinaceum, Triadenum virginicum, Lycopus cokeri, Eupatorium resinosum, Carex atlantica* and *Woodwardia areolate* — most can be found in examples of the Sandhills Marsh Subtype.

Synonyms: *Orontium aquaticum - Schoenoplectus (etuberculatus, subterminalis) - Eriocaulon decangulare - Juncus trigonocarpus* Herbaceous Vegetation (CEGL007860).
Ecological Systems: Atlantic Coastal Plain Blackwater Stream Floodplain Forest (CES203.247).

Sites: The Sandhills Marsh Subtype occurs on floodplains of streams in the Sandhills Region. This subtype typically occurs on the edges of active beaver ponds or in beds of recently drained ponds.

Soils: Typical soils of Sandhills Region streams are Bibb and Johnston (Typic Fluvaquents and Cumulic Humaquepts). These soils are generally high in organic matter and are kept constantly saturated by the seepage of water from the adjacent porous soils. As such, they may be changed less by impoundment than most, but presumably become more anoxic. Over time, accumulated organic matter rather than transported mineral sediment tends to fill the Sandhills ponds.

Hydrology: The Sandhills Marsh Subtype may be permanently or nearly permanently flooded to shallow depths or may be unflooded but permanently saturated. Drained or partially drained ponds may have no standing water. While beavers generally prefer second order streams (Snodgrass 1997), the stable stream flow characteristic of Sandhills creeks may make smaller creeks attractive while also making higher order streams stable enough for dams.

Vegetation: The vegetation of the Sandhills Marsh Subtype is dominated by emergent herbaceous plants. The species composition is extremely variable and is not well documented. Species that have been noted as patch dominants or as abundant in some sites include *Sparganium americanum*, *Dulichium arundinaceum*, *Rhynchospora* spp., *Schoenoplectus subterminalis*, *Carex striata*, *Glyceria obtusata*, *Eleocharis robbinsii*, *Eleocharis quadrangulata*, *Orontium aquaticum*, and *Iris virginica*. Species that were noted relatively frequently include *Scirpus cyperinus*, *Andropogon glomeratus*, and *Carex glaucescens*. Other species include *Juncus abortivus*, *Juncus canadensis*, *Juncus effusus*, *Juncus coriaceus*, *Juncus repens*, *Carex intumescens*, *Carex atlantica*, *Carex lonchocarpa*, other *Carex* spp., *Dichanthelium scabriusculum*, *Eleocharis tuberculosa*, *Eleocharis equisetoides*, *Rhynchospora chalarocephala*, *Rhynchospora macra*, *Xyris fimbriata*, *Xyris caroliniana*, *Xyris smalliana*, *Sagittaria engelmannii*, *Sagittaria graminea*, *Eupatorium resinosum*, *Lycopus cokeri*, *Rhexia mariana*, *Proserpinaca pectinata*, *Hydrocotyle umbellata*, *Triadenum virginianum*, and *Solidago salicina (patula* var. *strictula)*. *Sphagnum* is sometimes abundant. Aquatic species such as *Nymphaea odorata* or *Brasenia schreberi* may be present in small numbers amid the emergent vegetation. Woody plants may be absent, may consist of sparse trees and shrubs remaining from before impoundment, or may consist of sparse-to-dense young individuals invading the marsh after pond drainage. While woody species general to open wetlands, such as *Viburnum nudum, Vaccinium formosum*, or *Acer rubrum,* may be present, pocosin species such as *Lyonia lucida*, *Cyrilla racemiflora*, *Magnolia virginiana*, *Clethra alnifolia*, and *Smilax laurifolia* are more typical.

Range and Abundance: Ranked G2?. This community may potentially be found anywhere in the Sandhills Region, but examples have been documented primarily from the large public lands of the region and are scarce. Similar communities presumably occur in South Carolina but it is unclear if they range any more widely. It is possible that ponds of this character could occur elsewhere in the Coastal Plain, but no examples have been found. The combination of low mineral sediment input and long-term saturation by seepage is scarce outside the Sandhills.

Associations and Patterns: It is common for beaver ponds of the Open Water Subtype and Sandhills Marsh Subtype to occur interspersed with reaches of Sandhills Streamhead Swamp and Streamhead Pocosin along the streams. Ponds sometimes are single and sometimes are in complexes with multiple active and abandoned dams, with multiple patches of Open Water and Sandhills Marsh Subtype; other ponds or complexes may consist entirely of the Sandhills Marsh

Subtype. They are often bordered by Streamhead Pocosin but can be bordered by upland communities.

Variation: This subtype is currently defined more narrowly than other marsh subtypes, but nevertheless is extremely variable. A very wide range of species may dominate patches. Among species lists available for this community, virtually no species has as much as 50% constancy and, more than in most communities, a large proportion of species has been noted in only one or two examples.

The physical typology of beaver ponds and pond clusters described by Krues and Bason (2015) and summarized under the Open Water Subtype may be useful.

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

These communities can form fairly rapidly when a pond is built, but may be slower to develop than the Open Water Subtype because the shallower water may take longer to kill the existing trees. Some live trees, generally showing signs of stress, are present for some time, before they eventually succumb to the flooding or are cut by the beavers. Snags may be abundant for several years. The role of stumps and fallen logs in providing microsites for plants of drier sites is even more important in this subtype than in the deeper water. Establishment of some herbaceous vegetation can be rapid, but the community continues to develop and change in composition and diversity with time. It is unknown how much of the tremendous variability observed is related to duration of impoundment in addition to variation in flooding conditions.

The Sandhills Marsh Subtype may also spread rapidly into deeper parts of the pond when a dam is abandoned. It may be invaded by woody vegetation rapidly or slowly. It may potentially succeed to the Sandhills Mire Subtype, Cypress–Gum Subtype, or return to a Sandhills Streamhead Swamp. However, if part of the dam remains, it may retain enough water to prevent woody invasion and to allow the marsh to persist for some years. It appears that this phenomenon may be more common in the Sandhills than in other regions. Lee Gerald (personal comm. 1990s) described the successional trend of Sandhills beaver ponds: Sphagnum comes in quickly in drained ponds, and sedge-grass vegetation develops on this. Shrubs and trees, especially *Acer rubrum, Alnus serrulata*, and *Cyrilla racemiflora* invade the marsh over the space of 10-20 years, starting from the head of the pond and the edges. *Nyssa biflora*, persisting through the impoundment or newly established, along with *Acer rubrum*, tends to dominate the drained pond bed, with herbaceous cover beneath. This presumably represents the Sandhills Mire Subtype. Former ponds remained hardwood dominated and did not return to Streamhead Pocosin after 40 years, but it is unclear when, or if, they became Sandhills Streamhead Swamp rather than remaining as the Sandhills Mire Subtype.

Comments: The vegetation of Coastal Plain Semipermanent Impoundment subtypes is not well studied. Very few CVS plots exist. Sites descriptions often do not document their vegetation in great detail. In addition, many examples are relatively new and were not present at the time of older site descriptions.

The classification of the Sandhills Marsh and Sandhills Mire subtypes needs further consideration and possible revision. The Sandhills Mire Subtype was based on quantitative data on drained ponds on Fort Bragg (Hall 2005), but comparable data are not available elsewhere in the Sandhills. There are believed to be significant floristic differences between the mires of Fort Bragg and ponds elsewhere, but the relationship between those floristic differences and the successional stages of drained ponds remains unclear. Accumulation of species lists for ponds in the Sandhills Game Land indicates that the floristic differences among these areas are not strong, and now appear to be less than the variation among ponds within each area. Since both early and late successional stages must occur in both places, the distinction needs to be clarified to be either a structural/successional one, or a more useful floristic split needs to be identified.

See the Typic Marsh Subtype and other subtypes for general comments and references on beaver ponds, landscape diversity, and ecosystem services. Because Sandhills beaver ponds accumulate more organic matter, and are less subject to erosion by severe floods, they may be even more important in sequestering carbon.

References:

Hall, S.P. 2005. A quantitative analysis and classification of the habitats of *Neonympha mitchelli francisci* at Fort Bragg and Camp Mackall. Report to Endangered Species Branch, Fort Bragg. Contract No. W912747–04-P0324.

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.

muhlenbergii, and *Rhynchospora macrostachya*. Most of the species listed above, especially those of highly acidic, bog-like environments, do not occur at all in the Typic Marsh Subtype. Species indicative of the Sandhills Mire Subtype include *Eriocaulon decangulare*, *Carex glaucescens*, *Carex howei*, *Carex atlantica*, numerous other *Carex* species, *Orontium aquaticum*, *Eupatorium resinosum*, *Lycopus cokeri*, *Xyris* spp., *Sphagnum* spp., and numerous others.

Synonyms: *Nyssa biflora - Alnus serrulata / Carex (mitchelliana, atlantica* ssp. *capillacea, stricta) - Glyceria obtusa - Peltandra virginica* Shrubland [Provisional] (CEGL004800).
Ecological Systems: Atlantic Coastal Plain Blackwater Stream Floodplain Forest (CES203.247).

Sites: The Sandhills Mire Subtype occurs on floodplains of streams in the Sandhills Region. This subtype typically occurs in the beds of ponds that have been drained for some years.

Soils: Typical soils of Sandhills streams are Bibb and Johnston (Typic Fluvaquent and Cumulic Humaquept). These soils are generally high in organic matter and are kept constantly saturated by the seepage of water from the adjacent porous soils. As such, they may be changed less by impoundment than most, but presumably become more anoxic. Over time, accumulated organic matter rather than transported mineral sediment tends to fill the Sandhills ponds.

Hydrology: The Sandhills Mire Subtype tends to be unflooded but permanently saturated. Minor stream flooding may occur but is rare.

Vegetation: Vegetation of the Sandhills Mire Subtype is an open woodland or shrubland with a well-developed herbaceous layer beneath. *Acer rubrum* and *Nyssa biflora* are the dominant trees, with the latter young or having survived through the life of the pond. Shrubs typically are *Alnus serrulata*, *Viburnum nudum*, *Cyrilla racemiflora*, and *Arundinaria tecta* but may also include *Clethra alnifolia*, *Lyonia lucida*, *Morella caroliniana*, and *Ilex glabra*. *Smilax laurifolia* and *Smilax walteri* are often present. The herb layer is dense to moderate. *Sphagnum* is often extensive. Herbs that are dominant or abundant fairly frequent (Hall 2005) include *Leersia oryzoides*, *Carex howei*, *Carex atlantica*, *Carex mitchelliana*, *Carex glaucescens*, *Carex lonchocarpa*, *Scirpus cyperinus*, *Glyceria obtusa*, *Dichanthelium scabriusculum*, and *Dichanthelium dichotomum* var. *dichotomum*. Other species less frequently abundant include *Dulichium arundinaceum*, *Carex stricta*, *Andropogon glomeratus*, *Rhynchospora stenophylla*, other *Rhynchospora* spp., *Peltandra virginica*, *Xyris fimbriata*, *Xyris iridifolia*, *Eriocaulon decangulare*, *Iris virginica*, and *Sparganium americanum*. Other fairly frequent species include *Orontium aquaticum*, *Eupatorium resinosum*, *Lycopus cokeri*, *Sarracenia flava*, *Drosera* spp., *Carex debilis*, and *Woodwardia virginica*. A great diversity of additional species occur in at least a few examples.

Range and Abundance: Ranked G2?. This community has only been documented on Fort Bragg, but may potentially be found anywhere in the Sandhills Region. Similar communities could possibly occur in South Carolina.

Associations and Patterns: It is common for beaver ponds of the Open Water Subtype and Sandhills Mire Subtype to occur interspersed with reaches of Sandhills Streamhead Swamp and Streamhead Pocosin along the streams. Ponds sometimes are single and sometimes are in complexes with multiple active and abandoned dams, with multiple patches of Open Water and

Sandhills Mire Subtype. But other ponds or complexes may consist entirely of the Sandhills Mire Subtype. They are often bordered by Streamhead Pocosin but can be bordered by upland communities.

Variation: Three variants are recognized, based on Hall (2005):
1. Typic Variant, which remains quite heterogeneous;
2. Bog Variant, which appears to occur where adjacent Sandhill Seeps feed acidic seepage water into the mire, and seep plants mix with those of the mire;
3. Tussock Sedge Variant, strongly dominated by *Carex stricta*, to the exclusion of most other herbaceous species.

Hall (2005) suggested recognition of several additional types, most of which are more similar to each other than are these. Also distinct in Hall (2005) were those dominated by *Dichanthelium scabriusculum* and *Dichanthelium dichotomum*, as opposed to the more typical mixed vegetation. These need more study but appear to result from excessive sediment washing into a drained pond, and so may not be a natural variant. The three variants appear to be very distinct, perhaps more than the Typic Variant is from the Sandhills Marsh Subtype, at least in flora.

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

The Sandhills Mire Subtype, as currently defined, appears to succeed from the Sandhills Marsh Subtype or from a bare drained pond bed that had been open water. This successional stage can last for several decades, until a tree canopy and shrub layer characteristic of other community types develops.

Lee Gerald (personal comm. 1990s) described the successional trend of Sandhills beaver ponds: Sphagnum comes in quickly in drained ponds, and sedge-grass vegetation develops on this. Shrubs and trees, especially *Acer rubrum, Alnus serrulata*, and *Cyrilla racemiflora,* invade the marsh over the space of 10-20 years, starting from the head of the pond and the edges. *Nyssa biflora*, persisting through the impoundment or newly established, along with *Acer rubrum*, tends to dominate the drained pond bed, with herbaceous cover beneath. This presumably represents the Sandhills Mire Subtype. Former ponds remained hardwood dominated and did not return to Streamhead Pocosin after 40 years, but it is unclear when, or if, they became Sandhills Streamhead Swamp rather than remaining as the Sandhills Mire Subtype.

Comments: The classification of the Sandhills Marsh and Sandhills Mire subtypes needs further consideration and possible revision. The Sandhills Mire Subtype was based on quantitative data on drained ponds on Fort Bragg (Hall 2005), but comparable data are not available elsewhere in the Sandhills. There were believed to be significant floristic differences between the mires of Fort Bragg and ponds elsewhere, but the relationship between those floristic differences and the successional stages of drained ponds remains unclear. Accumulation of species lists for ponds in the Sandhills Game Land indicates that the floristic differences between these areas are not strong and now appear to be less than the variation among ponds within each area. Since both early and late successional stages must occur in both places, the distinction needs to be clarified to be either a structural/successional one, or a more useful floristic split needs to be identified.

A different subtype name may be warranted. The term mire, implying an organic-soil wetland with flora of boggy character, applies well to both subtypes, perhaps better to the herbaceous, earlier successional subtype called Sandhills Marsh Subtype here.

See the Typic Marsh Subtype and other subtypes for general comments and references on beaver ponds, landscape diversity, and ecosystem services. Because Sandhills beaver ponds accumulate more organic matter, and are less subject to erosion by severe floods, they may be even more important in sequestering carbon.

References:

Hall, S.P. 2005. A quantitative analysis and classification of the habitats of *Neonympha mitchelli francisci* at Fort Bragg and Camp Mackall. Report to Endangered Species Branch, Fort Bragg. Contract No. W912747—04-P0324

COASTAL PLAIN SEMIPERMANENT IMPOUNDMENT (CYPRESS–GUM SUBTYPE)

Concept: Coastal Plain Semipermanent Impoundment communities are ponded wetlands produced by beaver dams or by long-established man-made dams that produce similar ponds. They include drained impoundments whose vegetation remains distinct from other floodplain communities. The Cypress–Gum Subtype covers portions or examples supporting a substantial canopy of *Taxodium* or *Nyssa*. These are generally remnant trees that established in a Cypress–Gum Swap, but under the right circumstances, a similar canopy can become established once a pond has formed.

Distinguishing Features: Coastal Plain Semipermanent Impoundment communities are distinguished by occurrence in the Coastal Plain in active or recently drained beaver ponds or in artificial ponds that have a similar environment and vegetation. It is not entirely clear what allows artificial ponds to resemble natural beaver ponds. Good mimics are usually old mill ponds that have long been unused. Larger reservoirs and smaller farm ponds do not seem to develop similar communities and have no natural community analogue.

The Cypress–Gum Subtype is distinguished from all other communities (except the Sandhills Mire Subtype) by a well-developed open or closed tree canopy, mostly of *Taxodium* or *Nyssa* in an active or recently drained impoundment. The conceptual boundary with other subtypes is placed at 50% canopy tree cover, since sparser trees may survive in any subtype. The Sandhills Mire Subtype, if it has a canopy, is distinguished by its distinctive well-developed herb layer of *Sphagnum* and herbs of highly acidic, organic soils.

Synonyms: *Taxodium distichum / Lemna minor* Forest (CEGL002420).
Ecological Systems: Atlantic Coastal Plain Small Brownwater River Floodplain Forest (CES203.250). Atlantic Coastal Plain Small Blackwater River Floodplain Forest (CES203.249). Atlantic Coastal Plain Brownwater Stream Floodplain Forest (CES203.248). Atlantic Coastal Plain Blackwater Stream Floodplain Forest (CES203.247).

Sites: Coastal Plain Semipermanent Impoundments occur on the floodplains of blackwater or brownwater streams or rivers, rarely on tidal creeks. Beavers prefer second order streams (Snodgrass 1997), but they can use smaller or larger streams. On large river floodplains, beavers dam sloughs, tributary streams, or drainages from backswamps. Old mill ponds that mimic beaver ponds tend to be on relatively small streams. While beavers strongly prefer low gradient streams, very few streams in the Coastal Plain have high enough gradients to deter them. The Cypress–Gum Subtype occurs in both active and abandoned ponds.

Soils: Coastal Plain Semipermanent Impoundments can occur on any floodplain soil, though impoundment presumably modifies the preexisting soil if the pond lasts very long. The still water allows deposition of clay or muck. This layer may persist even after the pond drains and is revegetated. 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 in floodplains might remain in place for centuries.

Hydrology: The Cypress–Gum Subtype may be permanently flooded or may be unflooded but permanently saturated. The water may be shallow or deep.

Vegetation: The Cypress–Gum Subtype is a closed forest or open woodland dominated by water-tolerant trees: *Taxodium distichum*, *Nyssa aquatica*, *Nyssa biflora*, or *Taxodium ascendens*. In most examples, in deep water, there is only a sparse understory and shrub layer, consisting of individuals rooted on stumps and tree bases. Examples in shallow water, and on edges, have more cover of other trees and shrubs. *Acer rubrum* var. *trilobum* is the most common tree, but *Fraxinus caroliniana*, *Ilex opaca*, *Magnolia virginiana*, and occasionally other species may occur. Shrubs include *Cephalanthus occidentalis*, *Alnus serrulata*, *Rosa palustris*, *Cyrilla racemiflora*, *Morella cerifera*, *Itea virginica*, *Ilex laevigata*, and a variety of other species. Herbs vary widely. Deep water areas often have high cover of *Lemna* and other tiny floating plants, or of *Utricularia* spp. Any of the floating-leaf or submersed plant species of the Open Water Subtype, such as *Nymphaea odorata* or *Brasenia schreberi*, may occur, though at lower density. *Limnobium spongia* is extensive in several examples. Characteristic herbs of tree bases and stumps, such as *Boehmeria cylindrica* or *Hypericum walteri*, are often present in low numbers. In shallow water examples and on edges, a great range of herbs may occur. Any of the species of the Typic Marsh Subtype may be present, but more shade-tolerant species such as *Saururus cernuus* and *Carex* spp. are most likely.

Range and Abundance: Ranked G4G5. This subtype occurs throughout the Coastal Plain, including, though less commonly, in the Sandhills region. It presumably occurs in South Carolina, and probably occurs with little difference in character over much of the Southeast.

Associations and Patterns: The Cypress–Gum Subtype can be a site-specific subtype, a temporal phase, or a zone within a pond complex. Some impoundments in flat swamps may have only this subtype, while in others it is a zone grading to the Open Water Subtype in deeper portions. In other cases, especially where formed by damming sloughs or the edges of backswamps in large river floodplains, it may occupy the deeper part of a pond where Cypress–Gum Swamp was already established, while the Typic Marsh or Open Water Subtype occurs on the edges that were occupied by less flood-tolerant trees.

Variation: The Cypress–Gum Subtype, as currently defined, is one of the most variable in the state, especially in differences among sites. The variation is not well studied, but two variants are proposed to reflect what likely are the most important differences:
1. Brownwater Variant occurs on brownwater and intermediate river floodplains. It has clayey soil, a canopy that includes *Nyssa aquatica*, and associated flora characteristic of brownwater swamps.
2. Blackwater Variant occurs in blackwater river and stream floodplains. It lacks *Nyssa aquatica* and has flora characteristic of more acidic, nutrient poor wetlands. Sandhills ponds, and those associated with peatlands, may be different enough to warrant an additional variant, with a component of pocosin shrubs.

The differences between shallow water and deepwater examples are also substantial, with primarily aquatic and tree-base flora in the latter and substantial herbaceous or shrub cover in the former. It may be worth distinguishing variants based on this, but it is not clear that the differences can be sorted out in a useful way. Variation should also be observed and characterized between

examples where the canopy trees are relict from a preimpoundment community and those where they were established in a long-lasting pond. These may have different dynamics.

The physical typology of beaver ponds and pond clusters described by Krues and Bason (2015) and summarized under the Open Water Subtype may be useful.

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

The Cypress–Gum Subtype may form quickly, as a relict community, by impoundment of an existing Cypress–Gum Swamp. Once ponded water is present, the change in the character of the herb and shrub layers probably happens in a few years. The composition and structure may continue to change slowly after that, as additional pond species disperse into the pond, and as the most susceptible trees gradually die. As long as deep water remains, the trend generally will be toward a more open canopy over time, as all but the shallowest examples are unlikely to see new establishment even of *Taxodium* or *Nyssa* seedlings. However, short-term draining, followed by rebuilding of the dam, could allow a cohort of trees to become established. Without new tree establishment, the Cypress–Gum Subtype might gradually succeed to the Open Water Subtype, but it is unclear if most beaver ponds last long enough for this to happen. This may be more likely in the deeper water in the middle of the larger mill ponds, which would place more stress on the established trees. Townsend and Butler (1996) noted that beavers did not cut *Nyssa* and *Taxodium*, and that they were more likely to build ponds where more preferred food trees dominated.

The Cypress–Gum Subtype can also develop as a secondary community, through establishment in open areas of an existing pond. This requires a temporary drawdown of water level to allow seedling establishment and is likely to result in an even-aged stand. It is unclear how common this is, but it may not be uncommon to have temporary dam breaches or drainage in both beaver ponds and mill ponds.

When a pond drains permanently, the Cypress–Gum Subtype may quickly succeed to Cypress–Gum Swamp, but this is not well known. If the soil is changed in character by deposition of clay or muck in the pond, the area may not return to the previous community for quite some time. In the Sandhills, the Sandhills Mire Subtype might develop from the Cypress–Gum Subtype as well as from the Sandhills Marsh Subtype. For secondary communities, the trees may have established on pond edges that did not previously support Cypress–Gum Swamp, but they may remain dominant for the rest of their life span.

Comments: See the Typic Marsh Subtype and other subtypes for general comments and references on beaver ponds, landscape diversity, and ecosystem services.

The Cypress–Gum Subtype is distinctive in that the flood tolerance of *Taxodium* and *Nyssa* allow them to persist for many years, creating a shaded pond environment with much structural diversity. They likely are particularly important for birds and other vertebrates. They may be good sites for colony-nesting birds such as herons.

The NVC association corresponding to this subtype is very broadly defined, probably too broadly. *Taxodium distichum* Semipermanently Flooded Woodland (CEGL004442), another association overlapping this concept, has been merged in the NVC. A Successional Subtype, included in earlier drafts of the 4th approximation but never incorporated into NVC, has been dropped. Successional ponds may be partially or fully drained and may be affected by the vegetation established before drainage. Zonal communities can also succeed to each other even if a pond is not drained. Since the subtypes are broadly defined and overlap the kinds of successional vegetation, it seems best to treat most successional ponds as parts of the other subtypes, at least for the present.

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.

Townsend, P.A., and D.R. Butler. 1996. Patterns of landscape use by beaver on the lower Roanoke River Floodplain, North Carolina. Physical Geography 17: 353-269.