National Park Service
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Northeast Region
Philadelphia, Pennsylvania

Conceptual Models and Recommendations for Monitoring Riparian Plant Communities within Riverine Parks of the Eastern Rivers and Mountains Network

Natural Resource Report NPS/NER/NRR—2010/023

ON THE COVER
A section of rapids along the New River Gorge National River in West Virginia.
Photograph by: Gregory Podniesinski.

Conceptual Models and Recommendations for Monitoring Riparian Plant Communities within Riverine Parks of the Eastern Rivers and Mountains Network

Natural Resource Report NPS/NER/NRR—2010/023

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Northeast Region
Philadelphia, Pennsylvania

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Executive Summary

The National Park Service Inventory and Monitoring Program within the Eastern Rivers and Mountains Network (ERMN) has identified a number of vital signs to monitor the health of terrestrial and aquatic systems. Riparian plant communities are one of fourteen vital signs identified by the ERMN for long-term ecological moniroting. The purpose of this report is to provide background information on these communities for the five riverine parks included within ERMN: Upper Delaware Scenic and Recreational River (UPDE), Delaware Water Gap National Recreational Area (DEWA), Bluestone National Scenic River (BLUE), Gauley River National Recreation Area (GARI), and New River Gorge National River (NERI), for use in developing a monitoring program for riparian plant communities.

This report describes the settings of the river systems and general principles affecting riparian community structure and function. In addition, conceptual models encompassing both the geomorphic settings of each system and associated plant communities are discussed. Based on the presented background information and conceptual models, recommendations for developing a monitoring program for riparian plant communities are included in the final section of this report. These recommendations include: designing a monitoring program that integrates size, condition, and context of rare plant communities too examine long-term vegetation trends, use of historical and current aerial imagery to assess vegetation dynamics over time, and the examination of interrelated vital signs and their influence on the distribution and overall health of riparian plant communities.

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Introduction

The National Park Service has been developing key elements, or "vital signs", for use in the long term monitoring of park natural resources. Vital signs are select physical, chemical, and biological elements and processes of park ecosystems that represent the overall health or condition of the park, known or hypothesized effects of stressors, or elements that have important human values (Marshall and Piekielek 2007). Park managers assess vital signs to understand the integrity of the park's natural resources and make appropriate management decisions regarding resources and the processes that influence such resources.

The National Park Service Inventory and Monitoring Program within the Eastern Rivers and Mountains Network (ERMN) has identified a number of vital signs to monitor the health of terrestrial and aquatic systems. Riparian plant communities are one of fourteen vital signs identified by the ERMN for long-term ecological monitoring. As a first step toward developing a monitoring program for these communities, the Western Pennsylvania Conservancy has developed conceptual ecological models of the plant communities within the five riverine parks of the ERMN: Upper Delaware Scenic and Recreational River (UPDE), Delaware Water Gap National Recreational Area (DEWA), Bluestone National Scenic River (BLUE), Gauley River National Recreation Area (GARI), and New River Gorge National River (NERI). This report will first describe the settings of the river systems and general principles affecting riparian communities and then present ecological models of plant community development and succession in different geomorphic settings.

The report concludes with recommendations for elements to be included in a monitoring program of riparian plant communities to better understand their current conditions and document how these conditions may change over time.

Settings for River Systems

Climate

The Delaware River basin experiences a humid continental climate characterized by large annual ranges in temperature and an even distribution of precipitation. Proximity to the Atlantic Ocean provides some additional moisture and increases precipitation (Rossi 1999). Annual precipitation generally exceeds 114 cm in the basin. The mean maximum January temperature for UPDE is 0°C or less and only slightly above 0°C for DEWA, which allows for significant accumulations of river ice in most years (U.S. NOAA 2002). Average snowfall in UPDE section is generally over 200 cm and varies from about 130 to 170 cm in DEWA. The accumulation of a snowpack, especially in the UPDE watershed, allows for late winter-early spring flooding due to sudden snowmelt combined with warm rain events. The Delaware River basin is also subject to extreme precipitation events associated with intense summer storm systems as well as tropical storm systems moving along the Atlantic coast.

The New, Bluestone, and Gauley river basins experience a humid continental climate characterized by large annual ranges in temperature and steady precipitation throughout the year. Average annual precipitation for the parks varies between 115 and 120 cm (U.S. NOAA 2002). The mean temperature is approximately -1.0°C in January. Average annual snowfall for this area varies from 40 to 50 cm. Tropical storms, seasonal thunderstorms, and melting snowpack can result in regional flooding events (Purvis et al. 2002). As a result of the rivers' climate, accumulations of river ice are rare in this system.

Geology

UPDE Geology

The bedrock geology underlying the Delaware River within UPDE and DEWA includes two different physiographic provinces, the Southern New York Section of the Appalachian Plateau and the Middle Section of the Ridge and Valley (Fenneman and Johnson 1946) (Figure 1). The UPDE portion (from Hancock, NY to Port Jervis, NY) lies entirely within the Southern New York Section of the Appalachian Plateau and is characterized by nearly horizontally bedded sandstone, siltstone, and shale of Upper Devonian age (Harrell through Spechty Kopf Formation). The formation gently dips to the northwest with occasional folds and little variation between the Pennsylvania and New York sides of the river. The plateau has been uplifted and subsequently dissected by the Delaware River and its tributaries. Bedrock jointing may contribute to north-south flowing streams having relatively straight, laterally offset segments (e.g., Lackawaxen Creek, perhaps the Delaware mainstem). Very limited bedrock geology information is available for this portion of the river, as the region has not received much attention from either PA or NY geologists.

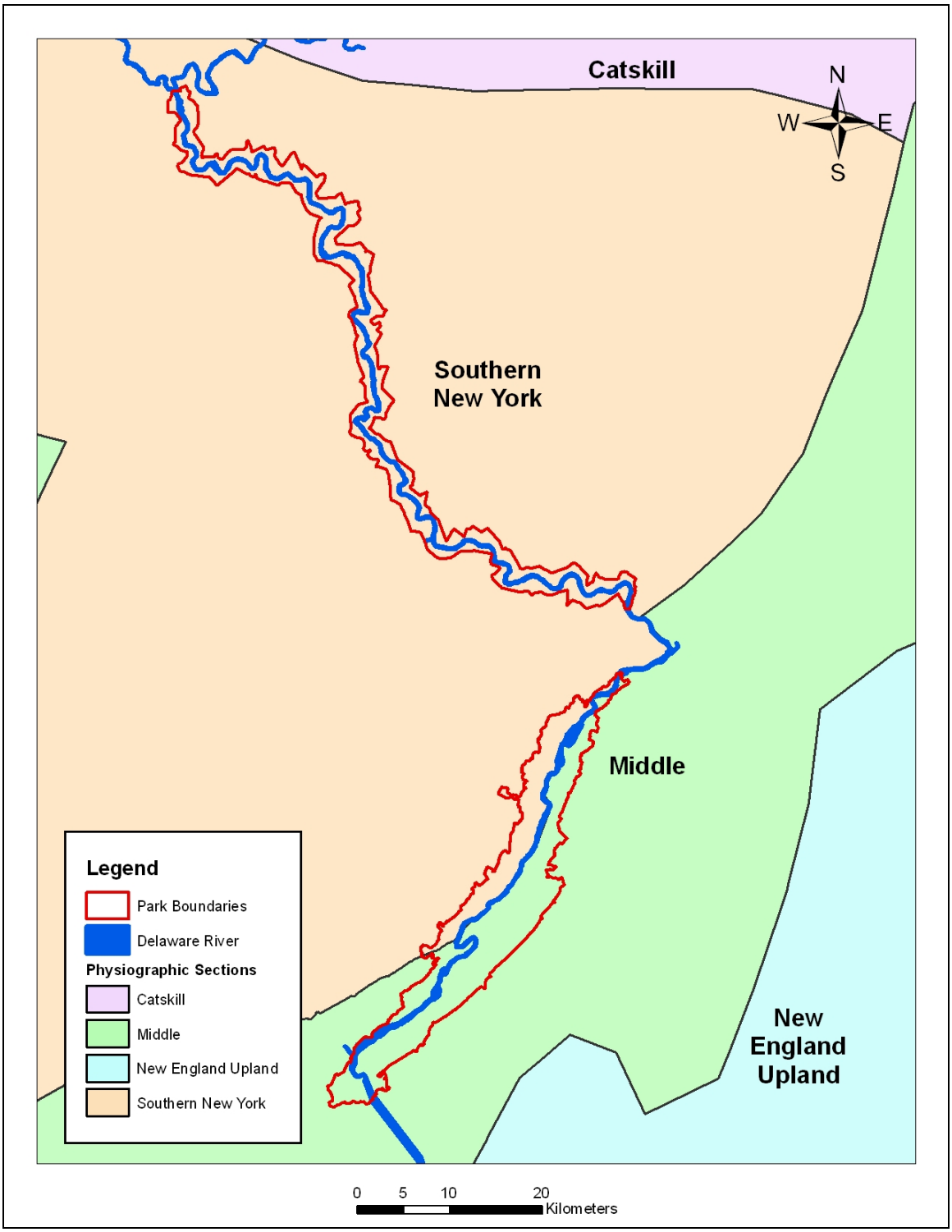

Figure 1. Physiographic provinces of UPDE and DEWA park units.

DEWA Geology

The structural geology of DEWA differs greatly among the sections of the physiographic provinces (Epstein 2001) (Figure 2). The bedrock of the Southern New York Section of the Appalachian Plateau Province dips gently to the northwest with occasional gentle folds. The bedrock consists of Middle and Upper Devonian age strata, including the Marcellus Formation (shale and shaly limestone), the Mahantango Formation (siltstone and silty shale), and the Trimmers Rock Formation (siltstone, shale, and fine-grained sandstone). The Marcellus Formation is limited to a narrow band near Bushkill Creek. The Mahantango Formation is the dominant formation within this section of the park and forms the rolling uplands as well as the steep cliffs and escarpments along the western edge of the Delaware River valley. The Trimmers Rock Formation is limited to the extreme western portion of the park and includes the upper portion of Dingmans Creek near Fulmers Falls.

Within the park, the Ridge and Valley Province consists of strongly folded Ordivician, Silurian, and Devonian age strata. The Ordivician stratum consists of slate and sandstone of the Martinsburg formation. This stratum is limited to the southwestern portion of the park near the Delaware Water Gap where it forms the lowest portion of the southeast facing slope of Kitattinny Mountain. Directly above and to the northwest of the Martinsburg Formation lies the Silurian Shawangunk Formation consisting of (from oldest to youngest): the Minsi Member (quartzite, conglomerate quartzite, and conglomerate), the Lizard Creek Member (thin to thick interbedded quartzite and argillite shale), and the Tammany Member (conglomerate and quartzite). The weather-resistant quartzite beds of the Shawangunk Formation form the ridge and cliffs associated with the Kitattinny Ridge and the Delaware Water Gap. Northwest of the Shawangunk Formation lies the Silurian Bloomsburg Red Beds which lie in the center of the Dunnfield Syncline (along Dunnfield Creek) near the Delaware Water Gap and along the northwest facing slope of most of the Kitattinny Ridge.

Northeast of the Walpack Ridge, the Bloomsburg Red Beds Formation extend from the toeslope of the Flat Brook floodplain to just below the summit of the Kitattinny Ridge (capped by the Shawangunk Formation). The Bloomsburg Red Beds Formation varies in composition from relatively weather-resistant silica-cemented sandstone and sandstone conglomerate to more easily weathered clayey sandstone, siltstone, and shale. Adjacent to the Bloomsburg Red Beds to the northwest are a series of Upper Silurian Formations (Decker, Bossardville Limestone, and Poxono Island Formations), which consist of limestone, dolomite, calcareous sandstones and shales, sandstone, siltstone and sandstone conglomerate. South of Walpack Bend, these formations form the southeast facing slope of the Delaware River valley (including The Hogback) until approximately Shawnee-on-Delaware. North of Walpack Bend, these formations trend to the northeast, forming the bottom of the Flat Brook valley and low rolling hills at the foot of the Kitattinny Ridge.

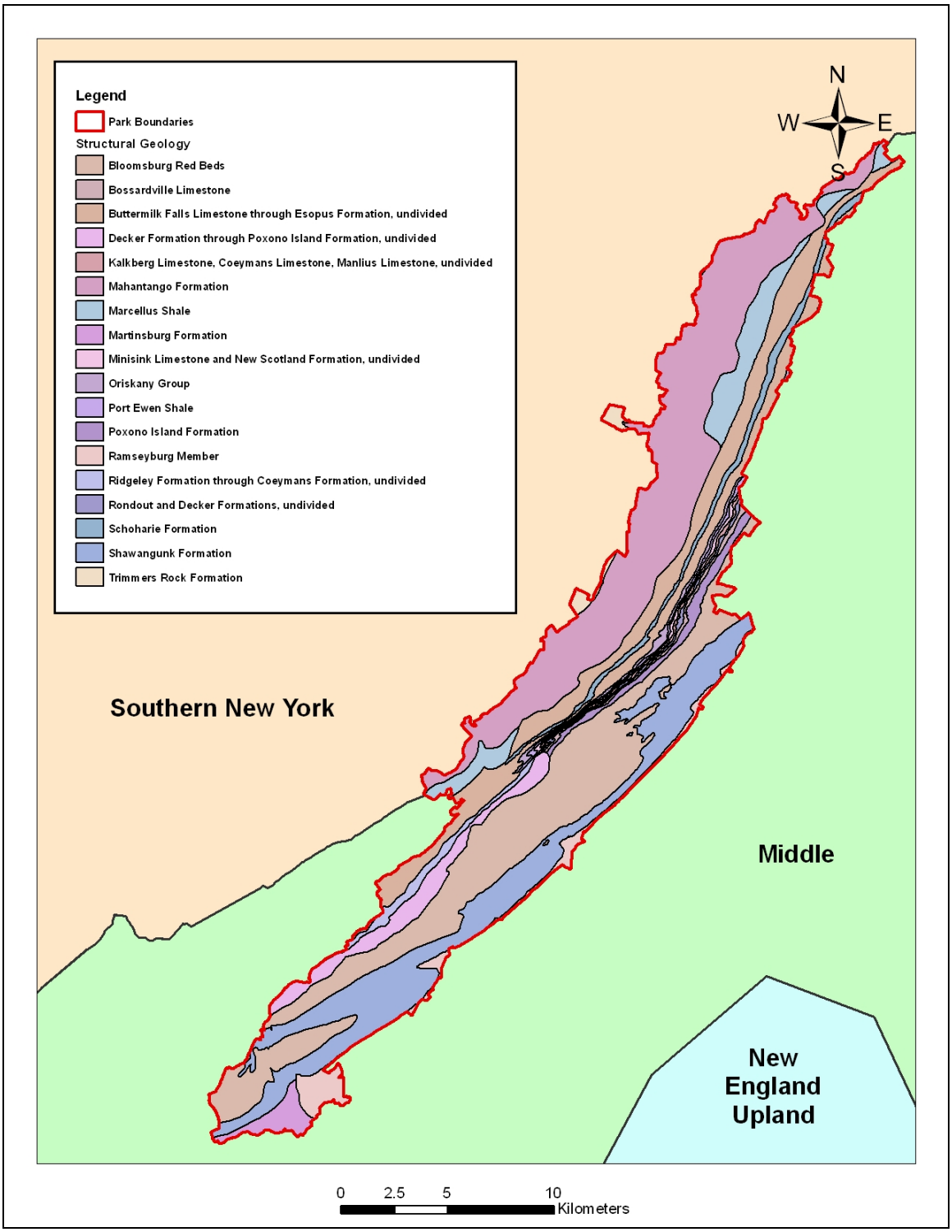

Figure 2. Physiographic province sections and structural geology of Delaware Water Gap National Recreation Area.

Parallel and to the northeast of the Upper Silurian Formations lie Lower Devonian bedrock consisting of six formations (Ridgely, Shriver Chert, Port Ewen Shale, Minisink Limestone, New Scotland, and Coeymans) mapped as one unit (Ridgeley through Coeymans Formations) (Figure 2). This unit is characterized by numerous alternating beds of limestone, calcareous shale, calcareous sandstone, and sandstone conglomerate. This unit extends approximately from north of Depue Island to the northeast through the ridge of the Hogback at Walpack Bend, eventually exiting the park near Peters Valley. Topography associated with the formation is low ridges and rolling hills. North of Walpack Bend this formation forms the northwest slope of Flat Brook valley. The furthest western unit of the Middle section of the Ridge and Valley Province consists of Lower to Middle Devonian bedrock of the Esopus (silty shale and siltstone), Schoharie (calcareous siltstone), and Buttermilk Falls (limestone) formations. The Buttermilk Falls formation is of particular interest, as it appears to be associated with several rare calcareous plant communities within the park (Arnot and Montague Fens, Montague Calcareous Riverside Seep, and Calcareous Riverside Outcrop). Northwest of this unit is the transition to the Southern New York section of the Appalachian Plateau Province, as indicated by the Devonian Age Marcellus Formation discussed above. The Ordivician Age Martinsburg Shale, which occurs south of Kitattinny Ridge and the Delaware Water Gap, is relatively flat to gently rolling terrain.

Blue-New-Gauley River System Geology Overview

The bedrock geology underlying BLUE, GARI, and NERI is found within the Kanawha section of the Appalachian Plateau (Fenneman and Johnson 1946). The bedrock is typically composed of sedimentary rocks such as shale, sandstone, or a combination of both. The bedrock within the parks consists of the Mauch Chunk (Late Mississippian age) or the more resistant Pottsville (Pennsylvanian age) groups. The younger Pottsville sediments sit unconformably on top of the Mauch Chunk (Cardwell 1975). The Mauch Chunk group is more exposed in the southern portions of the parks due to the geomorphic history of the New River and is divided into four formations (from oldest to youngest): the Bluefield, Hinton, Princeton, and Bluestone. The Pottsville group is divided into three formations (from oldest to youngest): Pocahontas, New River, and Kanawha.

BLUE Geology

BLUE is characterized by formations of the Mauch Chunk group (Figure 3). The underlying bedrock is predominately sandstone and shale with scattered thin coal deposits and is comprised of the Hinton, Princeton, and Bluestone formations of the Mauch Chunk group. The older Hinton formation is the predominant formation in the park and forms the valley floor and most gorge slopes. Thin argillaceous limestone can be present in the Hinton formation (Cardwell 1975). As a result, the soils tend to be more calcareous and the herbaceous flora generally richer and more diverse in BLUE compared to NERI and GARI. This formation tends to follow the course of BLUE as it flows into NERI. Exposure of the Hinton formation reflects downcutting of the river through the upper formations.

GARI Geology

GARI is characterized by sandstone of the Kanawha and New River formations (Figure 4). The Gauley River cuts down into the New River formation while the plateaus above are underlain by

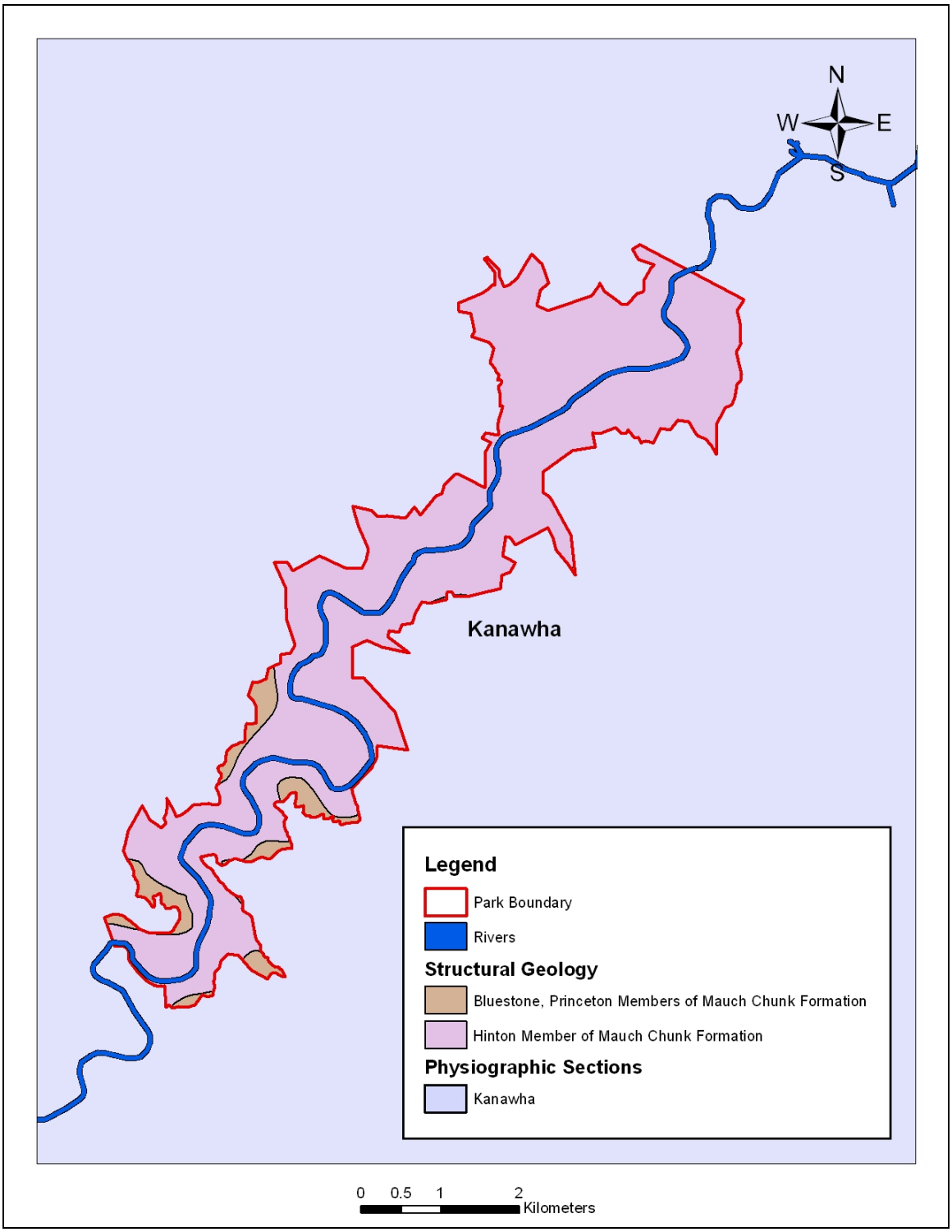

Figure 3. Physiographic province sections and structural geology of the Bluestone National Scenic River.

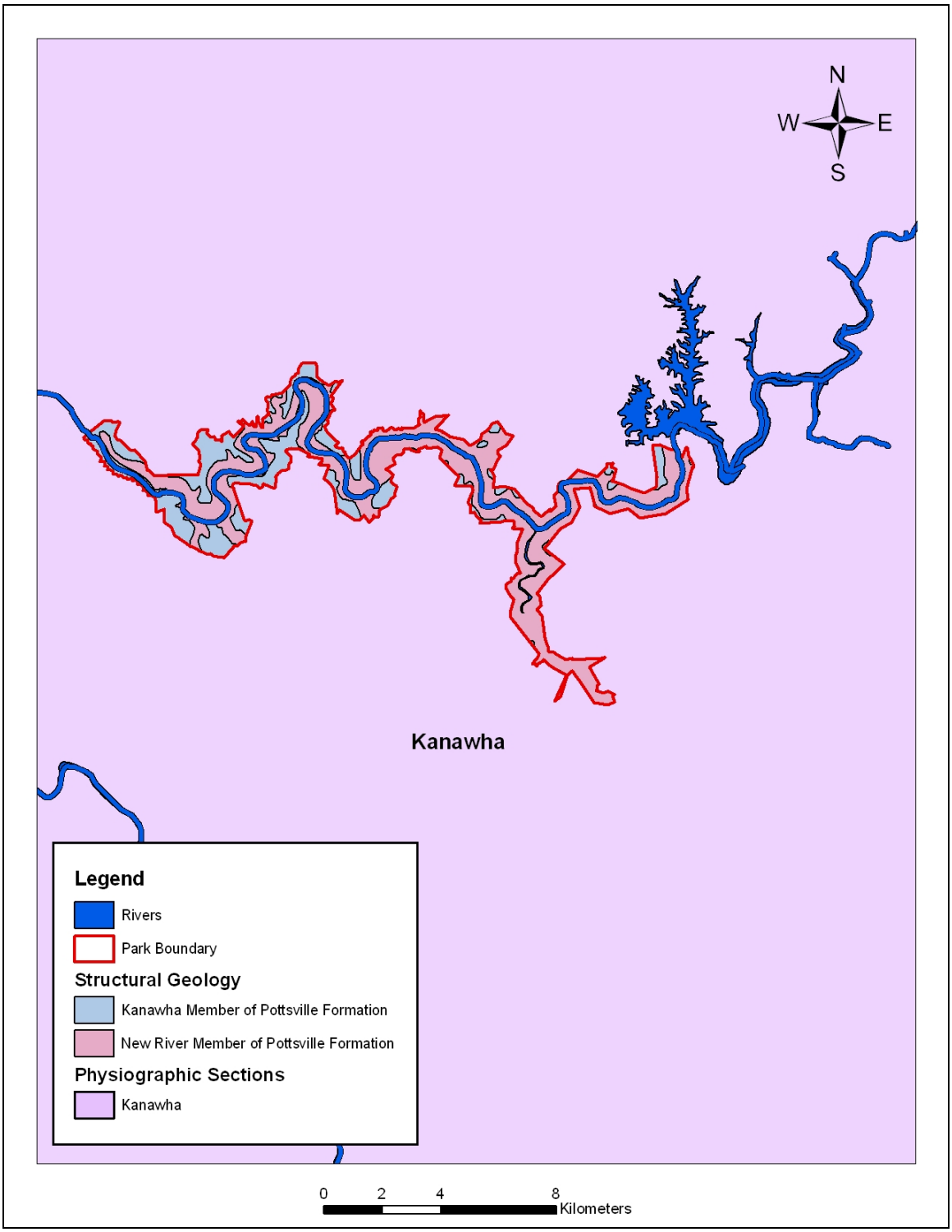

Figure 4. Physiographic province sections and structural geology of the Gauley River National Recreation Area.

the Kanawha formation. The flow of the river against the resistant Pottsville formations has resulted in deep entrenchment of the river system. Entrenchment of the stream and subsequent exposure of the New River formation decreases as the Gauley River leaves the recreational area boundaries.

NERI Geology

NERI is underlain by formations of both the Mauch Chunk and Pottsville groups (Figure 5). The bedrock is primarily dominated by the Mauch Chunk group in the south with the New River cutting down to the Hinton and Princeton formations in the southern two-thirds of the park until it reaches Thurmond. Brooks Falls and Sandstone Falls, in the southern section of the park, are formed from resistant sandstone outcrops of the Stoney Gap member of the Hinton formation. From Thurmond until the northern boundary of the park, except for Surprise Rapids and Manns Creek, the river cuts into the Pocahontas formation of the Pottsville group with the plateau above mainly underlain by the New River formation. Surprise Rapids and Manns Creek both channel into the Bluestone and Princeton members of the Mauch Chunk group. The formations of the Pottsville group are dominated by sandstone, shale, and coal with some siltstone intermixed (Cardwell 1975).

Topography

UPDE and DEWA Topography

The topography of UPDE section of the Delaware River reflects down-cutting into the Glaciated Low Plateau Section of the Appalachian Plateau, resulting in low mountains with steep tributary drainages flowing to the river. While the bedrock dips to the northwest, the elevation of the plateau decreases to the southeast. Plateau elevation near Hancock is approximately 560 m, 455 m near Callicoon, and 335 m near Millrift (southern terminus of UPDE). The Delaware River at Hancock lies at 274 m, 225 m at Callicoon, and 134 m at Millrift. The average gradient is approximately 1.2 m/km.

Topography varies widely within DEWA. This is illustrated most dramatically at the Delaware Water Gap where the Delaware River (elevation 90 m) cuts through the Kitattinny Ridge creating spectacular views from Mt. Tammany (470 m) and Mt. Minsi (445 m). The elevation of the Delaware River floodplain decreases as the river runs through the park, from approximately 120 m at Mashipacong Island at the park's northern boundary to approximately 90 m at Arrow Island, just south of the Delaware Water Gap. The average gradient is approximately 0.5 m/km. The height of Kitattinny Ridge varies between 425 m and 487 m with one of the highest points occurring north of Crater Lake at 490 m. The Hogback and Walpack Ridge run through the central portion of the park with heights varying from 210m to 365 m. The plateau of the Glaciated Low Plateau sits at approximately 245 m to 290 m, although elevation along the plateau can vary from 210 m to 320 m. The northeast portion of the park in New Jersey gently rises from the Delaware River floodplain at 120 m to approximately 245 m at the park's eastern boundary. The valleys surrounding Flat Brook and Bushkill Creek occur at approximately 245 m in elevation.

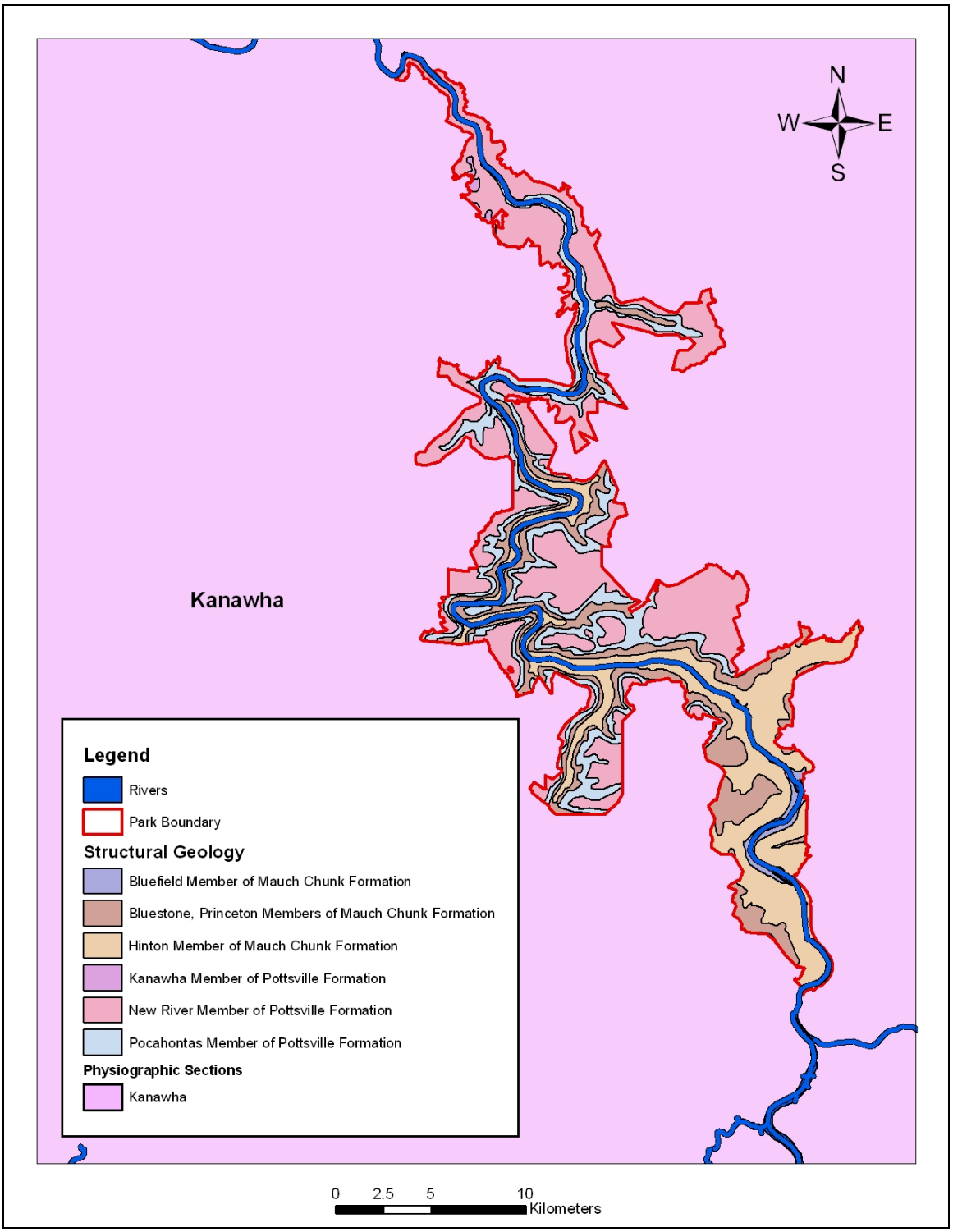

Figure 5. Physiographic province sections and structural geology of New River Gorge National River.

Blue-New-Gauley River Systems Topography

The topography of BLUE, GARI, and NERI all reflect the geomorphic history of the river system. By the end of the Cenozoic era, the ancient mountain ranges formed by tectonic collisions to the east had worn away through erosion. The region became a gently sloping coastal plain, draining to the northwest and traversed by slow-moving meandering streams. In the early Tertiary period, about 50 million years ago, the entire eastern margin of North America ws uplifted as much as 2,000 m and tilted gently westward. This rejuvenated the streams, which began to rapidly downcut valleys into the newly elevated landscape. This downcutting has produced, and continues to produce, the topography of West Virginia (Van Gundy 2000). Near the northern boundaries of the Blue-New-Gauley river systems, the resistant Pottsville formations rapidly dip to the northwest therefore reducing heavy entrenchment. This is evident where the Gauley and the New River converge into the Kanahwa River as the steep cliff topography disappears and the floodplain widens (Fridley 1950).

BLUE is characterized by steep cliffs and a steep river gradient. The average elevation of plateaus in BLUE is approximately 680 m at both ends of the park. The elevation of the Bluestone River is approximately 490 m near the park's southern border and 436 m near the Bluestone Dam. The average gradient from the plateau to the river's edge is 50% resulting in steep slopes with maximum inclines of 200% in some areas. However, slopes tend to lessen near the floodplain near the Bluestone Dam. The average gradient of the Bluestone River through the park is 3.1 m/km.

The topography of GARI is characterized by steep sloping cliffs and a steep river gradient. The average elevation of the plateau within GARI ranges from 500 m near Gauley Bridge to 520 m near Summersville Dam. The average elevation of the Gauley River ranges from 195 m near the Gauley Bridge to 414.5 m near the Summersville Dam. In contrast, water within the Summersville Dam is approximately 520 m in elevation at full capacity. The average gradient from the plateau to the river is approximately 80%, resulting in a steep narrow gorge with several cliff bands. However, the slope decreases to approximately 50% towards the western boundary of GARI before the Gauley River converges with the New River. The average gradient of the Gauley River within GARI is 5.5 m/km, which accounts for the fast-paced current of the river.

NERI is characterized by a steep gorge with decreasing slopes (plateaus) towards the edges of the park. The general slope of the park is north to northwest facing. The elevation of the plateau within NERI is approximately 930 m at Hinton, 560 m at Oak Hill, and 470 m at Fayetteville. Approximate elevation of the New River within the NERI is 402 m at Hinton, 304 m at Oak Hill, and 250 m at Fayetteville. The average slope from the plateau to the river's edge is 40% at Hinton, 70% at Oakhill, and 50% at Fayetteville. The river gorge is narrow in areas where the river cuts through the more resistant Pottsville formations (north of Thurmond) and wider where the Mauch Chunk is exposed (south of Thurmond) (Vanderhorst et al. 2007). The average gradient of the New River within NERI is 1.9 m/km with steeper gradients located throughout.

Hydrology

Delaware River Hydrology

The Delaware River is the longest free-flowing river east of the Mississippi, extending 531 km from the confluence of its east and west branches at Hancock, NY to the mouth of the Delaware Bay and is fed by over 200 tributaries. The drainage basin covers 35,066 km^2, draining parts of Pennsylvania (16,633 km^2 or 50.3% of the basin's total land area); New Jersey (7,690 km^2, 23.3%); New York (6,118 km^2, 18.5%); and Delaware (2,600 km^2, 7.9%).

In Pennsylvania, many of the tributaries flow off of the Glaciated Low Plateau, through steep ravines that are often dominated by eastern hemlocks (*Tsuga canadensis*), and contain waterfalls of various heights. The larger and most important of these streams are, from north to south, Equinunk Creek, Lackawaxen River, Raymondskill Creek, Adams Creek, Dingmans Creek, and Toms Creek. The Big Bushkill Creek, a major Pennsylvania tributary, is joined by Little Bushkill Creek before it enters the Delaware River just upstream of the Hogback. Three additional tributaries, Brodhead Creek, Cherry Creek, and Caledonia Creek, enter the Delaware River just upstream from the Delaware Water Gap. In New York, important tributaries include the east and west branches of the Delaware River at Hancock and the Neversink River, just below Port Jervis. In New Jersey, from Port Jervis to the Delaware Water Gap, significant tributaries include the Flat Brook (entering at the Hogback) and the Vancampens Brook (entering near Poxono Island).

Blue-New-Gauley River Systems Hydrology

The Bluestone River spans the southern portions of Virginia and West Virginia and is a tributary of the larger New River. The Bluestone River is approximately 126km long with its headwaters originating in Virginia and flowing northeasterly through West Virginia until its confluence with the New River. The river joins the New River near Hinton, WV, at Bluestone Lake, an artificial lake created by an U.S. Army Corp of Engineers dam impoundment of the Bluestone River. The drainage basin of the Bluestone River covers 1,190 km^2 (Purvis et al. 2002). Simmons Creek, Flipping Creek, Crane Creek, Widemouth Creek, Rich Creek, Bush Creek, Little Bluestone River, Mountain Creek and Indian Branch are the major tributaries of the Bluestone River. Little Bluestone River, Mountain Creek, and Indian Branch are located within BLUE whereas the others listed are outside of the park.

The Gauley River is approximately 172 km long and flows southwesterly/westerly from Pocahontas County, WV to its confluence with the New River to form the Kanahwa River. The watershed of the Gauley River is approximately 3,683 km^2 (Purvis et al. 2002). Several major tributaries of the Gauley include the Williams River, Cherry River, Cranberry River, Hominy Creek, Peters Creek, and Meadow River as well as some smaller tributaries. Peters Creek and Meadow River are the only unregulated major tributaries that flow into GARI. The steep gradient of the river and resistance from the underlying bedrock produces approximately 30 rapids, nine of which are classified as Class V or above.

The New River is 515 km long and begins with its headwaters in North Carolina, fed by the South Fork New River and North Fork New River. The greater Kanahwa-New River drainage

basin comprises 7,884 km^2 in Virginia, 1,958 km^2 in North Carolina and 21,818 km^2 in West Virginia (Purvis et al. 2002). Major tributaries include the Bluestone River (upstream of the Bluestone Dam) and the unregulated Greenbrier River (downstream from the Bluestone Dam), both of which feed into the New River. Other major tributaries within the park include Laurel Creek, Meadow Creek, Glade Creek, Piney Creek, Dowdy Creek, Dunloup Creek, Manns Creek, and Wolf Creek. The New River confluences with the Gauley River at Gauley Bridge, WV, to form the Kanahwa River. Approximately 33 rapids exist along the river, of which half are considered Class III or above.

Dams

UPDE Dams

While the main stem is free-flowing, there are a number of dams in the drainage, with the most important being the three dams on the tributaries of the upper Delaware River: Cannonsville Dam on the West Branch (1,175.6 km^2 watershed, capacity 369.1 million m^3), Pepacton Reservoir (963.5 km^2, capacity 530.7 million m^3) and the Neversink Reservoir (239.6 km^2 watershed, capacity 132.1 million m^3). The dams were installed and became operational over a period of ten years (Neversink Dam built 1953, Pepacton Dam built 1954, and Cannonsville Dam built 1963). These dams were constructed primarily to provide water to the New York City region, and in conjunction with other smaller reservoirs in the basin provide drinking water to five percent of the United States population (despite a watershed that covers less than 0.4% of the continental U.S.) (DRBC Website, http://www.state.nj.us/drbc/thedrb.htm). The impact of the dams on the natural pattern of flow in the river has been significant, especially in the upper portion of the river, below Hancock, where the combined effects of the Pepacton and the Cannonsville dams are the greatest. The general effect of regulated dams on riparian vegetation is to attenuate flood flows, with decreased flow velocity and scouring and increased flood duration (but at lower river stage). Related geomorphic processes, including the erosion, transport, and deposition of sediment, are altered. Preliminary review of aerial imagery from 1938 to 2003 indicates very little physical changes in most islands and tributary mouth bars in the study area. Interestingly, extreme flood events in 2004–2006 were only slightly attenuated by the reservoirs, with significant sediment movement and channel modification in some portions of the river. The main channel was not significantly affected, but many islands and bars were either reshaped or their elevation altered by erosion and sedimentation.

Blue-New-Gauley River Systems Dams

Two West Virginia dams, the Bluestone Dam and the Summersville Dam, directly regulate the flow of the Bluestone River, New River, and Gauley River. The Bluestone Dam (11,823 km^2 watershed) is located on the New River at Hinton, WV and affects flow of the Bluestone River and the New River. This large concrete gravity dam was constructed in the 1940s by the U.S. Army Corp of Engineers for flood control and was designed to provide natural flow from the Bluestone River to the New River (Purvis et al. 2002). Construction of the dam resulted in the formation of Bluestone Lake. Although BLUE is a designated National Scenic River, the Bluestone River is not entirely free flowing within the park. Occasional flooding by reservoir backup from Bluestone Lake affects the lower reaches of BLUE (most evident below the

confluence of the Bluestone River with the Little Bluestone River). Currently, the dam serves to meet the needs of flatwater recreation.

The Summersville Dam is a rock-fill dam that impounds the Gauley River to form the Summersville Lake (Purvis et al. 2002). The dam was built in 1966 for flood control, low water augmentation, and for recreational use. In 2001, the dam was converted to hydro-electrical power and, as a result, reduces the flow variability in the Gauley River (Purvis et al. 2002). Given that both dams are bottom release dams, colder water is discharged, which lowers downstream water temperatures. Currently, the dam serves to meet the needs of whitewater recreation.

Geomorphology

The close link between geomorphology and the distribution and structure of riparian vegetation requires a review of the geomorphic features common to the study areas.

Delaware River System

The middle Delaware River (from the Delaware Water Gap to Hancock NY) is an alluvial upland river system of straightened-confined meandering character (Type B according to Rosgen 1994) with a pluvio-nivial flow regime (i.e., high flows related to rain and snow melt in the fall and spring, and low flow in the summer (Parde 1968; Parasiewicz 2001). Based on Rosgen's stream classification system (Rosgen 1994), this portion of the river would vary between 2B/1C. Such stream types are bedrock and boulder controlled, have moderate entrenchment and produce series of extensive rapids. The Delaware River in general occurs in a glaciated U-shaped valley or a Type V valley on Rosgen's classification (1994).

Longitudinally, the upper Delaware section from Hancock to Port Jervis is confined in a very narrow valley with limited capacity for riverbed meandering and the formation of geomorphic features such as point bars. The overall width of the valley bottom (including the river) is seldom much wider than 500 m. Aside from some channel braiding near Hancock where the east and west branches meet and near Callicoon, the rest of the river down to Port Jervis (about 122 km) contains about ten large islands (roughly 300 to 1,000 m long, 80 to 200 m wide) and 20 low cobble-gravel islands/bars. Islands over 500 m long generally have elevated sections that support riparian forests. Islands less than 500 m long and cobble-gravel bars support riparian shrubland and herbaceous vegetation. The channel bed is primarily free stone cobbles and boulders, and typically confined on one or both sides by bedrock. Sand and finer deposits are limited in extent and occur below bends and constrictions in the river along slackwater sections of shoreline. Sand and sandy loam deposits may also occur on the higher elevations of islands and downstream from obstructions (e.g., coarse woody debris) where the flood currents are slower. Instream sand bars are very rare. The shoreline, in confined reaches, is very narrow (often less than 30–50 m wide) and characterized by scoured cobbles, gravel, and a concave slope that terminates abruptly into upland forest. Where the valley bottom is wider, one or both sides of the river are bounded by glacial deposits, forming high terraces that appear to seldom flood. Between the river and this terrace, the riparian zone may consist of a gently sloping gravel, cobble, and sand flat, with an abrupt bank where it meets the glacial fill terrace.

At several locations on the UPDE section, bedrock is exposed in the riparian zone, with notable examples at Skinner's Falls and near Narrowsburg. At Skinner's Falls, the exposed bedrock zone is 10 to 20 m wide, while near Narrowsburg the bedrock presents a more vertical rock face with the occasional narrow ledge (generally less than 5 m wide) that dips to the north or northwest. Rock outcrops also occur periodically downstream below Narrowsburg. Rocks outcrops in UPDE are typically resistant sandstones.

DEWA portion of the study area has distinct geomorphic sections. This section of the river would be considered a 3B/4B based on Rosgen's classification. Such stream types would be cobble and gravel controlled, have moderate entrenchment, and have a moderate to high width/depth ratio. From approximately Milford to the Hogback (near Bushkill), the river runs through the Minisink Valley. The Delaware River valley is at its widest here, varying from 1,000 to nearly 1,400 m wide. The river valley becomes constricted (approximately 200 m wide) as it runs through the Hogback Ridge. From Hogback Ridge to the Delaware Water Gap, the river valley widens again to about 600 to 900 m wide with a number of large islands. At the Delaware Water Gap, the river constricts again, with a width of 100–200 m and very little riparian vegetation. The park terminates just below the Water Gap at Arrow Island. DEWA section contains approximately 19 large islands (roughly 300 to 2,700 m long, 70 to 75 m wide) and 16–20 low cobble-gravel bars. Between Milford and the Hogback, the islands are similar in appearance to those in the UPDE as described above. Below the Hogback, the river gradient decreases to about 0.3 m/km, and a number of the larger islands typically have one or two terraces with loamy to sandy loam alluvial soils. These terraces generally support larger and more mature Silver Maple Floodplain Forests than islands above the Hogback. Presumably the lower gradient in this reach has allowed the accumulation of fines (sand, silt and clay) on the island floodplain terraces. Many of the larger islands also have one or more cross channels.

As in UPDE, DEWA portion of the river appears to lack well-developed point bar features. Although the Minisink Valley portion is up to 1,400 m wide and lies over glacial deposits, archeological evidence suggests that the river's course has shifted little in the past 6,000 years (Ritter et al. 1973). Below the Minisink Valley, from the Hogback to the Delaware Water Gap, the river is confined by the geologic formations of the Ridge and Valley Province with little opportunity for meander development.

Bedrock outcrops in DEWA section include limestone outcrops near Montague and sandstone outcrops near the Delaware Water Gap. The bedrock typically dips steeply to the northwest, with the bedrock exposures also being steeply angled toward the river and having limited lateral extent before transitioning into upland vegetation (generally less than 5 to 10 m wide).

Blue-New-Gauley River Systems

The Bluestone, Gauley, and New rivers all flow through a combination of Type I and II valleys (Rosgen 1994). Type I valleys are V notched canyons with steep relief while Type II valleys are colluvial valleys with moderate relief. The course of the rivers tends to alternate between these valley types within each park. The valleys of these systems are all V-shaped with BLUE and GARI being more constrained than NERI.

Several geomorphic features define BLUE. The Bluestone River within BLUE is a 2B/2C type stream according to Rosgen (1994). Type 2B/2C streams are moderately entrenched, boulder controlled, and have moderate width/depth ratios. The overall width of the valley (including the Bluestone River) is seldom wider then 200 m, which constrains the flow of the system resulting in high-energy flows through a meandering river channel. Straight sections of BLUE are dominated mostly by scour shorelines with some low floodplains and floodplain terraces. Due to the meandering nature of the Bluestone River, point bars have developed on the inside bends of the river. No significant islands occur in BLUE.

GARI contains various geomorphic features but is dominated by scour shoreline. The Gauley River is considered a 2B/1C type stream (Rosgen 1994; Bennett and McDonald 2006). Type 2B/1C streams are moderately entrenched streams with moderate width/depth ratios characterized by boulder and bedrock features that produce extensive series of rapids. The overall width of the valley (including the Gauley River) is seldom over 100 m wide, which contributes greatly to the high energy of the flow regime. The dominant geomorphic feature for GARI is river scour shorelines. The scour shorelines tend to be very narrow, often only a few meters wide, and are flooded frequently. In addition, GARI has few small islands and eight point bars. Islands present are mostly boulder piles with sparse vegetation. Point bars are found on the inside edge of river bends where the slower moving backflow deposits cobbles and material. There were also a few instances of exposed bedrock, which is subjected to flooding. The exposed bedrock, or flatrock, is composed of the resistant Pottsville sandstone.

NERI is dominated by scour shoreline, sloping shorelines and point bar geomorphic features. The New River within NERI could be considered a 1C/2C type using the Rosgen classification (Rosgen 1994). Such stream types are bedrock and boulder controlled, moderately entrenched, produce extensive rapids, and have a moderate to high width/depth ratio. The overall width of the valley (including the New River) is seldom wider than 350–400 m. There is substantial scour and sloping shorelines that tend to follow the straight portions of the river. There are several point bar features that tend to develop on the inner curve of river bends. There are a few islands; one large, high terraced island near Brooks Falls and several smaller, low terraced islands scattered throughout.

Riparian Ecosystems

Riparian ecosystems occupy the ecotone between upland and aquatic systems. The riparian ecosystem can be defined as the stream channel between the low- and high-water marks plus the terrestrial vegetation above the high-water mark that may be influenced by extreme flood events (Naiman et al. 1993; Nilsson and Berggren 2000).

Ecological processes at play affect species composition directly or indirectly through the influence of flooding on physiological and physical stresses. Ice scour also contributes to the physiological and physical stress of plant communities but is limited only to the Delaware River since ice formation does not occur on the Blue-New-Gauley river systems. (Note: the discussion of ice scour effects in the following sections applies only to the Delaware River riparian communities).

Life History Strategies

Life history strategies are the means by which organisms carry out the functions necessary for survival and reproduction. In riparian communities, the temporal and spatial heterogeneity of available habitat allows for nearly every conceivable variation in life history strategies (Toner and Keddy 1997; Decocq 2002; Lamb and Mallik 2003; Turner et al. 2004; Karaus et al. 2005). Heterogeneity in the riparian environment reflects the underlying geology, climate, hydrology, natural disturbances, and life history traits of riparian species (Naiman et al. 2005). Spatial heterogeneity is responsible for a wide variation of habitats present on the Delaware River and the Blue-New-Gauley river system, including scoured bedrock outcrops, point bars, island heads and riffle zones, quiet floodplain pools and back channels, low and mid-elevation floodplain terraces and levees. Temporal heterogeneity includes seasonal variations in flow and water quality, storm events, and vegetation succession (from seasonal to decadal time frames). Life history strategies also reflect adaptation to habitat predictability (or lack thereof). In general, the interaction of spatial and temporal variability controls the degree of predictability in site conditions. For example, water-willow (*Justicia americana*) beds are typically the lowest elevation riparian community and are routinely and predictably subjected to high velocity flows (the Delaware River and the Blue-New-Gauley river system) and ice scouring in winter (limited to the Delaware River only). At the opposite end of the elevation gradient on the Delaware River, the Sugar Maple Floodplain Forest is “predictably” subject to infrequent, short-duration flood events. An example of a higher elevation floodplain community on the Blue-New-Gauley river system is the Oak-Tuliptree/Mountain Silverbell Floodplain Forest found along NERI. This community is subject to low frequency and low energy flooding as evidenced by the development of litter layers and organic-enriched soils (Vanderhorst et al. 2007).

Morphological and Physiological Adaptations of Riparian Plants

Life history strategies of riparian plants typically include adaptations to the riparian environment. Riparian plants can be assigned to one or more of four general classes reflecting functional adaptations for colonization and establishment (after Naiman et al. 2005):

Invader: Produces large numbers of wind and water-dispersed propagules then colonizes alluvial substrates.

Endurer: Resprouts after breakage or burial of either the stem or roots from floods or partial herbivory.

Resister: Withstands flooding for weeks during the growing season; also withstands moderate fires or disease epidemics.

Avoider: Lacks adaptations to specific disturbance types; individuals that germinate in an unfavorable habitat do not survive.

On the Delaware River and the Blue-New-Gauley river system, woody plants typical of the lower active riparian zone often exhibit more than one of the above life history strategies and are often a function of local site conditions. For example, river birch (*Betula nigra*) produces large numbers of seeds that are dispersed by the wind or carried by water to bare alluvial soils (invader). River birch typically occur on island heads and scoured shorelines where they may be subjected to regular ice and flood scour (endurer) and can tolerate flooding for extended periods during the growing season (resister). In contrast, woody plants typical of the higher terraces, occur in microhabitats where stresses are limited (avoiders). Sugar maple (*Acer saccharum*) and bitternut hickory (*Carya cordiformis*) are examples of this on the Delaware. These two trees tend to occur on higher floodplain terraces or higher portions of islands where physical stress (e.g., scour, breakage, burial in sediments) and flood stress (anaerobic soil conditions) are limited. On the Blue-New-Gauley river system, eastern hemlock (*Tsuga canadensis*) is another example of an avoider species. Similar to the avoider species found on the Delaware, hemlock is usually limited to higher terraces where the exposure to physical stress and flooding is reduced.

Morphological adaptations of plants to the riparian environment reflect responses to anaerobic soil conditions, unstable substrate, and reproductive strategies. Flooded soils have greatly reduced available oxygen, which is rapidly depleted by the metabolic demand of soil flora and fauna. Many riparian plants (e.g., many sedges and rushes) have adaptations to anoxic soil conditions including aerenchyma tissue with airspaces for the diffusion of oxygen from upper (aerated) to lower (anoxic) portions of the plant. Plants may also form adventitious roots to enhance oxygen diffusion above the anoxic zone. However, flooding of well-drained alluvial soils during the late-fall to early spring months on the Delaware River may not result in anoxic soil conditions, due in part to the low metabolic soil activity at low temperatures and the coarse nature of many alluvial soils that allows for water movement in and out of riparian soils (rheotrophic flow) before becoming anoxic.

The abrasion of plants by suspended sediment and debris and the erosion of soils during flood events also create important stresses on riparian vegetation. Vegetation occurring in the active flood zone of the Delaware River and the Blue-New-Gauley river system typically experiences a wide variation in flow. An important factor in plant survival, particularly in woody plants, is stem flexibility. Flood flows can produce a tremendous shear stress on woody plants, and plants with inflexible stems are likely to experience catastrophic stem failure and mortality. The three most common woody plants on the heads of islands and scoured shorelines of the Delaware River and the Blue-New-Gauley river system are shrubby black willow (*Salix nigra*), river birch, and sycamore (*Platanus occidentalis*). All of these species can withstand tremendous stream flows, with larger individuals often exhibiting a downstream-bent form (Figure 6). This environment is also prone to the erosion and deposition of a significant amount of sediment,

Figure 6. Sycamore - Mixed Hardwood Riverine Shrubland showing battered and bent boles of river birch (*Betula nigra*). Photograph by: Gregory Podniesinski, Pennsylvania Natural Heritage Program.

which may alternately expose and bury the stems and roots of woody plants and subject them to damaging abrasion by moving debris and sediment. Each of the above species is strongly rooted to the substrate and can re-establish vertical growth, even when bent over at nearly a 90° angle and partially buried. In addition, woody vegetation that occurs in stands linearly oriented to the direction of flow usually suffer less overall mortality since upstream individuals serve as a buffer by reducing flow velocity for downstream individuals.

Reproductive Strategies

Reproductive strategies observed in riparian plants are often correlated with patterns of disturbance that create habitat suitable for colonization and establishment. The majority of riparian woody plant species on the Delaware River and the Blue-New-Gauley river system are shade intolerant, both as seedling and adults, and require microhabitats with limited competition, especially for light. Therefore, many of these species time the dispersal of seeds to correspond with spring floods in order to take advantage of newly scoured substrate and sediment deposits. The window of opportunity is often limited to several weeks or less, as the seed of many species remain viable for only a short period of time. Cottonwood (*Populus deltoides*) and willow (*Salix* spp.) seeds are generally viable for only one to two weeks. Seed dispersal is typically wind (anemochory) and/or water (hydrochory) dependent. It is not uncommon for stands of willow, cottonwood, river birch, or sycamore to establish as narrow bands on point bars and scoured

shorelines, reflecting the deposition of water-borne seeds in strand lines by receding flood waters. Once deposited, the seeds usually germinate quickly and survival is dependant on substrate type, soil moisture, and the hydrology of the microsite. Seasonal timing for herbaceous vegetation may be less important, especially for annual herbs that can run through their lifecycle even in a flood-shortened growing season.

Asexual or clonal growth is also an important strategy for survival and spread in riparian habitats. Willow (*Salix* spp.), *Carex trichocarpa*, water-willow, and reed canarygrass (*Phalaris arundinacea*) stands are examples of species present on the Delaware River that exhibit clonal reproduction, particularly where frequent inundation, scour, and sediment deposition may make sexual reproduction unpredictable or impossible. Willows can also reproduce via broken branches, which produce adventitious roots on moist substrate and grow into new trees. Clonal growth often allows species to persist in habitats where larger individuals can utilize resources, but conditions prevent successful germination and establishment. For example, many island heads with coarse gravel and cobble deposits may be too drought-prone in the upper portion of the substrate to allow successful willow colonization in most years, but already established individuals can reach deeper for soil moisture and therefore spread laterally across an island head. In general, clonal growth is favored in open habitats, where vertical competition for light is limited.

General Distribution of Communities

Role of Soils in Riparian Vegetation Distribution

The local distribution of riparian vegetation is strongly influenced by the pattern and distribution of alluvial soils. Reoccurring erosion and deposition events that move and redistribute organic and mineral material create a complex mosaic of soil conditions within floodplain geomorphic features (Oliver and Larson 1996). As a result, soil properties (e.g., soil moisture, texture, nutrient availability, organic matter content, hydroperiod) that influence plant germination, establishment, and growth can vary greatly over short distances. In addition, variation in soil properties such as texture can modify the impacts of flooding, with fine textured soils with low permeability becoming anoxic much faster than coarse textured soils (e.g., gravel and cobbles), which allow greater subsurface water flow and better oxygenation.

Organic matter (OM) in riparian soils can influence the rate of nitrogen mineralization, nutrient cycling, and soil moisture. The presence of OM can influence the size of pore spaces, and increase the surface area available for denitrifying bacteria as well as energy in the form of absorbed dissolved OM. Fine particulate OM and the attendant microbial community tend to retain mineralized N as well as mineralized C, and make it available for a short period of time to floodplain vegetation. High rates of N mineralization in fine soils are strongly correlated with enhanced primary productivity (Pastor et al.1984; Reich et al. 1997).

Riparian soil and sediment moisture also greatly affect the distribution of vegetation. Riparian soils vary in their ability to hold water and are influenced by tributary and subsurface groundwater flows (Hupp and Osterkamp 1985; Brinson 1990). Soil moisture is also influenced by distance from the river, microtopographic variation, and soil hydraulic conductivity. The lag time between rising river stage and inundation of a riparian site will vary with the above

parameters. The duration of flooded or saturated soils will depend on soil texture and OM content and the composition of underlying alluvial sediments (and evapotranspiration during the growing season) as well as the annual hydroperiod. The highly variable nature of the factors controlling riparian soil moisture results in soil moisture gradients that can be steep and often discontinuous, and may be result in abrupt transitions between plant community types.

The distribution of riparian vegetation is not only a function of the physical characteristics of soils but also involves the water demands and water uptake capacity of individual plant species (Naiman et al. 2005). Factors influencing individual species success include: root architecture, ability of soil to hold moisture, root growth to access water at greater depth, physiological and morphological adaptation to changing moisture conditions, and plant size and age.

Lateral Zonation

Lateral zonation of riparian plant communities has been attributed to the combination of hydroperiods, landforms, sediment types, competition, and species life history traits. Hydroperiods, fluvial landforms, and sediment types are a consequence of distinct hydrogeomorphic processes. Common fluvial landforms on the Delaware River and the Blue-New-Gauley river system include active channel bars, interfluvial channels, swales, and terraces. These landforms vary in elevation above a given river stage and therefore represent variation in flood frequency, duration, and flow velocity. Often, the variability in landform type and elevation can explain much of the patterns seen in riparian communities, but not in all cases. On the Delaware and the Blue-New-Gauley river system, early successional plants often colonize low elevation riparian areas closest to the active river channel. These plant species are capable of thriving in highly disturbed areas that are low in nutrients and have high light availability. An example of a plant community found at this zone would be the water-willow community. At higher elevations, woody plant cover increases, demonstrating a general increase in shade tolerance and decreased flood tolerance. Communities at the edge of the active plain are typically long-lived, shade-tolerant species that can tolerate only brief periods of saturated or flooded soils. Examples of woody species found along the outer extent of the Delaware River floodplain include sugar maple and bitternut hickory. Oak - tuliptree floodplain forests (NERI) and eastern hemlock floodplain forests (BLUE) are examples of outlying floodplain associations along the Blue-New-Gauley river system. Plant communities may be distinct where the landforms have clear breaks in slope or abrupt changes in elevation (e.g., terraces, steep channel banks, and gorge slopes) like those seen along the Blue-New-Gauley river system. In situations where landforms change gradually (e.g., large islands and bars with a gradual rise from head to tail), plant community boundaries can become blurred with considerable overlap. In general, the elevation gradient of a landform can dictate hydroperiod, but as mentioned earlier, the effective hydroperiod can be modified by soil and sediment heterogeneity, with some micro-sites being drier or wetter than expected.

Longitudinal Zonation

Longitudinal variation in riparian vegetation can result from variations in climate, geology, channel gradient, elevation, geomorphic processes, sediment, and litter loads, as well as sea level change and the length of time substrates have been available for colonization (Nilsson et al. 1991; Rot et al. 2000; Catterall et al. 2001). Many of these factors co-vary along the length of

rivers. On the Delaware River, one of the more obvious longitudinal differences is the increasing dominance of silver maple on shorelines and island terraces in DEWA versus UPDE, especially below the Hogback Ridge. This coincides with a decreasing channel gradient, lower velocity flood flows, decreased scour, and finer textured soils and sediment on mid to high terraces in DEWA, conditions which tend to favor silver maple recruitment and establishment. Silver maple is relatively rare in UPDE and is limited to a few locations where the channel geometry allows fine sediments to accumulate on mid to high terraces, and where flooding occurs periodically but scouring is limited. Another longitudinal vegetation difference on the Delaware River is the distribution of bitternut hickory, which is ubiquitous on high terraces along the channel bank and occasional islands in UPDE, but is nearly absent on the floodplain below Milford in DEWA. The explanation for this pattern is unclear.

Longitudinal zonation of riparian vegetation, due mostly to underlying bedrock and gradient, also occurs along the Blue-New-Gauley river system. One example along the NERI is the occurrence of Eastern Red-cedar - Virginia Pine Flatrock Woodland community. This community is found on resistant rock outcrops adjacent to Camp Brookside and Sandstone Falls. Although these outcrops are located next to the active river channel, they are elevated above the channel and avoid frequent flooding thus enabling the development of shallow, rapidly draining soils and consequent establishment of this community.

Successional and Seasonal Community Patterns

Vegetation Succession

Vegetation succession in the riparian environment is typically a complex combination of primary and secondary succession. Major floods that scour and transport sediments can create and reshape fluvial landforms that are devoid of vegetation and open to colonization. At the same time, many existing landforms are only partially scoured or partially buried in sediments, with remnants of the existing vegetation persisting to recolonize. In addition, many riparian plants survive and colonize through flood-dispersed propagules, and plant fragments. Vegetation succession can also reflect the legacy of other disturbances such as drought, wind, fire, disease, litter accumulation, herbivory, etc. Succession in riparian communities involves a complex interaction of species life history traits with the pattern of disturbance, geomorphology, and climate.

Oliver and Larson (1996) presented vegetation succession as occurring in four stages:

Establishment: Following a disturbance, plants colonize open, unoccupied space. In riparian systems this would be recently deposited sediment or newly scoured, exposed bare substrate.

Stem exclusion stage: Plants fill-in and occupy all available habitat. New recruitment is prevented by competition from previously established individuals. Competition for resources (space, light, nutrients) results in elimination of less well adapted species or individuals. In riparian communities this is often seen as a dense even-aged shrubland or low forest.

Understory initiation stage: Increasing height of canopy with some overstory mortality allows development of understory vegetation. Shade tolerant herbs, shrubs, and trees become established. Multiple understory layers may develop.

Mature stage: Individual trees die as stand ages, canopy gaps open and release understory vegetation from low light conditions. As mature trees die, the forest begins to accumulate large, coarse woody debris and takes on an old-growth character. Autogenic processes (driven by biological interactions) drive further changes in biota. Allogenic processes (environment driven) may still shape the forest stand through disturbance events. Mature riparian forests are characterized by large living old trees, large dead standing snags, large downed trees, open canopies with multiple foliage layers, and a diverse understory.

Succession in riparian systems seldom occurs as orderly as described above. The interplay of autogenic and allogenic processes (especially floods) results in a quasi-stable state, somewhere between the first and last successional stage. In general, riparian vegetation undergoes a pattern of alternating disturbance events (flood scouring, deposition, landform creation, and destruction) and succession. The disturbance event may abruptly alter sediment grain size, thus altering degree of soil development as well as patch size and landform shape and position. Over time autogenic process will alter soil development, increase surface sediment texture, and increase nutrient availability. Inevitably another disturbance event (i.e., flood) will reset the community to an earlier successional stage and the process will repeat. Many of the shrub communities on the Delaware River demonstrate this pattern, where vegetation is held in check between the establishment and stem exclusion stages by flood and ice scouring, which breaks and removes stems before competitive exclusion becomes the dominant process. In the Blue-New-Gauley river system, the disturbance shifts from ice scouring to boulder scouring as large pieces of substrate break away and are transported downstream. Thus, quasi-stable states can persist for decades to centuries (Schumm 1977), with succession never advancing to the “Mature Stage”. It should also be noted that different lag times exist for physical and biological elements of riparian communities, so that contemporary vegetation is always adjusting to one or more past disturbance events.

In general, allogenic processes dominate on low elevation landforms, where disturbance intervals are short and successional processes have little opportunity to modify the local environment. The scour shoreline is an example of a geomorphic setting where frequent flooding prevents the development of vertical growth and vegetation is routinely damaged or removed, leaving open, bare boulder-cobble zones. In contrast, autogenic processes dominate in mature floodplain forests, which display old-growth characteristics such as large trees, multiple-layered canopies, large logs, and often a diverse understory (where Japanese knotweed and reed canarygrass have not invaded the herb layer).

Disturbance

In riparian systems, disturbance acts as a restructuring agent that can maintain ecological integrity, as with natural disturbances, or alter and degrade ecological systems, as is often the case with anthropogenic disturbances. The natural hydrogeomorphic processes determine the patterns and processes of the riparian zone. These are a function of the interaction of climate and geology, which determine discharge patterns and sediment bed loads. The resulting flow regime acts as a natural disturbance, resetting the riparian system through scouring and flooding of vegetation. These, together with the character of the riparian corridor and the available species pool, shape the biophysical properties of riparia on intact, natural landscapes (Naiman et al. 2005.).

Human-mediated suppression or reduction in natural disturbance can also lead to ecological degradation by removing environmental drivers that maintain system integrity. Anthropogenic disturbances are human-mediated events or activities almost unknown in natural systems in terms of type, frequency, intensity, duration, spatial extent, or predictability (Naiman et al. 2005). While the same factors influence modern riparian vegetation and landforms, human-mediated changes have altered the climate as well as the frequency and intensity of natural geomorphic processes. Some natural disturbances have been reduced or eliminated (e.g., nutrient pulses from large spawning migrations of shad), while novel disturbances have been introduced (e.g., chronic high nutrient inputs from agricultural runoff). These alterations to the riparian disturbance regime affect current vegetation through legacies, lag times, and cumulative effects.

Legacies include long-term or permanent human-mediated changes to the physical environment. The construction of large reservoirs on the Delaware, Gauley, and New rivers represent legacies that will alter the flow regime, water temperature, sediment transport, and other properties of the systems for at least the next several decades or longer. Lag times reflect biophysical processes acting in the past (or legacies) whose biotic expression may take place now or in the future. Altered riparian community succession due to historic river management and past land use in Europe has been documented for several rivers (Decamps et al. 1988; Johnson 1994; Harding et al. 1998; Tremolieres et al. 1998). On the Delaware, Gauley, and New rivers, tributary reservoirs have attenuated flood flows and may be responsible for a reduction in flood frequency and flow velocity. This may be responsible for an increase in woody plant cover on many low islands and gravel bars as the intensity of flood scour, and woody plant damage and mortality has decreased.

Riparia are subject to four general types of anthropogenic environmental change or stress: flow regulation, pollution, climate change, and land use. As opposed to natural disturbances that may revitalize and maintain natural systems, these stresses can degrade and impair riparian systems. Riparian systems are often affected by more than one human-mediated disturbance, requiring the examination of cumulative effects. The result can be a “distress syndrome”, where the ecological system is characterized by reduced biodiversity, altered productivity, increased disease outbreaks, reduced efficiency of nutrient cycling, increased dominance of exotic species, and smaller, short-lived opportunistic species (McIntyre et al. 1999; Rood et al. 2003). The Upper Delaware, Bluestone, Gauley, and New rivers, as examples, are impacted by multiple anthropogenic stressors such as: point and non-point-source pollution, acid rain, floodplain and channel alterations from roads, railroads, and bridges, and climate change. Prediction of how the combined effect of these stresses will affect riparian systems is daunting, especially since many biotic responses may be non-linear.

Flow Regime

Flow regime is the “key” environmental driver of the ecological integrity of riparian communities. Flow alteration is the single most important threat to riparian systems (Nilsson and Svedmark 2002). Guiding principles to consider when evaluating natural and modified flow regimes are (Naiman et al. 2005):

- The flow regime determines the successional evolution of riparian plant communities and ecological processes.
- The river serves as a pathway for redistribution of organic and inorganic materials that influence plant communities along rivers.
- Every river has a characteristic flow regime and associated riparian communities.
- Riparian zone are topographically unique in occupying nearly the lowest position in the landscape, thereby integrating catchment-scale processes.

As noted earlier, riparian systems are subject to multiple stresses in addition to altered flow regime. The difficult task for ecologists and resource managers is teasing out the role and importance when trying to manage for the health of riparian communities.

Ecological Consequences of Flow Regulation

The response of riparian vegetation to flow regulation depends on the degree of variance from natural flows and the local geology and climate. The resulting change in flow variability and sediment load will in turn modify local fluvial processes to which riparian vegetation responds. Flow regulation impacts sediment transport and reduces flood peaks, flood frequency, and channel forming flows. Subsequent impacts are: lower water tables, reduced lateral fluxes of water, sediment and organic matter, accelerated and modified successional processes, and the cessation of new habitat formation (Ward and Stanford 1995). The reduced frequency and extent of flooding combined with a lower water table allows riparian species to be replaced by upland species that are able to invade the floodplain under artificially stable and "terrestrialized" conditions (Decamps 1984). The net effect of flow regulation is to reduce the amplitude of the primary disturbance mechanism (flooding), thus creating equilibrium conditions for plant communities adapted for a non-equilibrium environment. The resulting maladapted communities may be subject to greater unanticipated amounts of damage when exposed to catastrophic flows (Naiman et al. 2005).

Alterations to seasonal flow patterns may put life cycles of riparian species out of synch with their environment. As an example, many plant species time reproduction to correspond with spring flooding, but low spring flows would strand many water-dispersed propagules close to the active channel. This zone often has coarse substrate unsuitable for seedling establishment, and could be inundated during altered higher summer flows and then exposed to severe ice scour during altered low winter flows. The net result may be changes in the spatial distribution of new plants as well as reduced reproductive success for many native species. This may also partially explain why the riverine scour vegetation community that lies adjacent to the active channel is dominated by annual exotic species.

Extent of Flow Regulation

Flow regulation on the Delaware River has altered the natural hydroperiod in the following ways (Parasiewicz 2001):

- The average annual flow volume has been reduced by approximately 50%, with chronic low flows much of the year.

- Seasonal patterns of peak and average flow discharges have been altered. The magnitudes of peak flows are a fraction of pre-dam peaks (recent record floods, 2004–2006, excepted). Winter and spring flows are greatly reduced, while summer flows may be higher than normal. Minimum flows may occur in fall, rather than in summer, due to fall increases in reservoir storage.
- Modification of daily flow pattern, with increased reservoir releases beginning and ending abruptly.
- Critical low flows during drought and winter seasons. Winter low flows may promote the formation of anchor ice.
- Substrate recruitment (sediment trapping) could promote the downcutting of the riverbed below reservoirs.

The Gauley River is another example of how flow regulation affects natural hydroperiods. Placement of the Summersville Dam in 1966 has dramatically altered peak discharges in the Gauley River below the Summersville Dam. Peak discharge (USGS gage 03189600) has not exceeded 18,200cfs since the dam began operation. In contrast, upstream of the Summersville Dam, the Gauley River near Craigsville (USGS gage 03189100) has exceeded 18,200cfs 22 times since 1970 (Bennett and McDonald 2006). Similar to the Delaware River example, sediment trapping occurs behind the Summesville Dam and results in the release of "hungry water" below the dam that increases erosion of the channel bed and river banks (Kondolf 1997).

Climate Change

Anthropogenic climate change has become a well-documented phenomenon (Schneider and Root 1988). Observational temperature and precipitation records, as well as a host of indirect indicators such as the length of the growing season, flowering and leaf-out events, snow melt and streamflow timing, provide supporting evidence that the northeast climate is already changing in ways consistent with global warming (Frumhoff et al. 2007). The climate conditions of Pennsylvania and West Virginia have both become wetter and warmer over the last 100 yr. Over the last century, the average temperature in Harrisburg, Pennsylvania, has increased 1.2°F, and precipitation has increased by up to 20% in many parts of the state (U.S. EPA 1997). The average temperature in Charleston, West Virginia has increased 1.1°F, and precipitation has increased by up to 10% in many parts of the state (U.S. EPA 1998).

Various climate models project that these trends in warming temperatures and altered precipitation patterns will become even more pronounced over the next century. By 2100, temperatures in Pennsylvania, under high greenhouse gas emissions scenario, are projected to increase by 8°F above average winter temperatures and 11°F above average summer temperatures. Under a lower emissions future, the warming is projected to be half as much (Union of Concerned Scientists 2008). Some climate models suggest that by mid-century, precipitation is expected to increase statewide by more than 5% above historical average and by late century, by more than 12% (Union of Concerned Scientists 2008). Similar increases in temperature and precipitation are projected for West Virginia. By 2100, temperatures in West Virginia could increase by 3°F (with a range of 1–6°F) in the winter, spring, and summer months and 4°F (with a range of 2–7°F) in the fall. Although projections differ among climate models, precipitation is estimated to increase by 20% (with a range of 10–30%) in all seasons with slightly more rainfall in the summer (U.S. EPA 1998). Other future climate related changes

consistent with increasing temperature and precipitation that will impact both states include: shrinking snow cover, more frequent droughts, and extended low-flow hydrological periods (Hayhoe et al. 2006).

Projected changes in climate conditions and their subsequent impact on hydrological indicators (terrestrial hydrological indicators, summer drying or drought, streamflow, and winter snow cover) will most likely impact riparian systems in Pennsylvania and West Virginia by altering water availability. As winters become wetter and summers hotter and drier, natural systems, such as rivers, that depend on seasonal rainfall, runoff, and soil moisture are likely to be affected (Hayhoe et al. 2006). The projections of drier, hotter summers and more frequent droughts imply a series of potentially serious impacts on water supply for rivers with one result being alteration in seasonal streamflow rates (Hayhoe et al. 2006). Winters may have higher flow rates while summer flow rates are decreased. Higher winter flows are related to an increase in the frequency of mid-winter ice jams that result in major flooding (Beltaos 2002) and potential damage and/or alteration to riparian communities. Low summer flow rates could adversely affect vegetation communities along river systems or place added pressure on competition for surface water resources.

Other aspects of climate change may also impact riparian plant species. Shorter and milder winters may allow the northward migration of southern species and provide an opportunity for less cold-tolerant exotic species to spread (e.g., kudzu, *Pueraria lobata*) (Rogers and McCarty 2000). Native species may also flower and fruit earlier, and become out of sync with other environmental cues. Milder winters could reduce or eliminate ice formation and remove an important factor in the distribution and structure of woody vegetation. Similarly snowmelt would occur earlier and the available snow pack volume may decrease, possibly reducing springtime flood flows.

The response of Delaware and WV riparian vegetation to climate change will depend on how changes in temperature and water availability manifest themselves. While increasing temperatures are nearly certain, future changes in the hydrology of these watersheds are still to be seen. The degree of impact will depend on how far future conditions deviate from the present.

Land Use Change

The land use changes described in the previous paragraphs can affect riparian communities through effects on temperature regimes, pollution, nutrient enrichment, and invasive species. Riparian vegetation affects the temperature regime of streams while stream temperatures modify riparian air and soil temperatures. Variations in temperature regimes can influence a number of physical and biological vegetation processes, including metabolism, growth, solubility of gases, and the timing of life history traits. The effect of riparian forest removal on stream temperature has been well documented, with higher summer temperatures due to increased insolation and lower winter temperatures due to increased short-wave radiation of heat. Lack of a canopy and increased heat radiation is thought to also promote the formation of anchor ice in some situations.

Land use changes can also account for sources of pollution to the riparian zone. Extensive coal mining, logging, and oil and gas exploration have occurred throughout the New River basin (Messinger and Hughes 2000; Purvis et al. 2002; Welsh et al. 2006). Mining and exploration can cause soil erosion leading to sedimentation of adjacent riparian communities and waterways as well as deposition of heavy metals into soils. Both the Delaware and WV rivers have a number of small towns that are directly adjacent to the rivers, as well as transportation infrastructure (roads and railroads) usually on or adjacent to the floodplain on both sides of the river. A study of water samples from four tributaries of the NERI showed fecal contamination from residential sewage (Mathes et al. 2004). Additionally, in the Upper Delaware River some reaches have been subjected to moderate to high density development of riverfront residences, many with mowed riverside lawns. Heavy rains following herbicide applications for transportations routes and lawn management can wash chemicals into the riparian zone (Purvis et al. 2002). The effects of these pollution sources can alter soil conditions and subsequent vegetation.

Human activity has greatly increased the amount of nutrients entering into and cycling through the environment. The primary sources of major non-point nutrient pollutions, nitrogen and phosphorus, are agriculture and urban activities (Sharpley et al. 1994). Nitrogen, in particular, is rapidly increasing in the land-based nitrogen cycle with potentially significant impacts on the species composition, productivity, dynamics, and diversity of natural systems (Galloway and Cowling 2002; Vitousek et al. 2002). Similarly, phosphorous (another important element in fertilizer) is being mined and applied to farmland where it is not only incorporated into the terrestrial nutrient cycle but also enters into aquatic systems via runoff. The addition of large quantities of both of these elements can result in saturated systems and can affect the chemistry and availability of other elements. Riparian systems are especially susceptible to nutrient loading due to their position at the bottom of the watershed. Once saturated with anthropogenic N and P, these elements will pass through riparian zones resulting in nutrient pollution of receiving bodies of water. The impact of nutrient loading on riparian communities is not well documented. Some studies suggest that increased nutrient loading leads to less diverse, impoverished plant communities (van der Brink et al. 1996).

Riparian zones are particularly vulnerable to invasive plant species, and consequently, many riparian systems are dominated by invasive species. Land use changes, through the clearing of adjacent upland, create edge influences and increased light availability, thus allowing for the invasion of exotic species (Brothers and Spingarn 1992; Parendes and Jones 2000). Once established, these species may proliferate given adequate growing conditions. In general, riparian zones have a higher percentage of nonnative species than the adjacent uplands (DeFerrari and Naiman 1994; Pysek and Prach 1994; Brown and Peet 2003; Eichelberger and Perles 2009a, b). Unfortunately, the same processes that support high species diversity in riparian communities also favor invasion by exotic species including transport of propagules, flooding disturbance, and water availability (Brown and Peet 2003; Naiman et al. 2005).

Conceptual Models

Conceptual ecological models were developed to elucidate processes affecting development and maintainance of riparian plant communities on the Delaware and the Blue-New-Gauley river system. In general, each model represents a geomorphic setting typically found on one or more of these rivers such as: low islands/cobble-gravel bars, large islands with one or more terraces, sloping scour shorelines adjacent to steep upland slopes, scour shorelines adjacent to high terraces and riverside rock outcrops. These models are focused primarily on native plant communities, although invasive communities are included in some models. Two invasive species communities common on the Delaware River are also discussed individually. The models have several general patterns. Decreased flood and ice/flood scouring will tend to favor succession to shrubland and forest. Decreased water levels will also favor succession and terrestrialization with a narrowing of the riparian zone. Increased flooding and scouring will tend to reset riparian zones to early successional communities. The Delaware River and the Blue-New-Gauley river system are discussed as separate sections. Descriptions of vegetation communities found in the riparian zones of the five parks addressed in this report are included in Appendix A (UPDE and DEWA) and Appendix B (BLUE, GARI, and NERI) (Perles et al. 2007; Vanderhorst et al. 2007; Perles et al. 2008; Vanderhorst et al. 2008).

Delaware River Communities

Low Island (Gravel-Cobble Bar)

Low Islands and small gravel-cobble bars are high energy environments where flood and ice scour hold woody plant succession in check through frequent removal, breakage, and abrasion of vegetation. These islands tend to lack terraces and the entire island may frequently flood. The substrate tends to be coarse and soil formation is absent. During low water periods, slightly elevated portions of the island may experience drought conditions. Figure 7 shows the general pattern of vegetation for this geomorphic setting; with low vegetation present in the high scour areas at the island head and lateral edges, and taller shrubs at the downstream end of the island. Many of these islands have open grassland behind the leading edge of tall shrub vegetation.

Figure 8 is a conceptual model of the relationship between plant communities characteristic of low islands on the Delaware River. Some islands have Water Willow Emergent Bed communities at the island head, which are normally partially exposed during low summer flows, though substrate often remains flooded or saturated. The near constant inundation of this vegetation, along with severe flooding and ice scour, prevents colonization by woody plants. This community is often absent from many islands, perhaps due to flow regulation impacts noted earlier. Abnormally low late summer and fall flows may drought stress water willow. Conversely, low winter flows may expose the beds, causing rhizomes to freeze, resulting in mortality.

Riverine Scour Vegetation occurs just above the Water Willow Emergent Bed community and may be quite extensive on islands and bars with a low elevation gradient. The substrate varies from coarse cobbles and gravel to sand. The environment is very stressful due to fluctuating water levels any time of the year, including drought conditions in summer and ice scour in

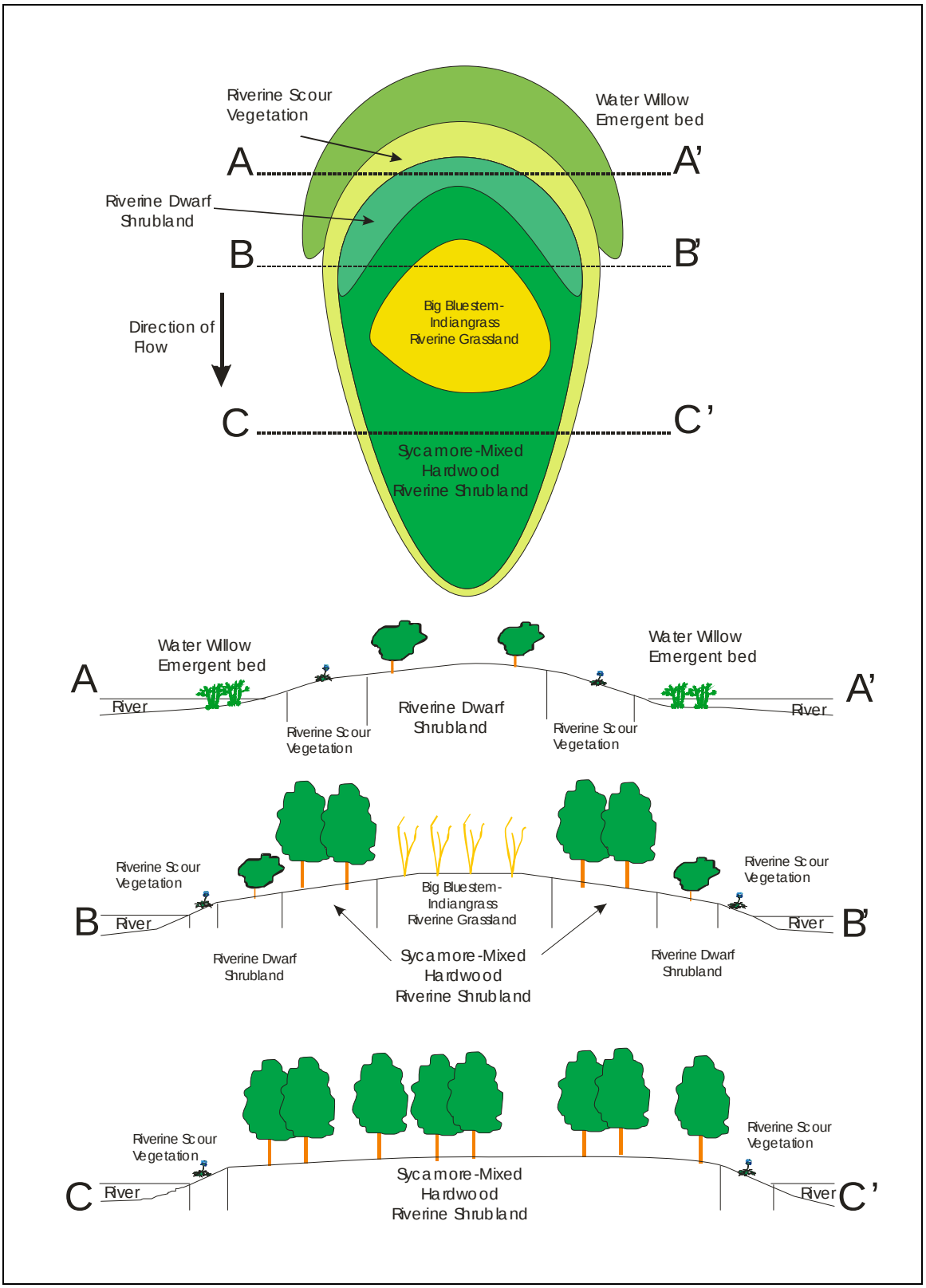

Figure 7. Generalized pattern of vegetation on low islands and cobble gravel bars on the Delaware River.

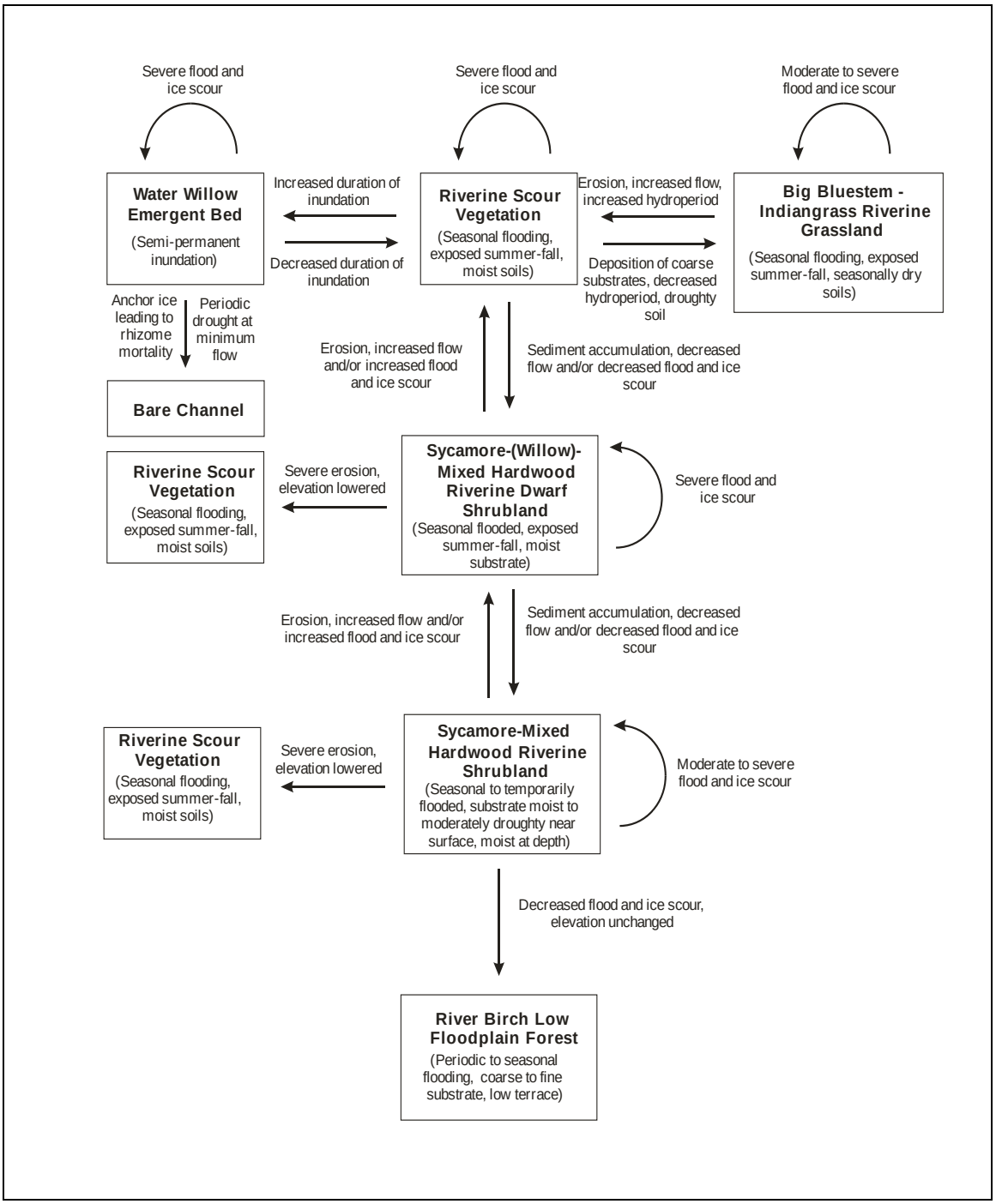

Figure 8. Ecological model of plant community dynamics on low islands and cobble-gravel bars on the Delaware River.

winter. This community may be under water for weeks at a time during the early growing season under current flow regulation. During cold winters, large ice deposits may also remain in this zone through early spring, delaying plant growth. As a result of the unpredictable environment, annual grasses and herbs dominate the vegetation in this zone, completing their life cycle in between disturbance events. The majority of plant species in this zone are exotics, with many being agricultural weeds. Widespread agriculture within the Delaware River valley is likely the source of many weed propagules.

Most of the other communities in this model will revert to Riverine Scour Vegetation following severe floods and erosion that removes existing vegetation. Succession to another community type will depend on the post-flood elevation of the site.

The Big Bluestem - Indiangrass Riverine Grassland community occurs on low islands and bars. This habitat often contains the rare sandy cherry (*Prunus pumila* var. *depressa*). As Figure 7 shows, many low islands have open grassland behind the Sycamore - Mixed Hardwood Riverine Shrubland. Whether this area was Riverine Scour Vegetation at some point in time is unclear, however, the general lack of woody vegetation suggests it was heavily scoured and coarse sand, gravel, and cobbles were deposited. The substrate appears to lack silt and clay and is often drought-prone. It is often found at elevations higher than either of the shrubland communities. Since it probably receives less scour than the shrubland community, it appears that summertime drought may prevent the establishment of woody vegetation. Elements of this community may mix with Sycamore - Mixed Hardwood Riverine Shrubland along the lateral edges of islands.

Sycamore - (Willow) - Mixed Hardwood Riverine Dwarf Shrubland is generally restricted to the heads of islands. The substrate is typically coarse cobbles and gravel, and may be flooded for extended periods throughout the year. The vegetation is a mix of annual herbs (similar to Riverine Scour Vegetation), stunted willows, and sycamore. This community may receive some of the most intense flooding and ice scouring, with woody vegetation being constantly bent, broken, and abraded. Black willow is the most common willow on island heads but rarely attains a height greater than 1–2m, and was not observed in flower or fruit. Colonization and establishment likely relies on rooting of broken stem and branch fragments and deposition of seeds by wind and water. Mature black willows are found occasionally along the shoreline of the Delaware and are the likely seed source. This community grades into the taller Sycamore - Mixed Hardwood Riverine Shrubland as the substrate increases in elevation and exposure to severe flood and ice scour lessens.

Sycamore - Mixed Hardwood Riverine Shrubland occurs behind the Sycamore - (Willow) - Mixed Hardwood Riverine Dwarf Shrubland on island heads, and often forms an irregular ring around low islands. It is subject to less intense, routine flooding and ice scour than the Sycamore - (Willow) - Mixed Hardwood Riverine Dwarf Shrubland, but is prevented from succeeding into mature forest by less frequent and severe flood and scour events. Evidence of this is the relatively straight vertical boles of new growth, several years old, growing from strongly bent and abraded lower stems. As noted above, this community is often adjacent to the Big Bluestem - Indiangrass Riverine Grassland, but appears to be prevented from colonizing the grassland by drought-prone soil conditions.

The River Birch Low Floodplain Forest is uncommon on the Delaware River and represents stands of the Sycamore - Mixed Hardwood Riverine Shrubland that have managed to succeed to forest stature, usually with river birch as the dominant and sycamore only occasional. Many of the trees are battered and bent, but greater than 5m in height (the general size limit for classification as tall shrub). The substrate and environmental conditions appear similar to the Sycamore - Mixed Hardwood Riverine Shrubland, but with possibly minor shifts in local geomorphology and channel bed, flood flow velocity, and decreased scouring. These stands survived major floods between 2004–2006 and appear to be stable.

Other communities that may occasionally occur on low islands include Reed Canarygrass Riverine Grassland, Hairy-fruit Sedge Wetland, and Japanese Knotweed Vegetation. When present, these communities occupy small patches, presumably in microhabitats where river scour may be less severe, soil texture is finer, and soil moisture is abundant. There was also one large low island in UPDE section of the river where the soils were loamier and the river much wider and presumably exposed to lower flood flow velocities. On this island, woody plant cover was low with a mix of Hairy-fruit Sedge Wetland, Reed Canarygrass Riverine Grassland, and Japanese Knotweed Vegetation, with small patches of Big Bluestem - Indiangrass Grassland. The abundance of terrestrial agricultural weeds suggested it may have been recently cultivated.

Large Island with Terraces

This model is similar to the Low Island (Cobble-Gravel Bar) described above, with the addition of communities that occur on higher terraces and are subject to decreased flood and ice scour. This model would also apply to the islands and shoreline terraces associated with tributary mouth bars at Brodhead Creek. The description here will be limited to the forests associated with the terraces. Figure 9 shows the general pattern of vegetation for this geomorphic setting; with the forested communities generally limited to the terraces on the downstream end of islands. Figure 10 is a conceptual model of the relationship between the plant communities characteristic of large islands with terraces on the Delaware River.

Silver Maple Floodplain Forest occurs on higher terraces where flow velocities are lower and fine sediments are deposited. Whether this community represents succession from the Sycamore - Mixed Hardwood Riverine Shrubland is debatable, as young silver maples tend to form even-aged stands at slightly higher elevations and downriver from the sycamore-dominated shrublands, where finer substrates are likely to accumulate. It may be that silver maple stands represent single recruitment events on bare sand and silt substrate with little canopy cover. This community may develop old-growth characteristics over time, with many large (possibly old) trees, large dead trees, and layered foliage. Another characteristic of old-growth is a diverse ground layer. However, most of the Silver Maple Floodplain Forest stands in the study area have been invaded by Japanese knotweed (*Polygonum cuspidatum*) and reed canarygrass. In the few places where this has not occurred, the understory vegetation is reasonably diverse with forest grass, herbs, and fern species, especially ostrich fern (*Matteuccia struthiopteris*). Silver maple seedlings are fairly shade intolerant and while some silver maple regeneration may occur under open silver maple forests, the high cover of invasive species (especially Japanese knotweed) may preclude seedling survival. An example of where possible regeneration failure may be occurring is at the mouth of Brodhead Creek. Recent catastrophic flooding has scoured under and tipped a large number of mature silver maples. Prior to the flood, the understory was dense knotweed.

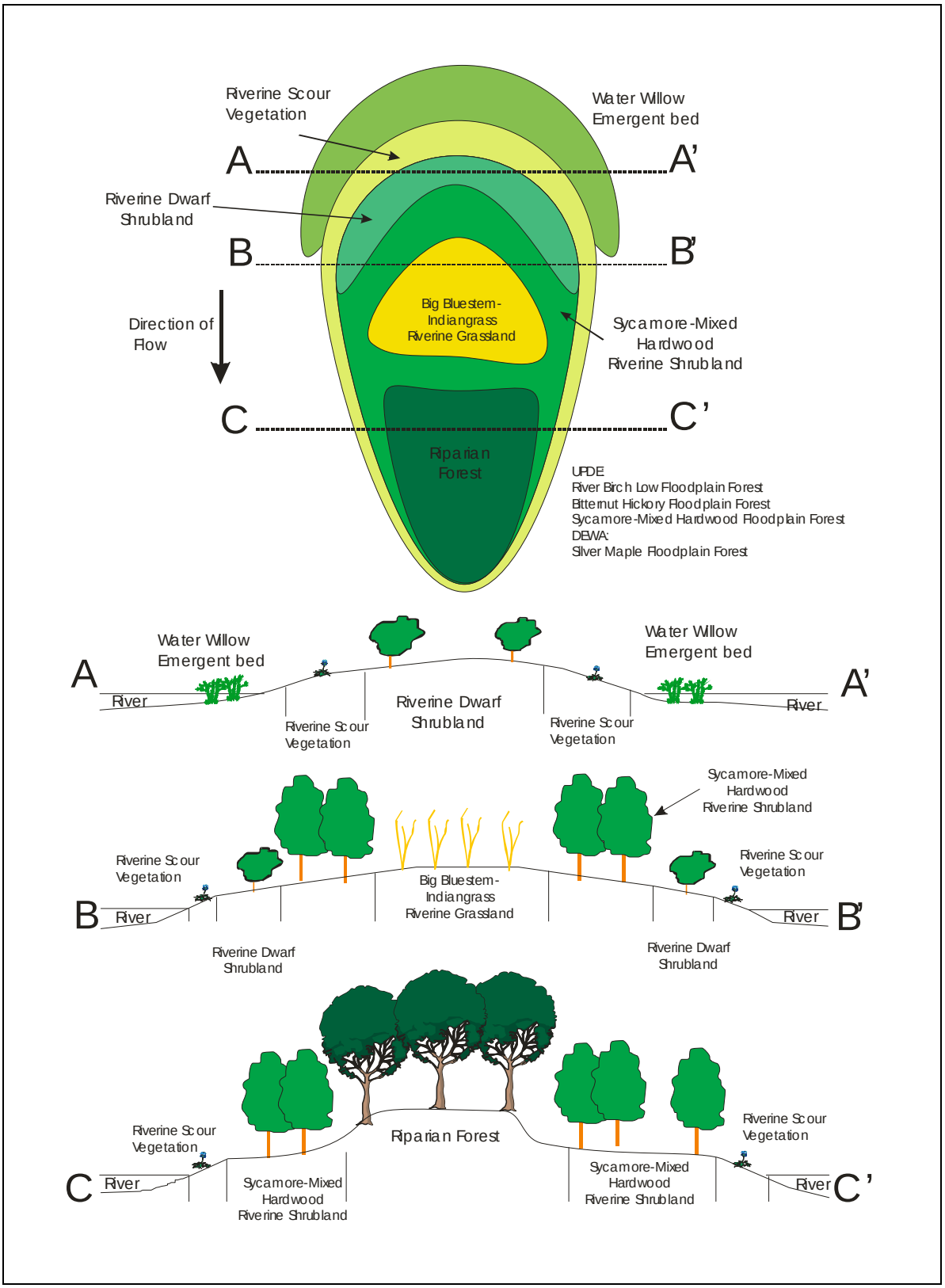

Figure 9. Generalized pattern of vegetation on large islands with terraces on the Delaware River.

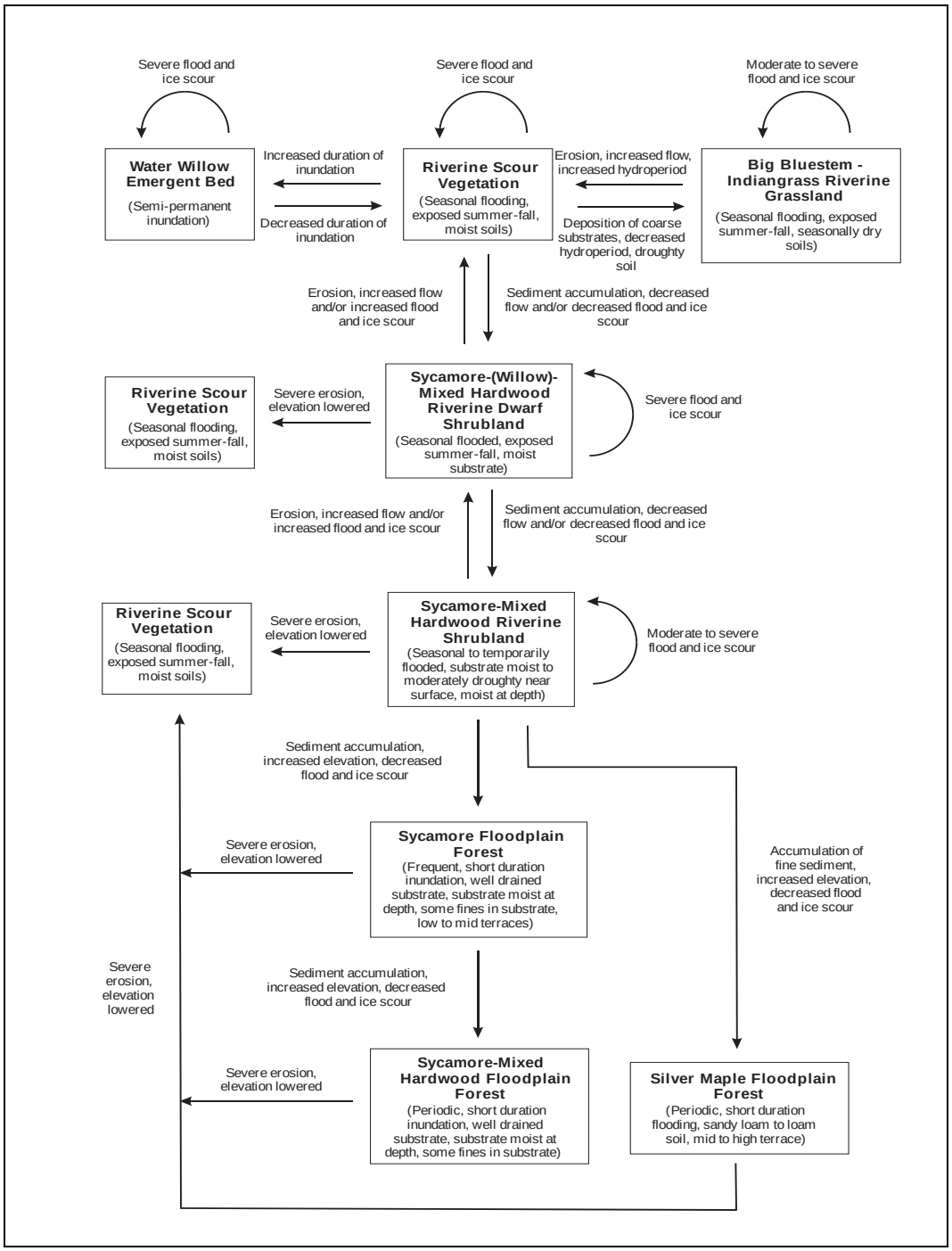

Figure 10. Ecological model of plant community dynamics on large islands with terraces on the Delaware River. The ecological model for large islands is similar to small islands but with additional forest types on high terraces of large islands.

After the flood, the knotweed is nearly as dense, despite the deposition of over a meter in many places of cobbles, gravel, and sand. It appears unlikely that any tree regeneration will occur in this area without elimination of the knotweed.

Sycamore Floodplain Forest is uncommon on the mainstem Delaware River and is associated more with the alluvial deposits at the mouths of larger tributaries such as the Brodhead and Bushkill Creeks. Transport and deposition of sediments to tributary mouths increases the elevation of terraces and bars and allows Sycamore - Mixed Hardwood Riverine Shrubland vegetation to succeed to forest. In mature stands, early associates, such as river birch, may eventually be eliminated through shading from the taller sycamore. Continued sediment accumulation and terrace building may allow the invasion of shade tolerant trees that could not persist in the lower, more frequently flooded Sycamore Floodplain Forest. At this point, the stand would more properly be classified as a Sycamore - Mixed Hardwood Floodplain Forest. As with the Silver Maple Floodplain Forest, these two communities are susceptible to invasion by Japanese knotweed. However, younger stands occasionally have a denser canopy and lower light conditions in the understory, which appears to limit knotweed colonization.

Other communities that may occur here (besides the invasive communities) include the Sugar Maple Floodplain Forest, the Bitternut Hickory Floodplain Forest, and the Hairy-fruit Sedge Wetland. The Sugar Maple Floodplain Forest is occasionally found as small patches on the mainstem, and in most instances appears to be a successional stand on formerly farmed or cleared floodplain terraces. Some occurrences on high floodplain terraces may be attributable to colonization on bare substrate following major floods. In general, sugar maple is not very flood tolerant and is limited to the higher floodplain terraces. It is a common understory species in some Silver Maple Floodplain Forests, possibly an artifact of flow regulation and reduced peak flows during flood events. Bitternut Hickory Floodplain Forest is rare on islands, with the best example on Butternut Island, near Callicoon, NY. It appears to occur in similar habitat as the Sugar Maple Floodplain Forest, but may tolerate more flooding. The Hairy-fruit Sedge Wetland occurs occasionally on islands in UPDE, with Butternut Island as one of the better examples. This community occurs behind the island heads but where the substrate has sufficient fines or organic matter to hold more moisture. In DEWA, several of the large islands below the Hogback have large stands of this community, typically under an open Silver Maple Floodplain Forest, on a mid to high terrace with a moist sandy loam soil.

Sloping Shoreline Adjacent to Steep Uplands

This geomorphic setting occurs in UPDE where the channel is confined and the floodplain narrow. Figure 11 shows the general pattern of vegetation for this geomorphic setting. Figure 12 is a conceptual model of the relationship between the plant communities characteristic of sloping shoreline adjacent to steep uplands on the Delaware River.

These areas are subject to intense flood and ice scour and may have stranded ice blocks for prolonged periods in winter and early spring. Riparian woody vegetation is rare or absent, presumably the result of the intense scouring. The vegetation appears to be organized into three discrete zones: Riverine Scour Vegetation, adjacent to the active channel, dominated by exotic annual herbs and grasses as described above; Hairy-fruit Sedge Wetland, and Reed Canarygrass Riverine Grassland. The hairy-fruit sedge (*Carex trichocarpa*) usually dominates the zone just

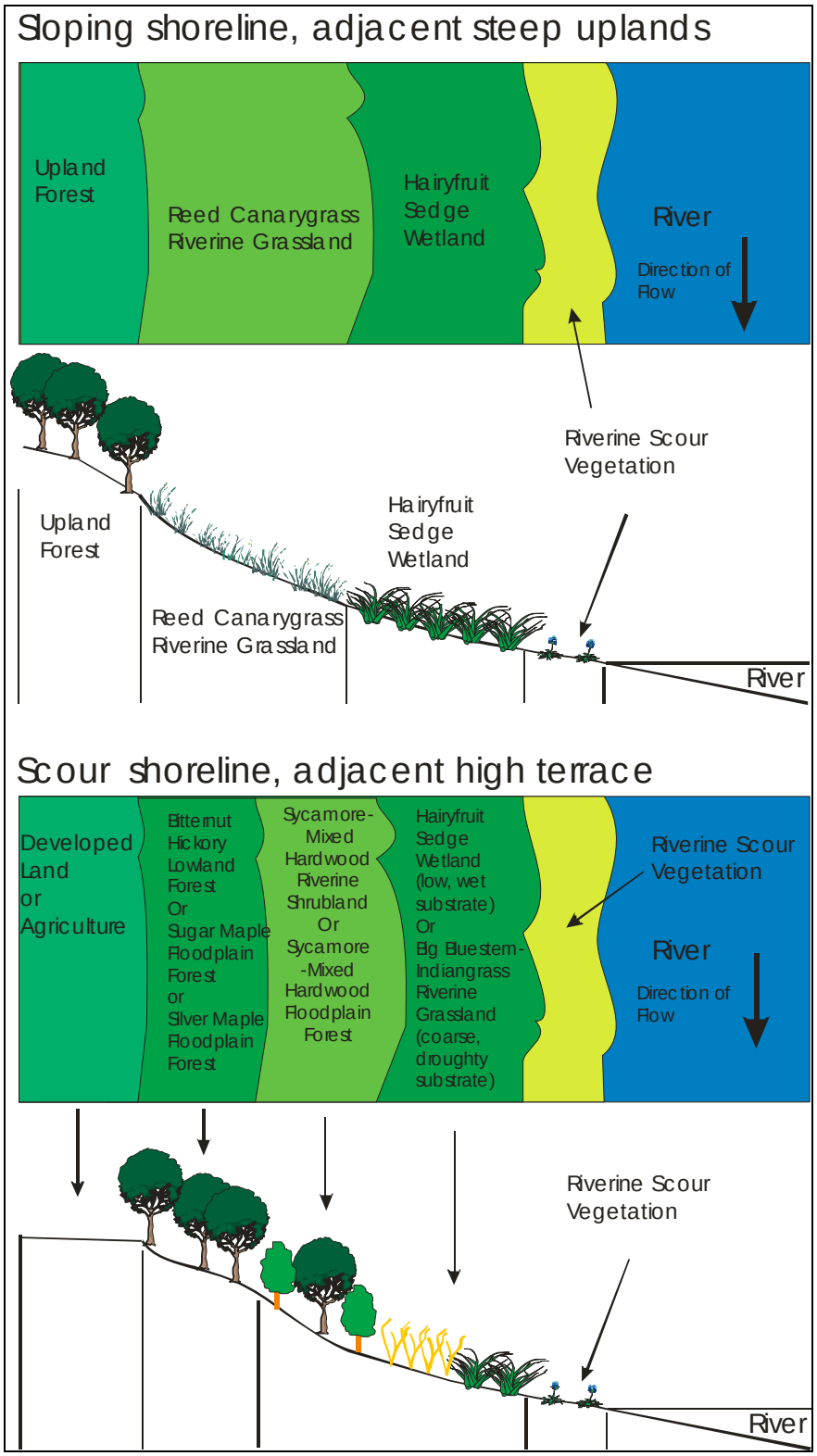

Figure 11. Generalized patterns of vegetation along shorelines of the Delaware River.

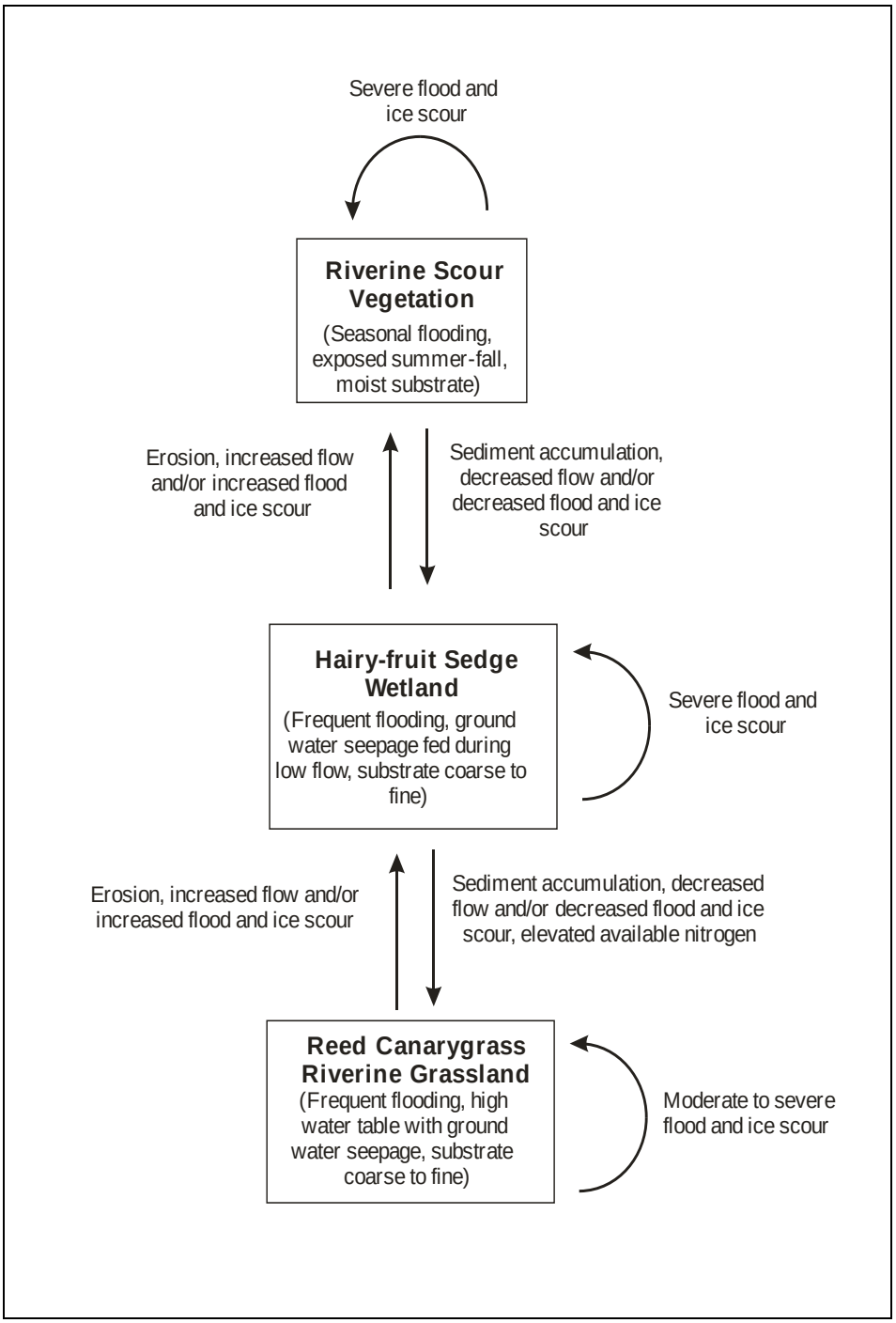

Figure 12. Ecological model of plant community dynamics on sloping shorelines adjacent to steep uplands on the Delaware River.

above the Riverine Scour Vegetation and may tolerate prolonged inundation better than reed canarygrass. However both species show considerable overlap in their vertical distribution from river channel to upland edge. Reed canarygrass is the clear dominant in the upper third of the shoreline, with hairy-fruit sedge absent. This zone does not appear to be drought-prone, and many areas have groundwater seepage, which may allow reed canarygrass to persist well above the river's normal flow. Japanese knotweed is rare in this setting.

Scour Shorelines Adjacent to High Terraces

This geomorphic setting occurs in UPDE and DEWA where low gravel bars and terraces are adjacent to high terraces of glacial deposits. These geomorphic settings can be complex with a number of communities occurring within close proximity in response to patchy substrate variation, elevation, and moisture availability. Figure 11 shows a general pattern of zonation. Figure 13 is a conceptual model of the relationship between the plant communities characteristic of scour shoreline adjacent to high terraces on the Delaware River.

As with the geomorphic settings above, the active channel is bordered by Riverine Scour Vegetation. Above the Riverine Scour Vegetation, the community composition can vary, with Hairy-fruit Sedge Wetland or sometimes Reed Canarygrass Riverine Grassland present if the substrate is only slightly elevated above the scour zone or the substrate is fine-textured. In many cases there is an abrupt rise of a meter or more where Big Bluestem - Indiangrass Riverine Grassland occurs on coarse sand, gravel, and cobble deposits. This habitat often contains the rare sand cherry (*Prunus pumila* var. *depressa*). Above this zone there is usually a Sycamore - Mixed Hardwood Riverine Shrubland or a Sycamore - Mixed Hardwood Floodplain Forest, depending on the age of the shoreline deposits and the degree of scour activity. As with the low islands, the Sycamore - Mixed Hardwood Riverine Shrubland community can be held in a state of arrested succession by repeated flood and ice scour. Above this zone in UPDE, usually on the slope of the adjacent high terrace is a narrow band of Bitternut Hickory Lowland Forest, or less often, either Sugar Maple Floodplain Forest or Silver Maple Floodplain Forest. In DEWA, this zone is nearly always dominated by Silver Maple Floodplain Forest. The sycamore-dominated forest and shrubland may be absent. In UPDE, the terrace slope is characterized by fine-textured soils, decreased flood and ice scour, and shorter duration of flooding. DEWA is similar, but the terraces may be subject to longer periods of inundation, favoring the more flood-tolerant silver maple. Japanese knotweed can occur in this setting in more mesic soil on low terraces and in the forest communities along the terrace slope.

Riverside Rock Outcrops

The riverside rock outcrop communities are simple systems where bedrock lies in and adjacent to the active channel, with a high frequency of flood and ice scouring. There is little opportunity for soil development and most vegetation is limited to cracks and crevices in the bedrock surface. In UPDE, these bedrock outcrops are primarily sandstone, are gently sloping to the north or northwest, and are covered with sparse vegetation of the Northern Riverside Rock Outcrop community. Plant species present tend to be perennial herbs and some shrubs, possibly reflecting the stable nature of the substrate. Moisture availability does not appear to be a limiting factor as the Northern Riverside Rock Outcrop tends to lie at or just above the normal flow and

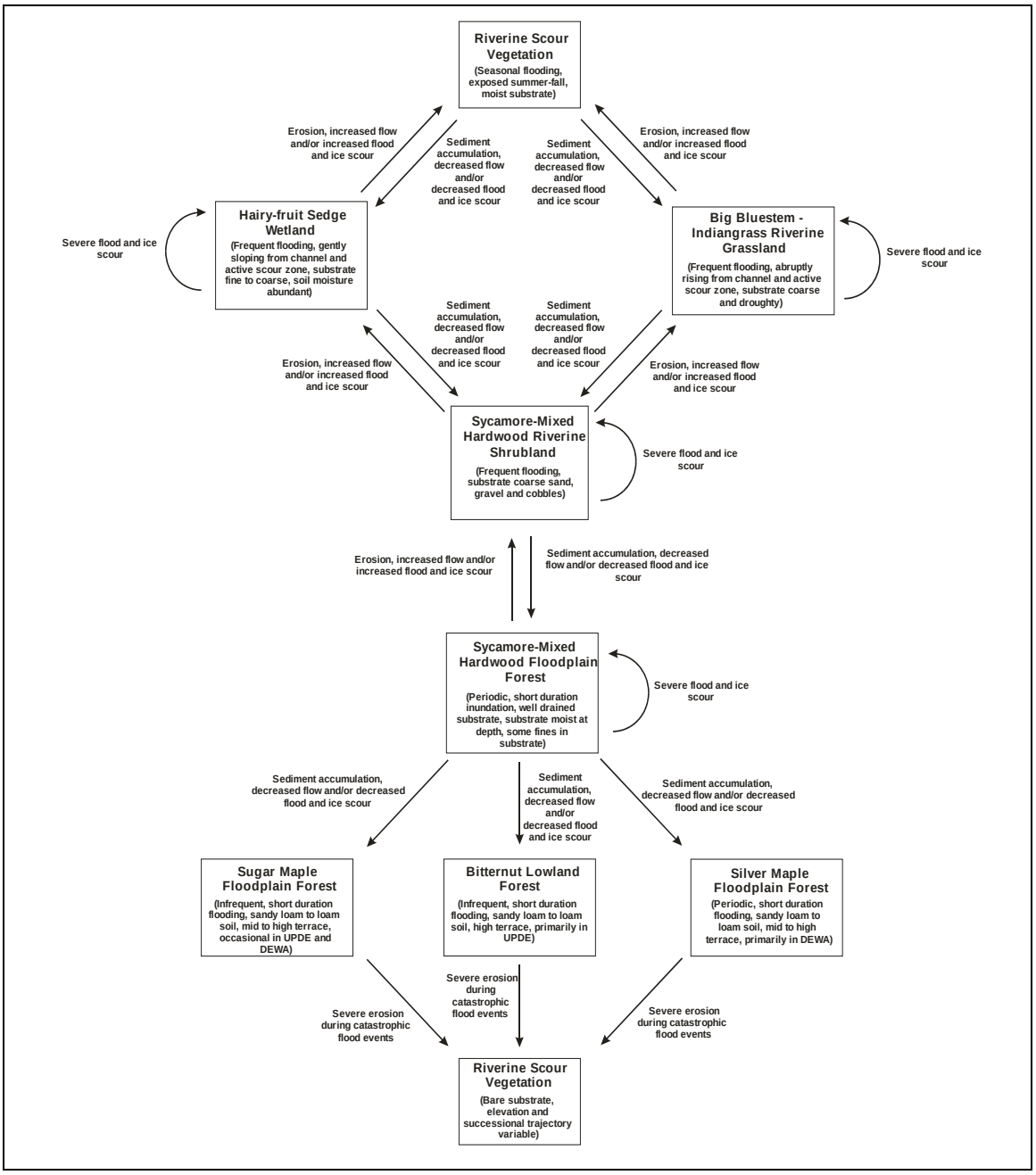

Figure 13. Ecological model of plant community dynamics on scour shorelines adjacent to high terraces on the Delaware River.

many areas receive groundwater seepage. This community appears to be very stable, but does rely on scouring events to maintain an early successional state.

In DEWA, most of the bedrock outcrops are limestone, belonging to the Buttermilk Falls Formation, which dip steeply to the west along the eastern shore of the Delaware River near Montague, NJ. The physical processes here are similar to the sandstone outcrops in UPDE, but the vegetation has a high number of calciphilic species not found elsewhere on the Delaware River. Outcrops with significant groundwater seepage are characterized by the Calcareous Riverside Seep community, while areas lacking significant seepage are characterized by the Calcareous Riverside Rock Outcrop community. As in UPDE, succession appears to be arrested by frequent flood and ice scouring, while the stable substrate appears to favor perennial over annual herbaceous species.

Invasive Communities

Reed Canarygrass Riverine Grassland

Reed canarygrass is a cosmopolitan species and was present in North America prior to European settlement. However, it is believed that the introduction of European cultivars led to reed canarygrass becoming an aggressive invader of wetland and riparian habitats (Lavergne and Molofsky 2004). Factors such as disturbance, changes in hydrologic regime, and nutrient run-off can enhance reed canarygrass establishment and spread. Reed canarygrass can be outcompeted by native vegetation under natural nutrient conditions, but with nutrient-enrichment typical of agricultural run-off (especially elevated nitrate concentrations), reed canarygrass quickly outcompetes and displaces native species (Green and Galatowitsch 2002; Perry et al. 2004).

This community is included in the two shoreline conceptual models as it was nearly always present and it was difficult in many cases to determine which community it had displaced. The distribution of reed canarygrass appears to be restricted to landforms with ample moisture, either through fine-textured soils with adequate water holding capacity or close proximity to the water table. In the case of sloping scour shorelines, the proximity of steep upland slopes likely results in groundwater discharge (seepage) within the narrow floodplain. In the high floodplain terrace scour shorelines, reed canarygrass occurs on low terraces with fine-textured moist soils. On the Delaware River, reed canarygrass may also occur on higher terraces (often under forest and woodland canopies) with finer textured soils that are not subject to drought. It appears to be less successful in invading severely scoured habitats and/or habitats that experience drought.

Japanese Knotweed Vegetation

Japanese knotweed is a very aggressive species in the Delaware River floodplain communities. Japanese knotweed is a creeping perennial that forms an extensive network of rhizomes that may spread 7 to 20m from the parent plant and to a depth of 2m (McHugh 2006). Propagation can be from seed, root, or stem fragments as small as 1cm. On floodplains, propagules germinate or root quickly on bare soil and will soon begin to form a colony. Japanese knotweed grows to a height of approximately 3m and forms very dense stands. Native herb flora are quickly outshaded and soon extirpated, resulting in a monoculture. Field observations on the Delaware River also suggest tree and shrub regeneration is non-existent under knotweed canopies. As

knotweed often dominates the understory of many mature silver maple and sycamore stands, this may have implications for future floodplain forest regeneration. Like reed canarygrass, Japanese knotweed prefers habitats with ample available moisture and often dominates the herb and shrub layer on floodplain terraces throughout the study area, particularly where fine-textured floodplain soils are present. Knotweed tends not to persist or grows poorly in severely scoured habitats or habitats that experience drought conditions.

Blue-New-Gauley River System Communities

The following section contains conceptual ecological models describing the processes that affect the development of riparian plant communities for the parks/recreational areas associated with three WV rivers: the Bluestone River, Gauley River, and New River. Since these rivers share similar geomorphic settings and overlap in plant species and plant community composition, they were treated collectively in the models below. Any differences are noted.

Flatrock Scour - (Gauley River, New River)

Gauley River

The flatrock scour setting found along the Gauley River differs from the same geomorphic setting described below for the New River. The few occurrences of the flatrock scour setting within GARI are composed of mostly low, flat rock outcrops, littered with boulder piles located above the active river channel. These rock outcrops are frequently flooded with little sediment accumulation and sparse vegetation. Habitat suitable for plant colonization and establishment is limited to fissures and potholes in the exposed bedrock and boulder piles.

New River

The flatrock geomorphic setting on the New River is characterized by two plant communities, Riverscour Prairie and Eastern Red-cedar - Virginia Pine Flatrock Woodland (see Figures 14 and 15). The flatrock setting occurs where Stony Gap sandstone of the Hinton Formation (Mauch Chunk group) has been exposed to reveal flat sheets of bedrock (Vanderhorst et al. 2007). It is considered rare and is limited to only three locations along NERI: Camp Brookside, Sandstone Falls, and Keeny Creek (Mitchem and Johnson 2001; Mahan 2004). The flatrock setting occurs immediately above the river in association with rapids. Anecdotal evidence suggests that catastrophic, periodic flooding events aided in the formation and maintenance of this feature (Johnson 2002; Mahan 2004). Sporadic scouring by floods help maintain a unique community of xeric species not typically associated with floodplains (Johnson 2002). However, placement of the Bluestone Dam along with regulation of waterflow has drastically reduced the potential occurrence of large-scale flood events thus resulting in soil formation and encroachment by hardwood species and invasives.

Based on its location within NERI and dominant plant communities, the flatrock geomorphic setting can be further subdivided into high flatrock and low flatrock. The high flatrock setting occurs at Camp Brookside and Sandstone Falls where the river is wider and less constrained. Eastern Red-cedar - Virginia Pine Flatrock Woodland is the dominant community found on the high flatrock feature (see below for a more detailed description of community characteristics). Soils within this community are shallow, rapidly drained sands and sandy loams over bedrock

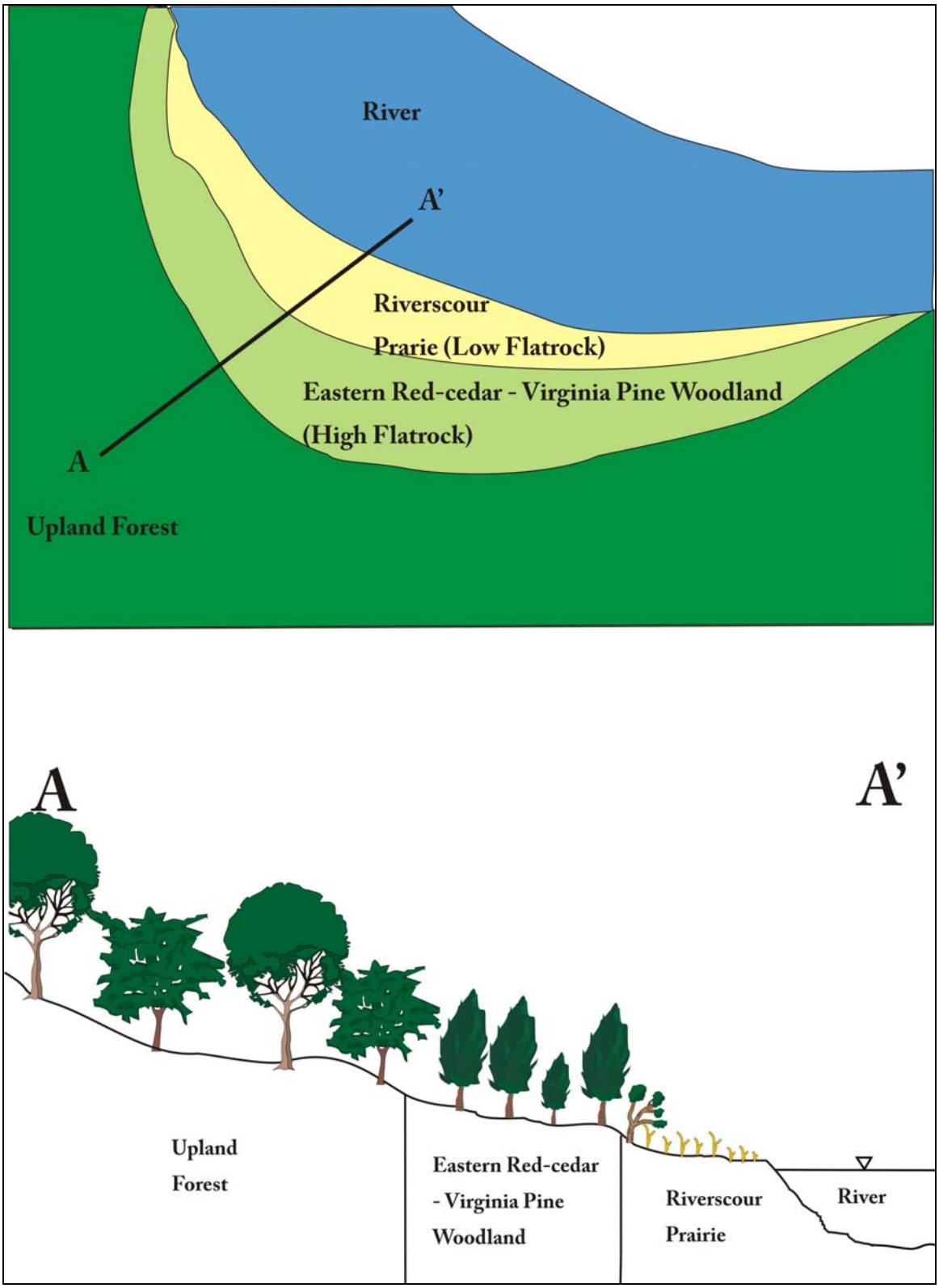

Figure 14. Generalized pattern of vegetation on low and high flatrock scour found in a few locations in NERI.

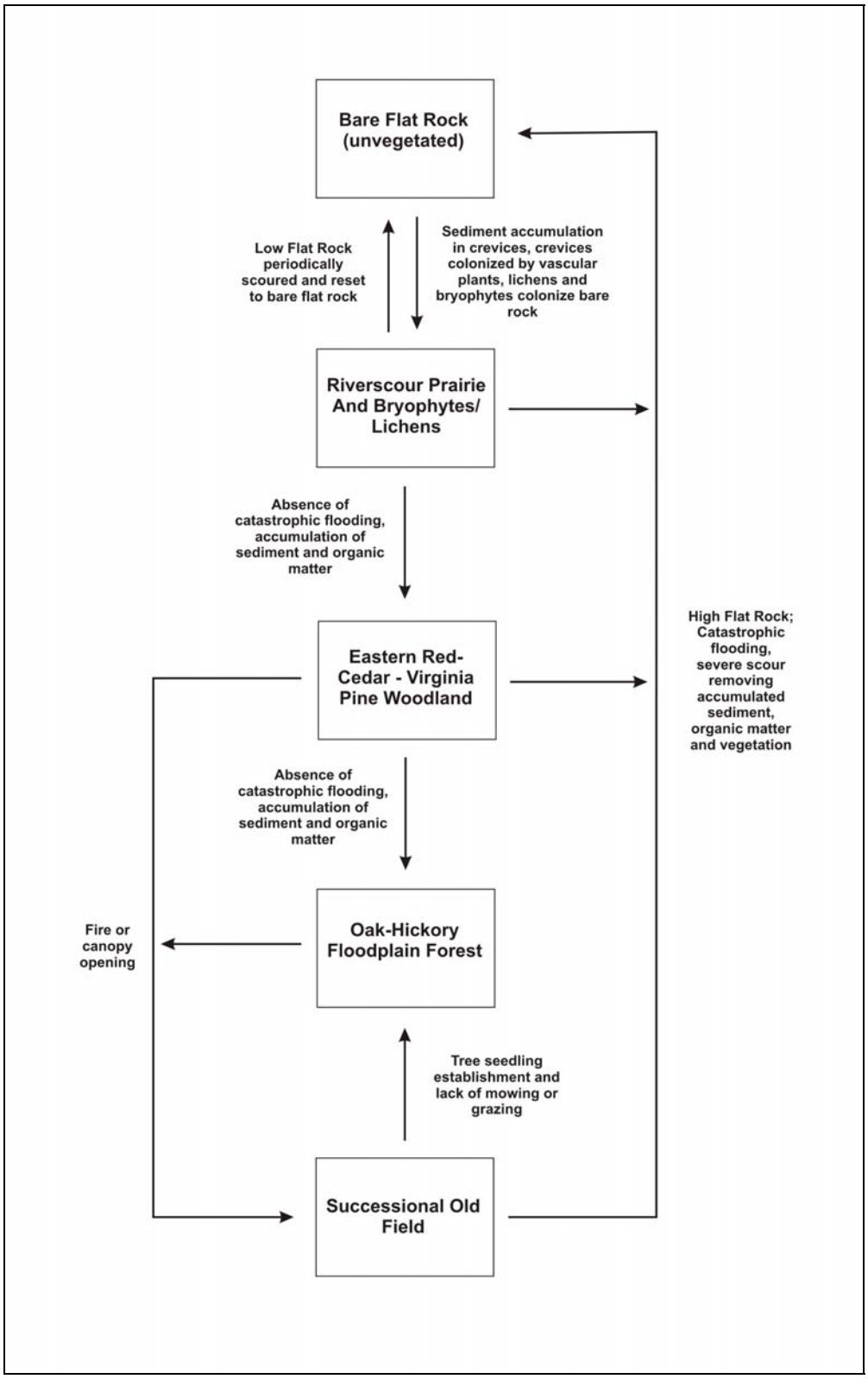

Figure 15. Ecological model of plant community dynamics for low and high flatrock scour found in a few locations along NERI.

(Vanderhorst et al. 2007). Catastrophic flood events once maintained this community but waterflow regulation coupled with the location of this community in proximity to the river channel (located along a wider, less constrained portion of the New River) has greatly reduced maximum flow and energy from floodwaters. This community supports several species of concern in WV, however, it is prone to disturbance by recreational activities and invasion by exotic wine raspberry (*Rubus phoenicolasius*).

The low flatrock setting is found in a few locations within NERI, including Keeny Creek and Camp Brookside (Mahan 2004). In this area, the river basin is narrow and constrained and prone to frequent, high energy flooding events. The flat bedrock is marked with fissures and potholes from flood scour. These defects allow for minimal soil accumulation, some water retention, and also allow for the growth of the Riverscour Prairie community. Exotics (such as *Sedum sarmentosum* and *Lespedeza cuneata*) are invading and seem to be increasing the rate of sediment accumulation (J. Vanderhorst, personal communication). State rare plants have been documented within this community.

The Eastern Red-cedar - Virginia Pine Flatrock Woodland is associated with higher elevation (relative to the active river channel) areas that appear to have been subjected to infrequent catastrophic flood events. During these events it is hypothesized that most or all of the accumulated soil is removed, leaving a relatively barren, rocky substrate. The most exposed areas adjacent to the active channel are dominated by lichens and bryophytes consistent with primary succession on a dry, bedrock substrate. Although adjacent to the active channels, these areas are sufficiently above the active river channel to avoid frequent flooding. Adjacent to this zone, the environment becomes less barren, with some accumulation of soil and soil organic matter. Under these conditions, there is an increase in drought tolerant herbs and woody species. Because the soils are very thin and poor, and the fact that the site fails to flood in most years, the vegetation is more similar to xeric dry cliff and cliff-rim vegetation. This community requires catastrophic flood events to remove accumulated soils and “reset” community succession. It is an open question as to how long lived this community type is before it succeeds to mesic forest (as shown in Figure 15 with the inclusion of Oak - Hickory Floodplain Forest representing a potential climax community within this geomorphic setting) or (prior to dam construction) is reset to a more open, barren rock condition.

Attempts to manage the community and prevent succession to more mesic terrestrial communities are unlikely to succeed without addressing the accumulation of increasingly richer soils. Even with periodic controlled high flow events, the lack of larger severe catastrophic floods will lead to the encroachment of more mesic upland vegetation and a narrowing of habitat suitable for flatrock scour plant communities. The amelioration of catastrophic flood flows by flood control dams may have relegated some occurrences of these communities to a “fossil community” status, and the flatrock scour plant community will eventually disappear through succession to riparian and mesic terrestrial forests.

<u>Sloping Shorelines - (New River)</u>

This geomorphic setting occurs in NERI along slow flowing, less constrained straights in portions of the river. A narrow stretch of floodplain usually occurs adjacent to high terraces or steep banks dominated by upland forest species. Soils consist of deep sandy sediments and are

the result of low-energy flood events. Figure 16 shows general patterns of vegetation for sloping shorelines found along the New River. Figure 17 is a conceptual model for sloping shorelines showing the processes that affect plant communities within this geomorphic setting.

Plant associations occur in linear zones reflecting stratification by elevation above the active channel and hydrology. Riverbank Annuals are found within and adjacent to the active channel shelf where flooding is frequent and extended periods of inundation occur. Patches may be ephemeral, but this association will likely persist under natural and altered flooding regimes (Vanderhorst et al. 2007). The zone above the Riverbank Annuals is dominated by Riverbank Tall Herbs. This association occurs on well-drained riverbanks that experience temporary flooding. This zone often contains seedlings and saplings of forested floodplain species and serves as an intermediary zone between the river and the floodplain forest. The floodplain forest is patchy and may contain a mixture of the following forest associations: Silver Maple Floodplain Forest, Sycamore - Ash Floodplain Forest, and Oak - Hickory Floodplain Forest. Silver Maple Floodplain Forests and Sycamore - Ash Floodplain Forests are more tolerant of temporary low-energy floods whereas Oak - Hickory Floodplain Forest occurs in small patches on the highest positions of river floodplains that are infrequently flooded. All three forest communities occur on well-drained sands and sandy loams.

High terraces may also be part of the sloping shoreline complex. These areas have finer alluvial deposits and may have once been cleared for agriculture or habitation. High terraces may experience temporary seasonal flooding and support mixed patches of floodplain and upland species. Successional Box-elder Forests and Sycamore - Ash Floodplain Forests occur on high terraces.

The development of plant communities in this geomorphic setting reflects lower flow velocities than observed elsewhere on the New River. Reduced flow velocity allows the accumulation of fine sand and sandy loam sediment, which favors both the Riverbank Annual and Riverbank Tall Herb communities. Prolonged periods of inundation with minor scouring and deposition create a zone of bare to sparsely vegetated substrate that can be colonized by Riverbank Annual species every summer. Above this zone, inundation is less frequent and of shorter duration, allowing the persistence of perennial herbaceous species (Riverbank Tall Herb community). This zone may be wholly to partially shaded by the canopy of adjacent floodplain forest communities. This community may revert back to the Riverbank Annual community if the bank undergoes erosion and the substrate elevation is reduced. Sediment accumulation in the Riverbank Tall Herb community or a reduction in hydroperiod (e.g., through altered flow regimes) would favor succession to a floodplain forest community. Where the substrate is somewhat coarser (underlying alluvial substrate is coarse sand, gravel, and/or cobbles), the forest association is more likely to be the Sycamore - Ash Floodplain Forest, whereas finer sediments would favor the Silver Maple Floodplain Forests. Both of these associations can tolerate periods of flooding, but the Silver Maple Floodplain Forest can better tolerate the lower oxygen availability associated with finer alluvial sediments. The Oak - Hickory Floodplain Forest contains vegetation more characteristic of mesic upland forests. The presence of this community indicates infrequent, short duration flooding. The occurrence of this community may indicate the accumulation of deeper (and higher elevation) sediment over time, down cutting of the active channel (putting the community at a higher elevation relative the active channel), or flow alteration (less frequent and shorter duration flooding).

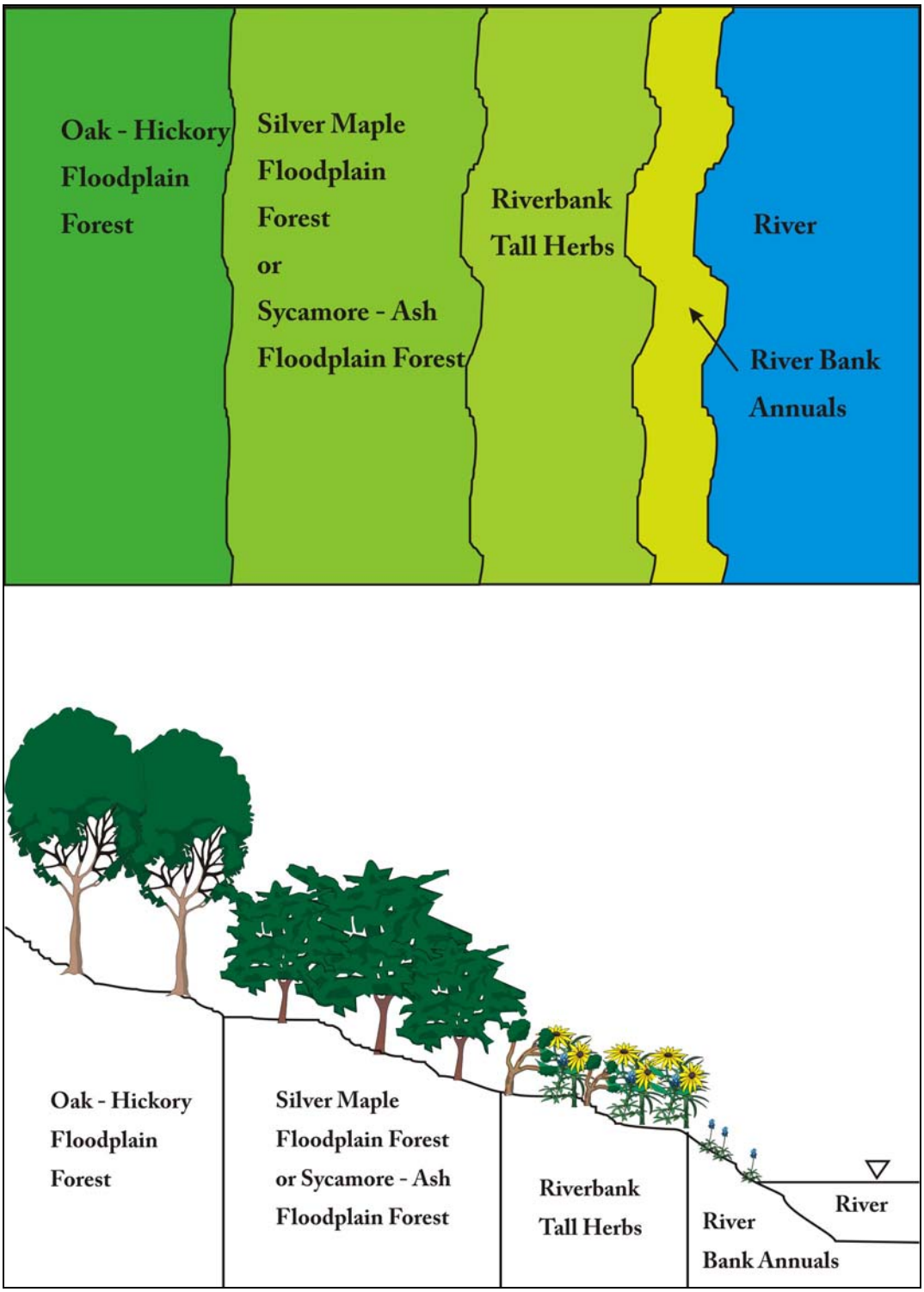

Figure 16. Generalized pattern of vegetation found on sloping shorelines along the New River.

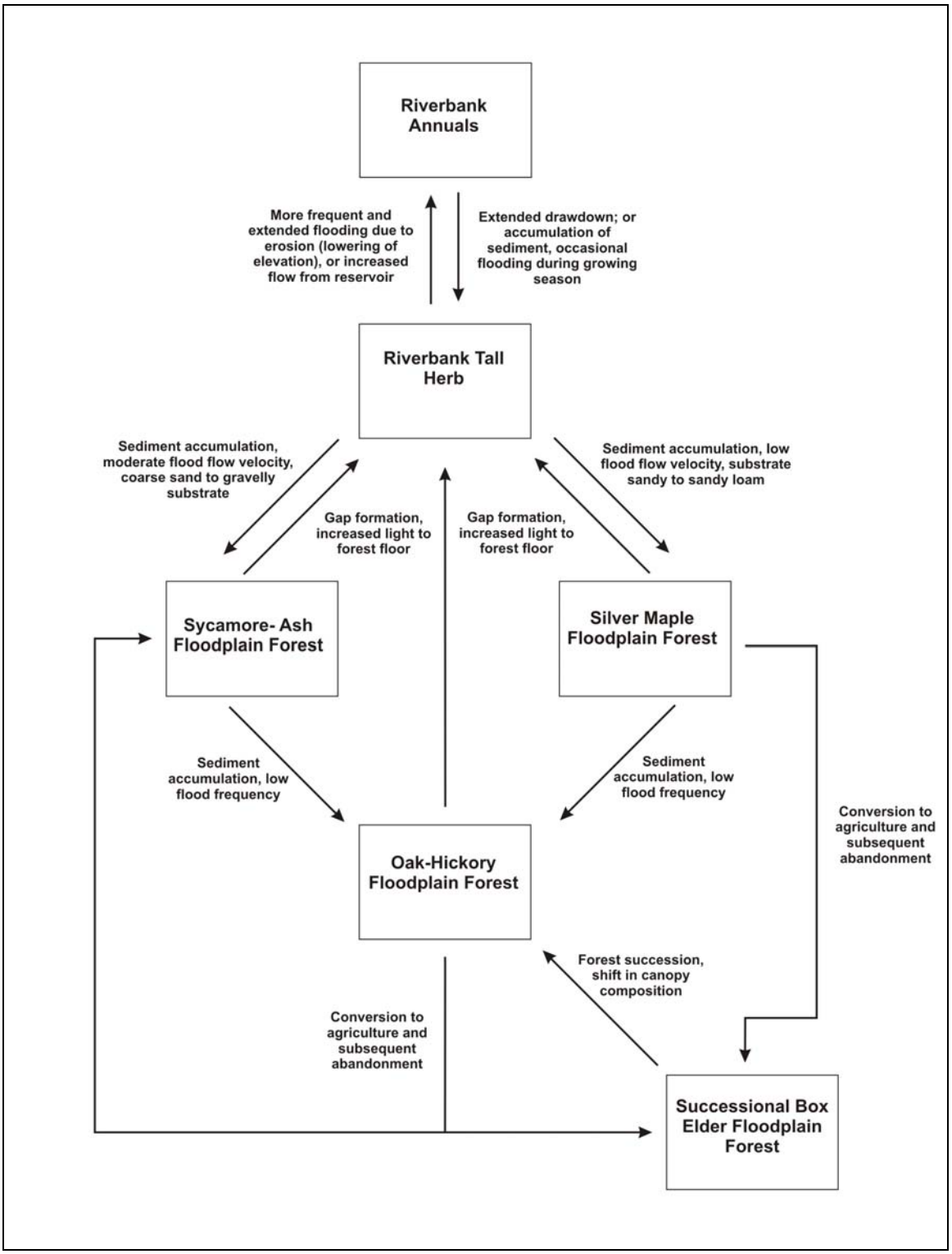

Figure 17. Ecological model of plant community dynamics for sloping shorelines found along the New River.

Where high flat terraces occur as part of this geomorphic setting, there is often a history of land clearing and agricultural use. On the New River, these areas are often dominated by successional communities such as the Successional Box-elder Forests. Elements of these communities are adapted to colonizing bare substrates typical of abandoned farmland and persist for some time. These communities may be long-lived if they are flooded frequently, however, depending on position on the terrace, they may succeed to the Oak - Hickory Floodplain Forest over time.

Scour Shorelines - (Bluestone River, Gauley River, and New River)

Scour shorelines occur on all three West Virginia rivers but vary in extent and floristic composition. This variation reflects differences in biogeography, stream size, and stream gradient. Figure 18 shows a general pattern of vegetation for scour shorelines found along the Blue-New-Gauley river system. Figure 19 is a conceptual model for scour shorelines showing the processes that affect plant communities within this geomorphic setting.

Bluestone River

Scour shorelines occur along most straight sections of the Bluestone River where the river channel is constrained and subjected to frequent, high-energy floods. This geomorphic setting is characterized by a narrow band of cobble and boulder deposits adjacent to the active channel that quickly transitions into a floodplain forest and eventually upland forest. The best developed scour shorelines are found along the upper reaches of BLUE where flooding from reservoir backup has little impact on riparian communities. However, a degraded version of this community occurs along the natural river channel, embedded in the reservoir backup zone from the Bluestone Dam. In areas subject to inundation from reservoir backup, floodplain forest and the Riverbank Tall Herb vegetation types are likely to expand at the expense of the Sycamore - River Birch Riverscour Woodland.

Plant associations that occur in this geomorphic setting may vary within BLUE but tend to follow a general pattern. A narrow zone of boulder-cobble is often present along the river's edge. Due to direct exposure to high-energy flood events, soil formation is often nearly nonexistent. This zone is characterized by the Sycamore - River Birch Riverscour Woodland on the Bluestone River. Colonization by sycamore and river birch reflect tolerance to battering by flood flows and corrasion by streambed materials (cobbles and boulders). The herb layer in this community does overlap somewhat with the Riverscour Prairie community seen on the New and Gauley Rivers, but the Bluestone River appears to lack the stream velocity and/or flood frequency to favor prairie vegetation over woodland (Riverscour Prairie tends to occur on the New and Gauley Rivers where flood frequency and severity near the active channel eliminates all or most woody vegetation). Big bluestem dominates the herb layer where the substrate is drought-prone (sand, gravel, and cobbles).

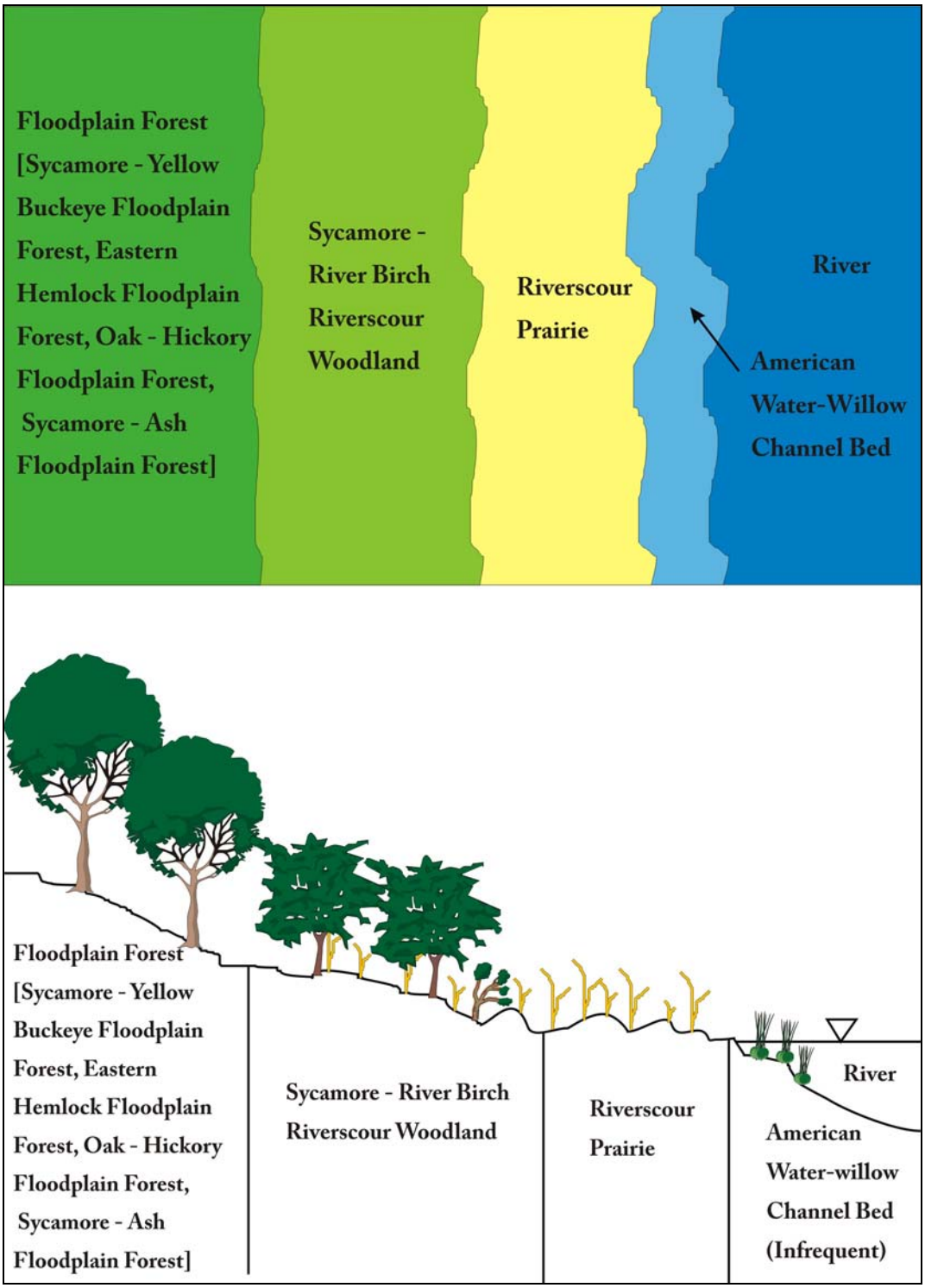

Figure 18. Generalized pattern of vegetation found on scour shorelines along the Blue-New-Gauley river systems.

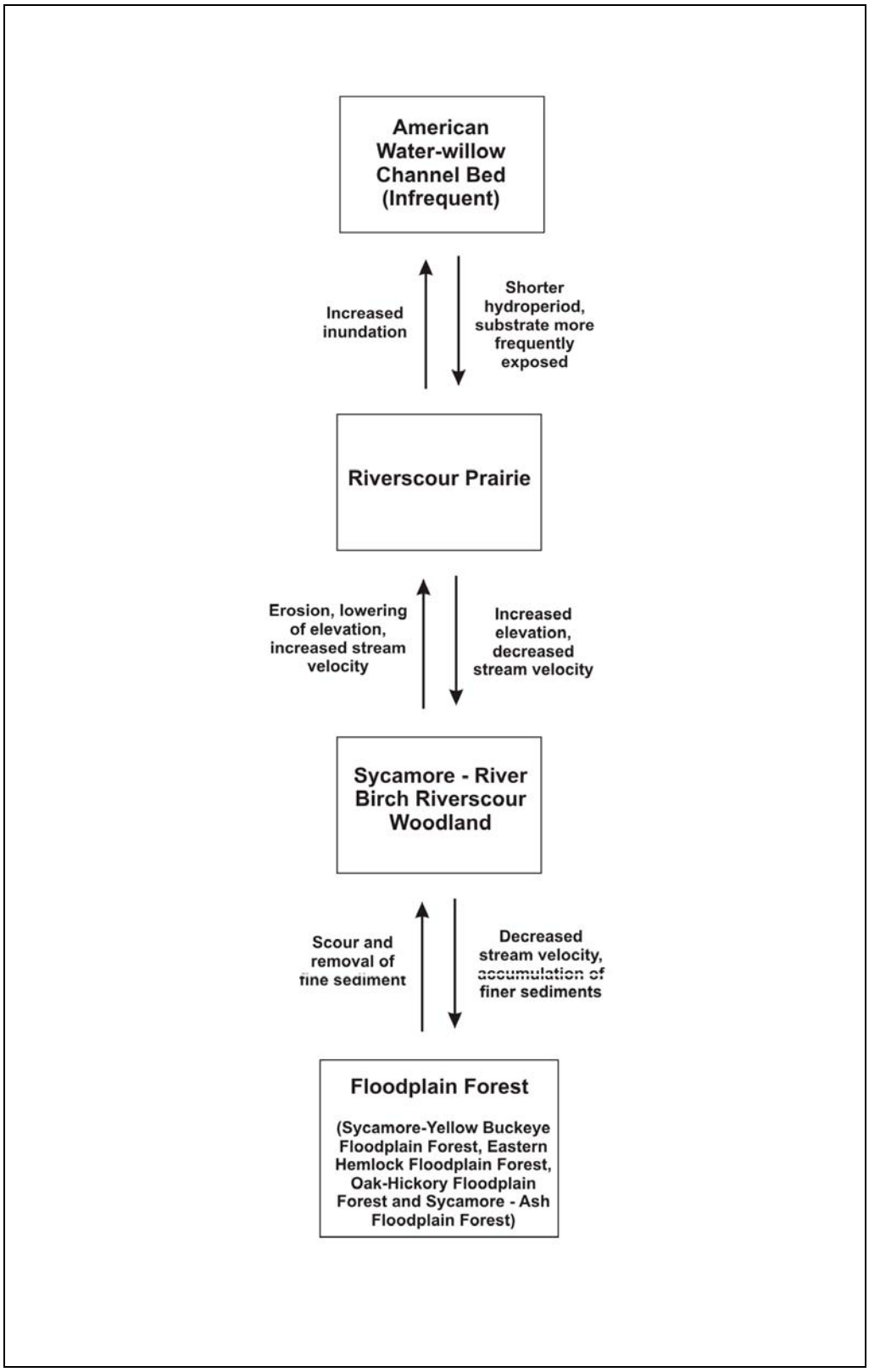

Figure 19. Ecological model for plant community dynamics for scour shorelines found along the Blue-New-Gauley river systems.

Within the river scour zone, there may be small patches with finer silt and sand sediments that form behind boulders and other streambed obstructions. These areas may be colonized by a suite of robust herbs characteristic of the Riverbank Tall Herb association. This community becomes more prevalent at higher elevations above the active channel where the proportion of fines in the soil increases. Above the active scour zone, this community occurs in small patches along the edge or in gap openings within floodplain forests (i.e., Sycamore - Yellow Buckeye Floodplain Forest, Eastern Hemlock Floodplain Forest, and Oak - Hickory Floodplain Forest). Beyond the floodplain forest community composite, this geomorphic setting may transition immediately into upland forest or may transition first into another geomorphic setting (see Floodplain Terraces) then into upland forest.

Gauley River

Scour shorelines are the major geomorphic feature of GARI. Because the Gauley River is a very high-energy river flowing through constrained channels with controlled flood events (from dam releases), the shoreline experiences regular scour action. Scour shorelines are characterized by coarse substrates consisting of boulders and cobble. Gravel and sand accumulation is minimal and limited to boulder shadows and boulder interstices. These areas are directly impacted by most flood events. In addition to the scour shoreline, some areas of the Gauley River also have an upper cobble bar that is usually only affected by the higher flood events. The substrate of the upper cobble bars is usually a mixture of cobble and sand.

The movement of large boulders and cobbles during flood flows tends to eliminate most vegetation from seasonally exposed channel shelves. These areas are characterized by small patches of American Water-willow Cobble Bar where water remains at or near the surface and by Riverscour Prairie where the substrate is exposed (and dry) for much of the summer. Many of the Riverscour Prairie species are drought tolerant and/or have tap-roots and can tolerate the seasonal drought conditions associated with the coarse sand, gravel, and cobble substrate. At slightly higher elevations farther away from the active channel, woody vegetation is better able to withstand flood flows and boulder corrasion, reflecting lower stream velocities away from the active channel. In this zone, the Riverscour Prairie usually transitions into the Sycamore - River Birch Riverscour Woodland. Above this zone, the vegetation usually transitions abruptly into upland forest. In some instances, the floodplain is adjacent to a low floodplain terrace subject to inundation during more extreme flood events. These terraces are typically dominated by Eastern Hemlock Floodplain Forest on colluvial boulder fields or sandy alluvial deposits. The dominance of hemlocks, which are intolerant of anaerobic soil conditions, indicates that although flooding occurs, the duration is short. The dominant vegetation type is Virginia Pine Floodplain Forest in some situations, where the drought-prone substrate is very coarse boulders or thin soil over bedrock. Drought-prone, thin soils combined with occasional catastrophic flooding may prevent succession to Eastern Hemlock Floodplain Forest, which appears to occupy similar, but more mesic terraces at the same elevation above the active river channel. Moderation of extreme flood flows by the Summersville Dam may prevent scouring in this community, with the subsequent accumulation of fines and organic material favoring succession to the Eastern Hemlock Floodplain Forest association. This vegetation may be analogous to the Eastern Red-cedar - Virginia Pine Flatrock Woodland association on the New River.

New River

Plant associations that occur on this geomorphic setting usually follow a general pattern. A narrow zone of boulder and cobble scour zone is present parallel to the river's active channel. This zone is directly exposed to scour from high-energy flooding. Flood events are mostly the result of dam releases to control reservoir water levels and direct flow from the Greenbrier River, which is not dammed. The biggest floods usually occur in the winter. Flotsam lines along the shoreline provide evidence of flooding. Colonization of the scour zone is patchy and the first community found growing in the interstices of boulders and cobble is usually American Water-willow Cobble Bar. Because this community is capable of surviving in saturated and semi-saturated habitats, it may occur both within the shallows of the main river channel and along the drier scour shoreline.

As with the Gauley River, the Riverscour Prairie community can also be found colonizing boulder and cobble interstices. The Sycamore - River Birch Riverscour Woodland usually grades into the Riverscour Prairie and may be more directly associated with the upper cobble bar portion of the shoreline than the lower scour area. Trees in this community, closest to the river, show signs of very high-energy flooding. They are often leaning, scarred, contorted, and/or their roots are exposed through floodwater erosion. Flood action also helps to maintain a fairly open canopy in this community. Before grading into upland forests, the Sycamore - River Birch Woodland may transition into the Sycamore - Ash Floodplain Forest.

Slackwater Shorelines - (New River)

Slackwater shorelines appear as small patches, widely scattered along the shorelines in NERI and are absent from BLUE and GARI. These shorelines occur downstream from rapids in the "eddy-zone". As a result of frequent, low-energy flood events, this geomorphic setting is characterized by fine-alluvial sediments with little cobble deposition. These areas often resemble wet beaches at low water. Evidence of flooding is apparent from flotsam piles accumulated by eddy flow. Flooding and upland seepage help maintain saturated soils. Figure 20 shows a general pattern of vegetation for slackwater shorelines along the New River. Figure 21 is a conceptual model for slackwater shorelines showing the processes that affect plant communities on slackwater shorelines along the New River.

Due to the hydric nature of soils in this geomorphic setting, vegetation is tolerant of saturated soil conditions. American Water-willow Cobble Bar occurs adjacent to the river's edge along with overarching patches of Black Willow Slackwater Woodland along drier portions of slackwater shorelines. In addition to these associations, Tall Riverbank Herbs may serve as a transition zone between high-frequency flooded areas to lower-frequency flooded areas dominated by Sycamore - River Birch Woodland upstream and downstream of the slack water areas. The hydrology and soils on site also appear suitable for establishment of Silver Maple Floodplain Forest, and indeed, silver maple is present at one site although uphill behind the flotsam line.

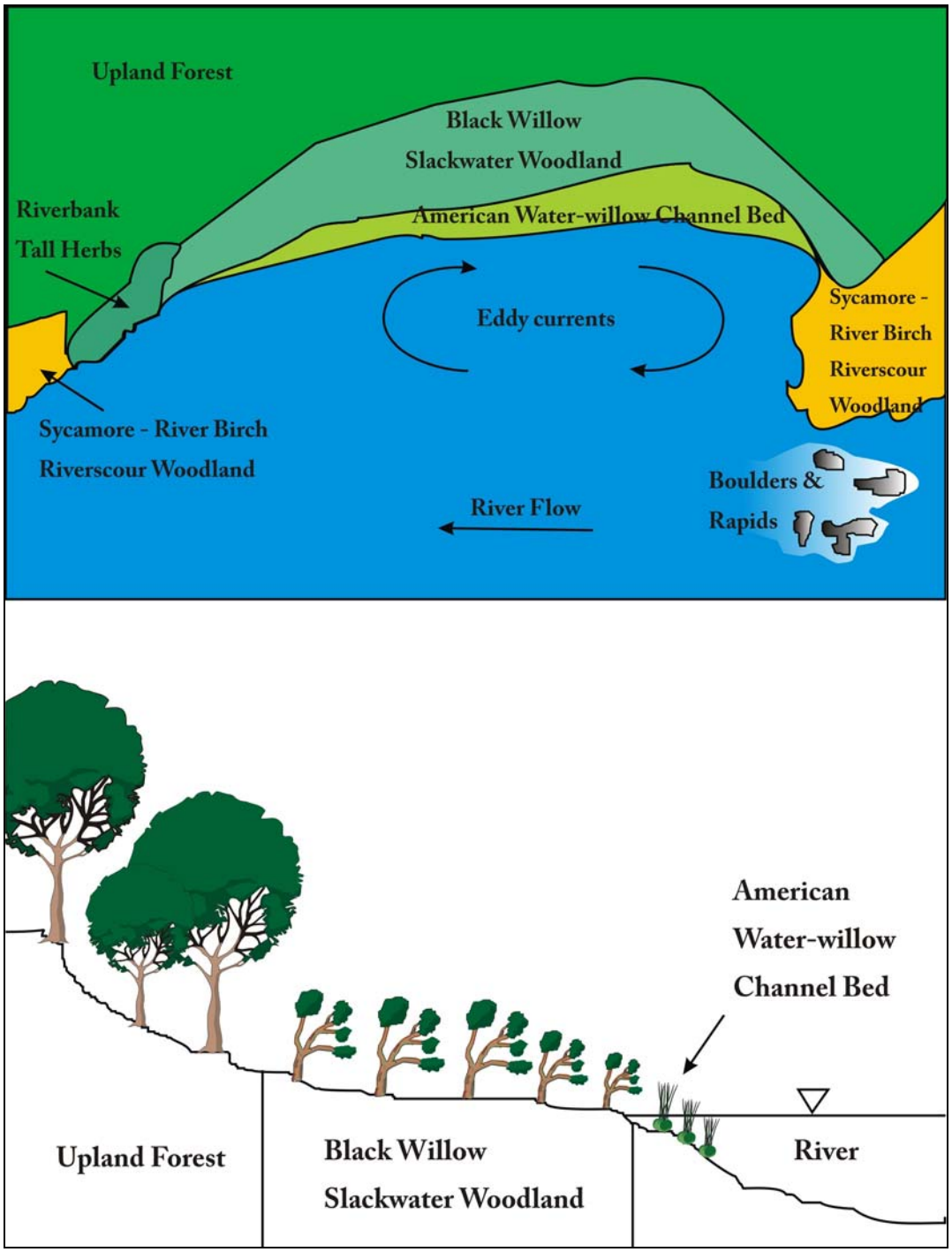

Figure 20. Generalized pattern of vegetation for slackwater shorelines along the New River.

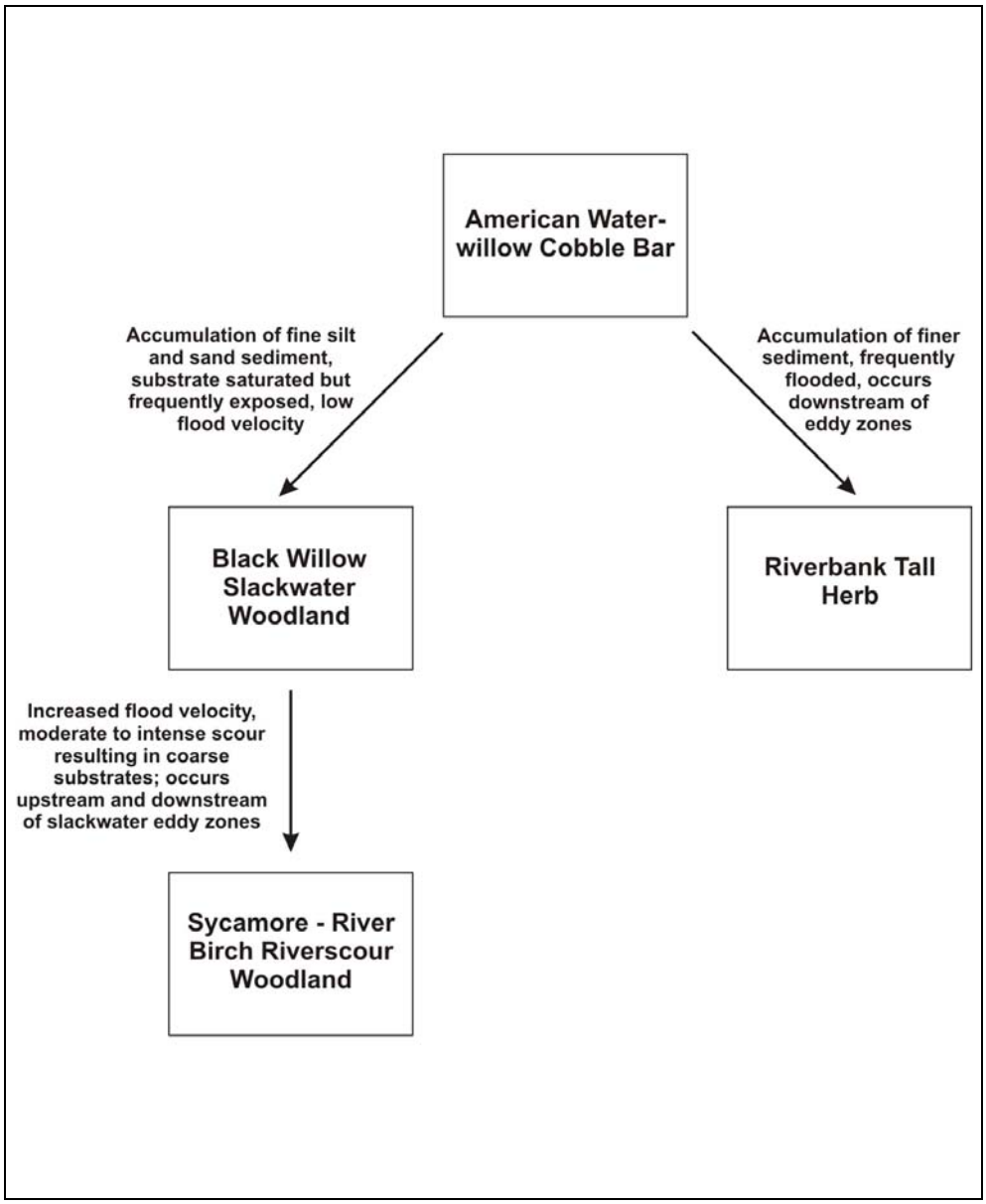

Figure 21. Ecological model of plant community dynamics for slackwater shorelines along the New River.

Tributary Floodplain Complex - (Bluestone River, Gauley River, and New River)

This geomorphic setting occurs along large, high-gradient tributaries of the Bluestone, Gauley and New Rivers. The shelves of these tributaries are prone to high-energy floods any time of the year. Vegetation along the shoreline is patchy and linearly oriented. Figure 22 shows a general pattern of vegetation for tributary floodplain complexes along the Bluestone, Gauley and New Rivers. Vegetation patterns are dictated by substrate and tolerance to high-energy floodwaters. Within the active channel shelf, high-energy flood events deposit boulders, cobbles, gravel, and sand. This area is typically semi-permanently saturated or temporarily flooded. In NERI, Twisted Sedge Rocky Creekbed occurs within this area of the floodplain complex. Moving away from the channel, substrates become more sandy and sandy loam. This area may be dominated by Tributary Floodplain Forest or Eastern Hemlock Floodplain Forest. On tributaries, these forest associations tend to occur in narrow stretches that quickly grade to upland forests and are prone to extensive damage by high-energy flood events. Oak - Hickory Floodplain Forest may also occur along tributaries of BLUE. Figure 23 is a conceptual model for tributary floodplain complexes showing the processes that affect plant communities within this geomorphic setting.

Point Bars - (Bluestone River, Gauley River, and New River)

Point bars are a geomorphic feature present along all three rivers. Point bars typically form on the inside of large bends in the river channel. Sediments eroded from the outer bend of the river are redeposited on the inner bend to form a point bar. Although these geomorphic features are larger and better developed on low-gradient, meandering rivers, the entrenched channels of the Blue-New-Gauley river system have some point bar features. Figure 24 shows a general pattern of vegetation for point bars along these three rivers in WV. Figure 25 is a conceptual model for point bars showing the processes that affect plant communities within this geomorphic setting.

Bluestone River

The Bluestone River has entrenched meanders where point bars have formed on the inner river bends. Point bar heads (upstream portion) are areas exposed to high energy flooding events. Substrates consist of boulders, cobble, gravel, and coarse sand with spare patches of American Water-willow Cobble Bar since this association is capable of withstanding prolonged flooding and high flow velocities. Beyond the boulder-cobble scour zone, the sparely vegetated floodplain often grades into upland forests. Point bar topography may vary and grade directly into the surrounding upland communities or may first be dissected by a backchannel (more or less cutting across the “neck” of the point bar) before transitioning into upland forests.

Vegetation patterns on point bars are somewhat similar to those found along scour shorelines. A narrow zone of boulder-cobble is usually present along the shore. This zone is directly impacted by high-energy floodwaters that dramatically limit soil development. The head of the point bar experiences greater scour action then the tail. Beyond the boulder-cobble scour zone is the Sycamore - River Birch Riverscour Woodland. High-energy floodwaters help to maintain an open canopy in this community and are evidenced by flotsam piles. Some point bars have elevated areas with patches of upland forest such as Successional Eastern White Pine - Tuliptree Forest. Eastern Hemlock Floodplain Forest dominates the high terrace of one point bar.

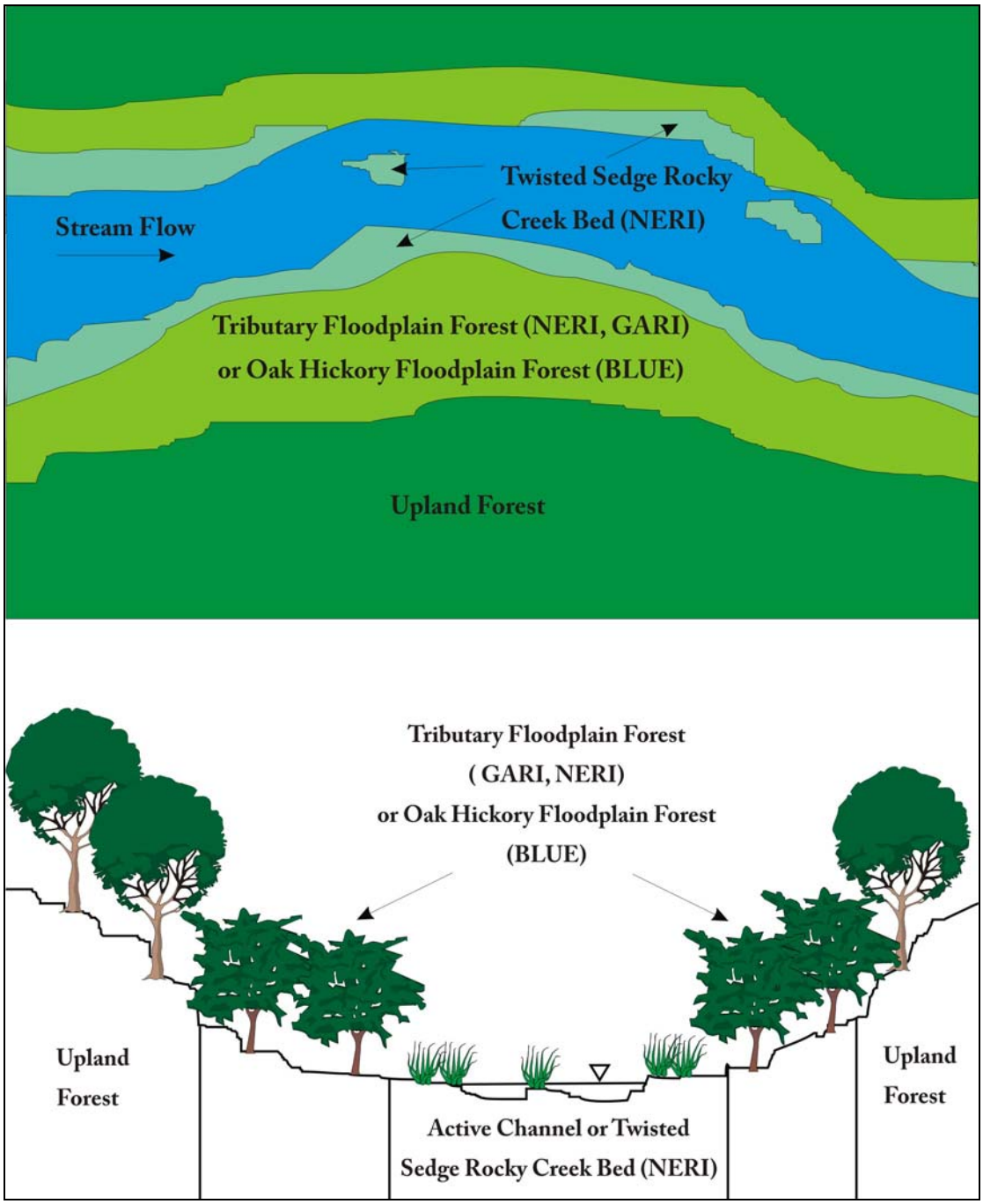

Figure 22. Generalized pattern of vegetation for tributary floodplain complexes along the Blue-New-Gauley river systems.

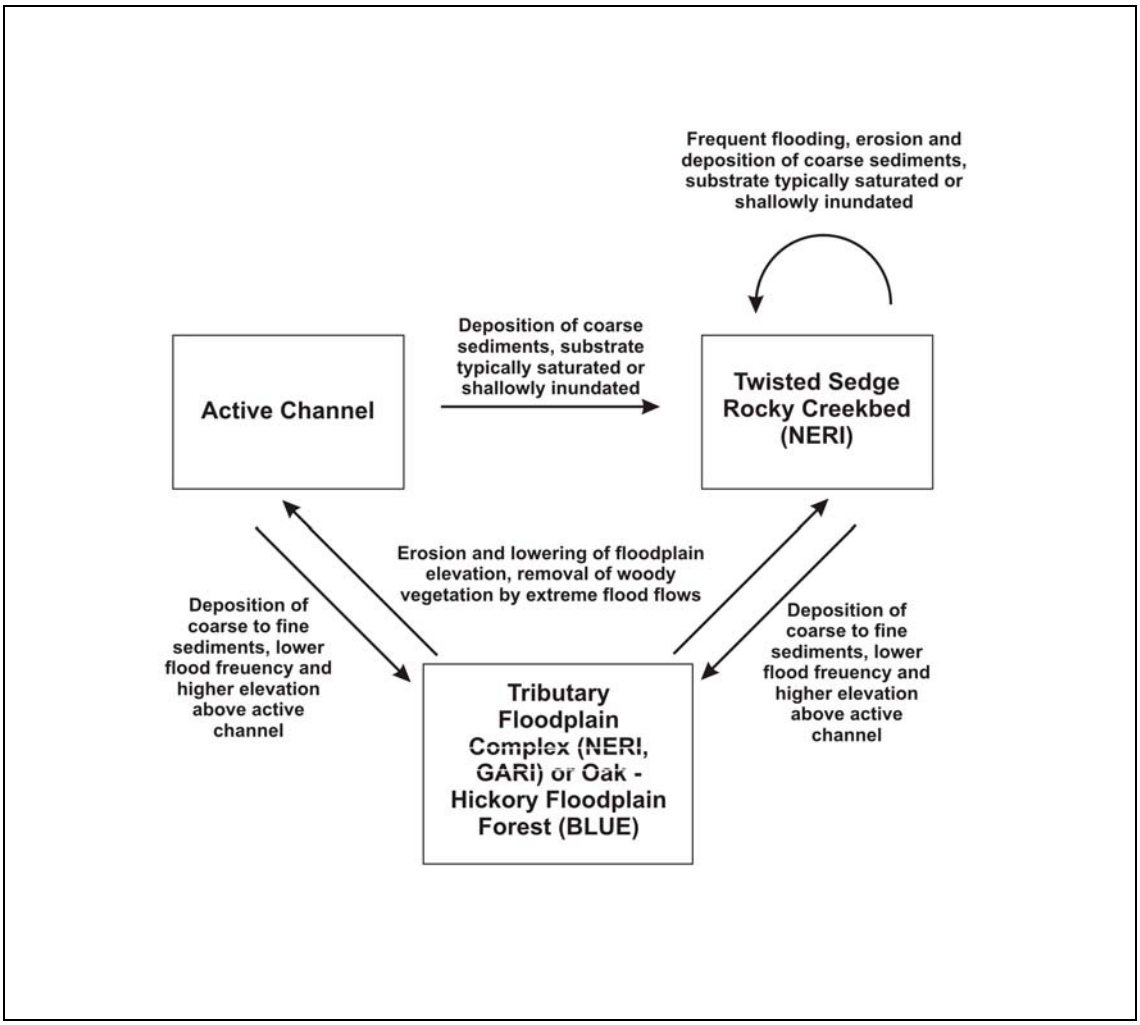

Figure 23. Ecological model of plant community dynamics for tributary floodplain complexes along the Blue-New-Gauley river systems.

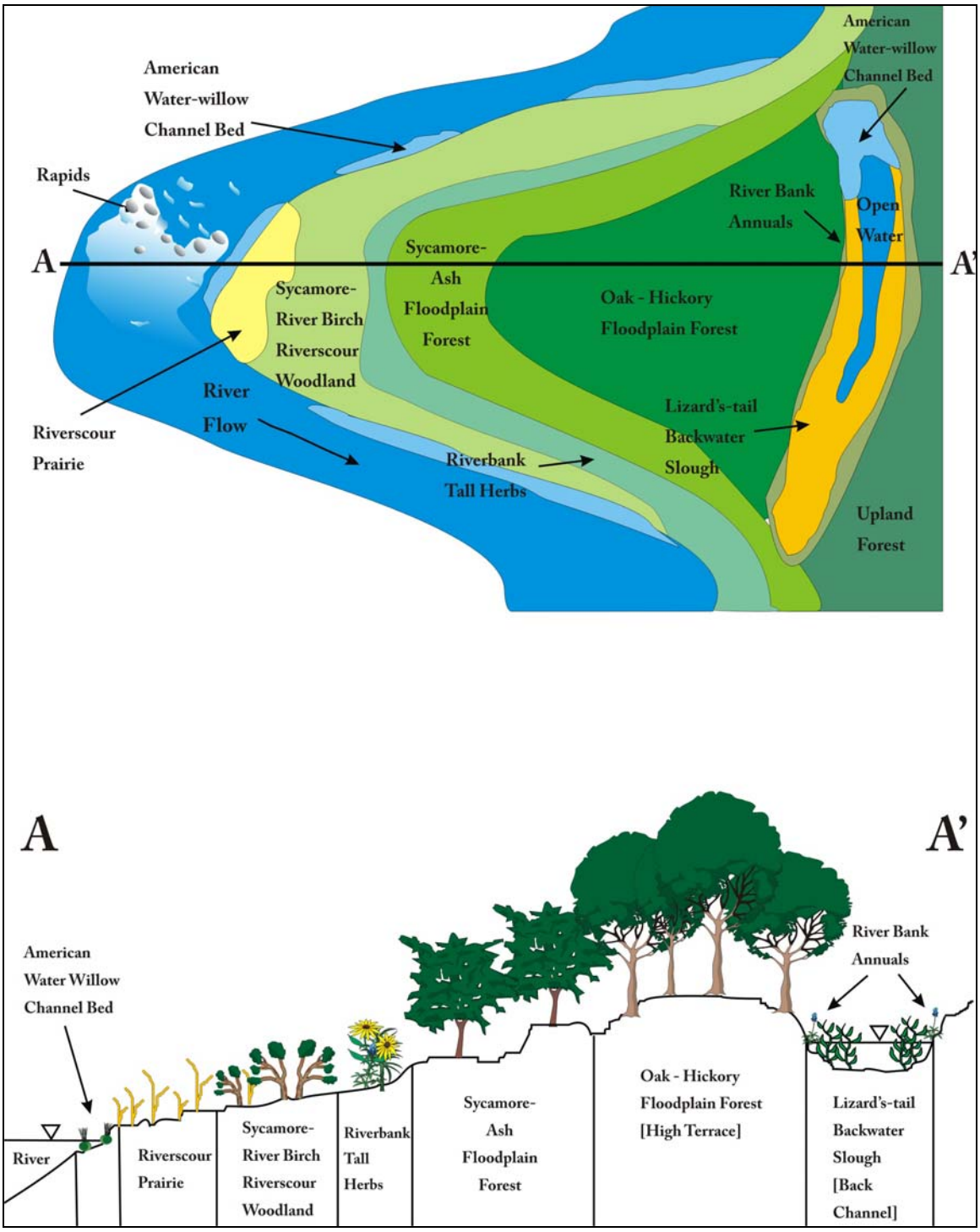

Figure 24. Generalized pattern of vegetation for point bars that occur along the Blue-New-Gauley river systems.

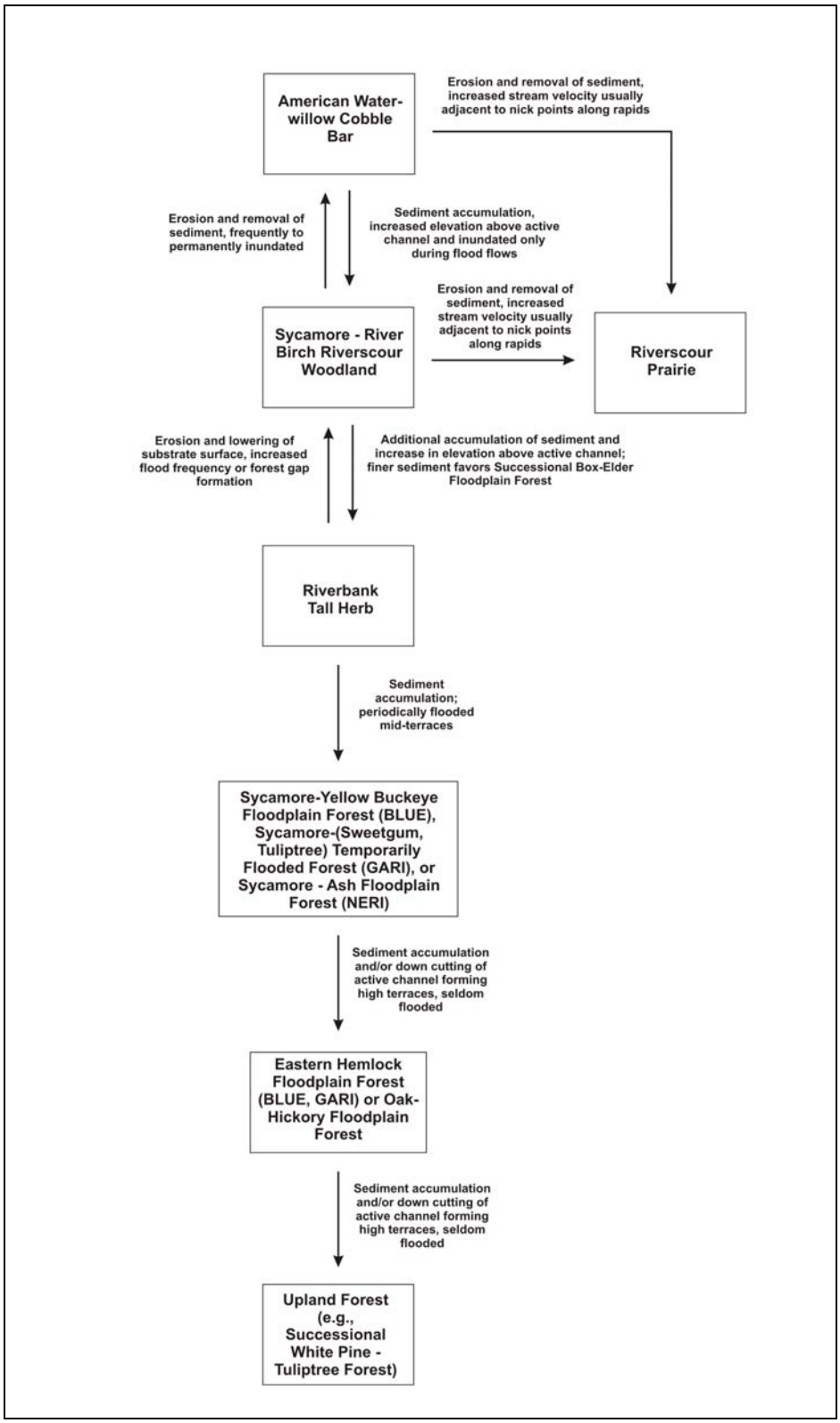

Figure 25. Ecological model of plant community dynamics for point bars that occur along the Blue-New-Gauley river systems.

Backchannels may be present behind point bars. These areas receive water inputs from flowing water during large flood events, eddy flow, seepage, upland surface runoff, and rain. Backchannels may have more ephemeral hydroperiods or may be permanent sloughs with periods of drydowns. Vegetation is variable and usually occurs along edges and shallower areas that become exposed during the growing season. In the reservoir backup zone of BLUE, backchannels are usually dominated by River Birch Backwater Floodplain Forest before transitioning into upland communities.

Gauley River

Point bars found along the Gauley River are not very similar to those found along BLUE and NERI. The head and sides of the point bars are directly exposed to high-energy floodwaters and prolonged flooding and consist of mostly scoured boulders and cobble. Downstream portions of the point bar and the tail are exposed to lower-energy flooding and may have interspersed sandy patches resembling small beaches. Woodland communities may be present beyond the scour zone and point bars may be dissected by a backchannel before transitioning into upland forests.

Vegetation patterns of point bars along the Gauley River are similar to those found along the previously described scour shorelines. Scoured boulders and cobble make up the shoreline. Vegetation is sparse due to the force of high-energy floodwaters and the lack of soil from floodwater induced erosion. American Water-willow Cobble Bar may be present within this zone. The Riverscour Prairie community may also be found colonizing boulder and cobble interstices. The more protected sandy patches along the downstream side and tail of the point bars may have patches of Riverscour Prairie with battered, stunted persimmon trees (*Diospyros virginiana*).

Within the high-energy scour zone, Sycamore - River Birch Woodland usually overlaps with the Riverscour Prairie. Higher elevation areas of the point bars may be dominated by Eastern Hemlock - River Birch / Rhododendron Woodland.

Backchannels are present on almost all point bars along the Gauley River. Flooding along with seepage, runoff, and rain serve as water inputs for backchannels. Some backchannels resemble boulder-lined ephemeral streams while others are more pool-like. The herbaceous layer is concentrated along the edges and shallower areas that become exposed during the growing season.

New River

Plant associations that colonize this geomorphic setting may vary within NERI but tend to follow a general pattern. Point bar heads (upstream portion) are areas exposed to high energy flooding events. Substrates consist of boulders, cobble, gravel, and course sand. Point bar heads may be dominated by American Water-willow Cobble Bar since this association is capable of withstanding prolonged flooding and high flow velocities.

The following communities may occur adjacent to the American Water-willow Cobble Bar (from low to high elevation above the active channel): Riverscour Prairie, Sycamore River Birch Riverscour Woodland, and Sycamore - Ash Floodplain Forest. These associations can withstand temporary inundation by medium to high-energy floods. Substrates are alluvial, including

boulders, cobbles, gravel, and sand, becoming finer as distance from the river channel increases. If a point bar has a low elevation gradient, Sycamore - Ash Floodplain Forest is the dominant forest community. This association is found on well-drained sands and sandy loams where low frequency and low energy flooding occurs. If a point bar has a higher elevation terrace, Oak - Hickory Floodplain Forests may also occur. The development of a litter layer and an organic soil horizon are evidence of low occurrence flooding within this community.

Point bar tails may experience frequent low-energy floods resulting in an accumulation of finer alluvial deposits. The tail is often colonized by American Water-willow Cobble Bar and Riverbank annuals.

Point bars on NERI may have backchannels that receive water inputs from the following sources: flowing water during large flood events, back flowing water during smaller floods (eddy flow), seepage, upland runoff, and rain. These backchannels are mostly permanent sloughs with periods of drydowns. Vegetation is variable and tends to occur along the edges or shallower portions that become exposed during the growing season. Backchannels may contain the following communities: American Water-willow Cobble Bar, Lizard's-tTail Backwater Slough, and Riverbank Annuals. This area may be prone to invasion by species like Japanese knotweed. Backchannels usually transition quickly into upland forests.

Islands - (New River)

The New River is the only river of the Blue-New-Gauley river systems that has established islands. Figure 26 shows a general pattern for islands in NERI. No significant islands exist in BLUE and those islands present in GARI are typically boulder piles with sparse, patchy vegetation.

New River

NERI contains both low and high islands with the higher islands having additional plant communities present as shown in Figure 26. Low islands in NERI lack an elevated terrace and the entire island may flood frequently. These islands are characterized by course substrate consisting of cobble and boulders. Gravel and sand may accumulate in cobble interstices by high-energy floods that retard soil development. Finer, alluvial deposits may occur on elevated portions of the island.

Low islands vary in their vegetational composition but tend to follow a general pattern. Most islands are surrounded by a scour shoreline consisting of cobble and boulder with no soil formation. Vegetation is sparse along this section of the island; however, the heads of some islands have patchy American Water-willow Cobble Bar communities. This community is able to tolerate hydric conditions and high-energy stream flow at the head of the island. American Water-willow Cobble Bar may also be present in the tail of the island in shallow water and temporarily exposed substrate. At slightly higher elevations, the American Water-willow Cobble Bar community may be replaced by the Riverscour Prairie community which is sparse near the active channel and may become moderately dense at high points on islands. Only one low island in NERI (Grassy Shoals), has a small patch of woodland on the highest point.

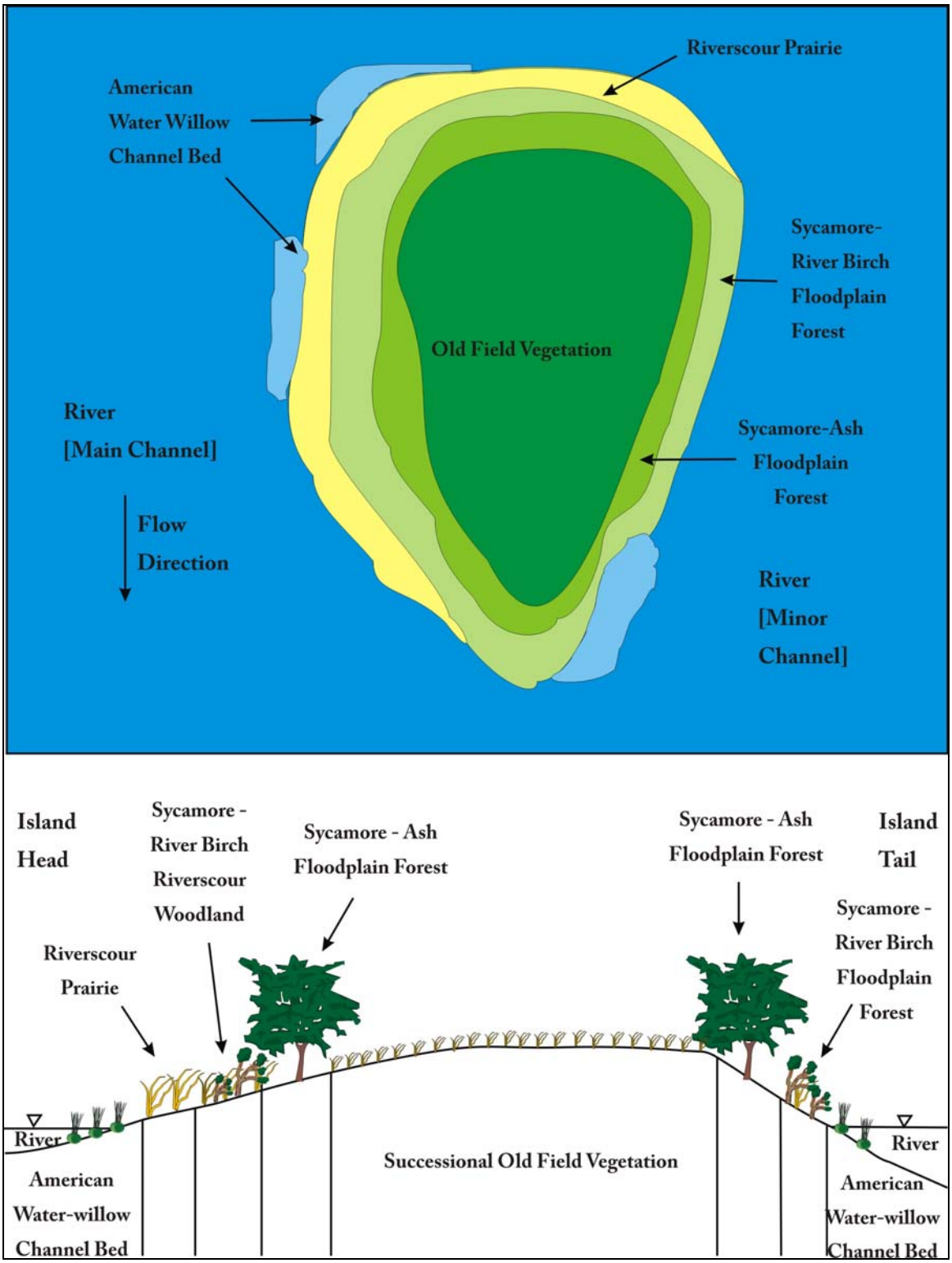

Figure 26. Generalized pattern of vegetation for high terraced islands that occur within the New River. Lower islands may lack the Successional Old Field Vegetation community.

Open woodland/forest communities often occur above the American Water-willow Cobble Bar and Riverscour Prairie communities. On uniformly low islands, Sycamore - River Birch Riverscour Woodlands may be quite extensive. This community occurs on coarse-textured substrates and may experience frequent high energy flooding. This community may also dominate the center of some islands, whereas, other low islands have Sycamore - Ash Floodplain Forests as their core community. Sycamore - Ash Floodplain Forests are found on finer alluvial deposits where less frequent and lower-energy flooding occurs.

Islands with higher terraces may transition from the Sycamore - Ash Floodplain Forests into an infrequently flooded, Successional Old Field Vegetation. The Successional Old Field Vegetation community is an artifact of previous agricultural use. Higher terraced islands were once cleared and farmed.

Low Floodplains and Floodplain Terraces - (Bluestone River)

Bluestone River

Low floodplains and floodplain terraces are most characteristic of the Bluestone River and are generally absent from the more steeply sloped New and Gauley River valleys. Low floodplains are scattered throughout the Bluestone River but occur mostly along the northern end where the confluence with Bluestone Lake (formed by the Bluestone Dam) causes backflow flooding of riparian communities. Frequent low-energy flooding contributes to the finer alluvial soils of this geomorphic setting and evidence of flooding is often apparent from the thin layer of fine silt coating floodplain vegetation. Along with backflow flooding, previous agricultural use has contributed to the semi-natural successional vegetation patterns within this geomorphic setting.

Vegetation communities along low floodplains occur in ill-defined patches but tend to follow a general pattern. Riverbank Tall Herbs generally occur on sandy floodplains adjacent to the Bluestone River where heavy annual alluvial deposits and full sunlight promote the growth of tall herbs (Vanderhorst et al. 2008). However, this community is not limited to the open shoreline and may occur with other communities associated with sloping shorelines and other geomorphic settings. This community may contain both state listed species of concern and invasive species.

Beyond the Riverbank Tall Herb community, the combined influences of previous agriculture and backflow flooding have created a complex patchwork of intergrading semi-natural successional vegetation types, degraded natural vegetation types, and weedy disturbed patches (Vanderhorst et al. 2008). This patchwork of communities persists on fine alluvial soils and is adapted for survival under temporary low-energy flood conditions (reservoir backflow and some natural flood occurrences). The Sycamore - Ash Floodplain Forest most likely occurs in small patches on the lower reaches of the floodplain along with Phase 2 of the Sycamore - River Birch Riverscour Woodland. The following modified successional communities occur along sections of the low floodplain that were once cleared for agriculture: Riverbank Tall Herb, River Birch Backwater Floodplain Forest, Successional Box-elder Floodplain Forest, Successional Black Walnut Floodplain Forest, and Successional Eastern Red-cedar Woodland.

Floodplain terraces are geomorphic settings found along the Bluestone River that are often associated with scour shorelines and low floodplains. As the name implies, floodplains terraces are elevated portions of the floodplain that are subject to infrequent flooding but still support some transitional floodplain species along with upland species. Soils in this geomorphic setting are usually sand to sandy loam and stone-free or somewhat stony. Accumulated litter on the soil surface serves as an indication of infrequent flood events.

Vegetation patterns of high floodplain terraces are an artifact of previous land use history. Many of these areas were once cleared for agriculture and since abandoned, with present communities composed of mostly semi-natural successional floodplain species mixed with upland species. The Oak - Hickory Floodplain Forest often occurs as a small, transitional community between more frequently flooded associations downhill and successional forests on previously farmed land uphill. On higher floodplain terraces, recently abandoned agricultural areas and cleared wildlife management areas may be dominated by Riverbank Tall Herbs and invasive species such as multiflora rose (*Rosa multiflora*). Older succeeding floodplain terraces may support patches of Eastern Hemlock Floodplain Forest and Successional Black Walnut Floodplain Forest along with upland species.

Suggestions for Monitoring Riparian Plant Communities

The National Park Service Inventory and Monitoring Program within the Eastern Rivers and Mountains Network (ERMN) has identified a number of vital signs to monitor the health of terrestrial and aquatic systems. Riparian plant communities are one of fourteen vital signs identified by the ERMN for long-term ecological monitoring (Marshall and Piekielek 2007). The following is a presentation of recommendations for elements to be included in a monitoring program of riparian plant communities with the overall goal being to better understand the current conditions and document how these conditions may change over time.

A monitoring program integrating measures of size, condition, and context will be useful in determining long-term trends of rare riparian plant communities. Size of the community can be used to assign priority status and track changes in extent over time. In this case, rare riparian plant communities of exceptional size may be given conservation priority while communities of small size may warrant restoration efforts. Condition in terms of anthropogenic impacts, substrate composition, vegetation structure, and vegetation demographics will provide data on the health and function of the riparian plant community. Impacts from visitor use (soil compaction, devegetation, and pollution) as well as immediate threats to species (roads, trails, campgrounds, and development) should be noted. Substrate variables such as the composition of unvegetated surface (coarse woody debris, leaf litter, bare soil, cobbles, boulders, gravel, etc), soil texture, and evidence of scour will be indicative of current flooding regimes. Measurements of structure and demographics include stratification of vegetation into herbaceous, understory, and canopy classes to derive importance values for species within each strata. Importance values can then be used to characterize the current vegetation structure and determine future cohorts of the community. Additionally, species diversity and species richness indices can be calculated to quantify the heterogeneity of a community. Context in this sense refers to the overall integrity of the community in the landscape. Threats to integrity may include encroaching development or agriculture which can result in pollution deposition, eutrophication, and sedimentation.

Another important component of a monitoring protocol will be to assess vegetation dynamics over time. Review of historic aerial imagery, particularly for pre- and post-dam construction, may be important for establishing some background information to analyze the influence of flow regulation on riparian plant communities along the Delaware and Bluestone-New-Gauley river systems. Based on structural differences in vegetation and reflectance values from the imagery, it may be possible to distinguish changes in community size and condition (i.e. presence of certain invasive species). Additionally, context could be accessed by reviewing the landscape surrounding sites. This approach will provide data for determining community persistence over time and can be analyzed for correlations with other vital signs.

Several other vital signs being tracked by the National Park Service may be strongly interlinked with the distribution and health of riparian plant communities. Climate data may be useful in determining shifts in temperature and precipitation, which can alter the length of the growing season (Wallen 1986), snow accumulation and snowmelt, (Thompson and Wallace 2001) and flooding regime (McCabe and Ayers 1989). In turn, these conditions can influence disturbance regimes and moisture conditions (McCabe and Wolock 1990), which shape floodplain plant communities. Reduced flow from dam construction can result in a decrease of erosive scouring

and water table levels (Marston et al. 1995) as well as an increase in the accumulation of organic material and alluvial sedimentation (Hupp and Osterkamp 1996; Bendix 1999). Such conditions can expedite the succession of pioneer and early successional communities to homogeneous alluvial forests (Johnson et al. 1976; Johnson 1992; Marston et al. 1995; Hughes and Cass 1997), thus decreasing the heterogeneity and diversity of the riparian landscape. Sediment load is an important factor in determining floodplain patterns and can determine the deposition or erosion of soils within the floodplain and, therefore, greatly influencing plant community dynamics and distribution. Data from these vital signs may be used to analyze correlations between phenomena and riparian plant community dynamics.

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Appendix A. Local and global descriptions for riparian plant associations that occur within the Upper Delaware Scenic and Recreational River and the Delaware Water Gap national Recreational Area. These descriptions were adapted directly from the following two sources: Perles et al. 2007 and Perles et al. 2008.

COMMON NAME (PARK-SPECIFIC): SILVER MAPLE FLOODPLAIN FOREST

SYNONYMS
NVC English Name: **Silver Maple - American Elm Forest**
NVC Scientific Name: ***Acer saccharinum* - *Ulmus americana* Forest**
NVC Identifier: **CEGL002586**

LOCAL INFORMATION

Environmental Description: This floodplain forest occurs on the downstream ends of islands and on high terraces along the shoreline of the Delaware River. The substrate is typically silt loam or sandy loam, as in Delaware fine sandy loam or Pope fine sandy loam. The forest floor frequently has numerous parallel swales created by flood scour. These forests are inundated only during larger flood events.

Vegetation Description: This floodplain forest is dominated by silver maple (*Acer saccharinum*), covering 40–75% of the canopy. Sugar maple (*Acer saccharum*) can be a canopy codominant, with sycamore (*Platanus occidentalis*) and river birch (*Betula nigra*) as occasional associates. The canopy trees typically extend 20–30 m in height, while subcanopy trees range in height from 5–10 m. The sparse subcanopy can contain sugar maple, bitternut hickory (*Carya cordiformis*), silver maple, boxelder (*Acer negundo*), white ash (*Fraxinus americana*), eastern hop-hornbeam (*Ostrya virginiana*), black cherry (*Prunus serotina*), and black walnut (*Juglans nigra*). The sparse short-shrub layer includes black raspberry (*Rubus occidentalis*) and is often dominated by the invasive species Japanese barberry (*Berberis thunbergii*) and multiflora rose (*Rosa multiflora*). The dense herbaceous layer contains reed canarygrass (*Phalaris arundinacea*), ground ivy (*Glechoma hederacea*), whitegrass (*Leersia virginica*), ostrich fern (*Matteuccia struthiopteris*), hedge false bindweed (*Calystegia sepium* ssp. *sepium*), dogtooth violet (*Erythronium americanum*), Jack in the pulpit (*Arisaema triphyllum*), spotted ladysthumb (*Polygonum persicaria*), giant goldenrod (*Solidago gigantea*), sensitive fern (*Onoclea sensibilis*), and sweet woodreed (*Cinna arundinacea*). The invasive species Japanese knotweed (*Polygonum cuspidatum*) can form dense thickets on the forest floor. Garlic mustard (*Alliaria petiolata*) and Japanese stiltgrass (*Microstegium vimineum*) are other common herbaceous invasive species in this forest. Vines such as eastern poison ivy (*Toxicodendron radicans*) and Virginia creeper (*Parthenocissus quinquefolia*) can also be common.

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Acer saccharinum* (silver maple)
Tree subcanopy	Broad-leaved deciduous tree	*Acer saccharum* (sugar maple)
Herb (field)	Vine/Liana	*Parthenocissus quinquefolia* (Virginia creeper)
		Toxicodendron radicans (eastern poison-ivy)
Herb (field)	Forb	*Calystegia sepium* ssp. *sepium* (hedge false bindweed)
		Glechoma hederacea (ground ivy)
		Polygonum cuspidatum (Japanese knotweed)
Herb (field)	Graminoid	*Leersia virginica* (whitegrass)
		Phalaris arundinacea (reed canarygrass)
Herb (field)	Fern or fern ally	*Matteuccia struthiopteris* (ostrich fern)

Characteristic Species: *Acer saccharinum, Acer saccharum, Matteuccia struthiopteris.*
Other Noteworthy Species: Information not available.
Subnational Distribution with Crosswalk Data:

State	State Rank	Confidence	State Name	Reference
NJ	SNR	1	Silver Maple - American Elm Floodplain Forest	Walz et al. 2006
PA	S5	1	Silver Maple Floodplain Forest	Fike 1999

Local Range: This forest occurs on island and terrace shorelines associated with the Delaware River in the Upper Delaware Scenic and Recreational River and the Delaware Water Gap National Recreation Area.
Classification Comments: Silver Maple Floodplain Forest can be distinguished from other floodplain forests by the dominance of *Acer saccharinum* (40–75% cover), often with *Acer saccharum* as codominant in the canopy or subcanopy.
Other Comments: None.
Local Description Authors: S. J. Perles (PNHP).
Plots and Data Sources: DEWA.108, DEWA.112, DEWA.124; Fike 1999, Podniesinski and Wagner 2002.
Delaware Water Gap National Recreation Area Inventory Notes: Information not available.

GLOBAL INFORMATION

NVC CLASSIFICATION

Physiognomic Class	Forest (I)
Physiognomic Subclass	Deciduous forest (I.B.)
Physiognomic Group	Cold-deciduous forest (I.B.2.)
Physiognomic Subgroup	Natural/Semi-natural cold-deciduous forest (I.B.2.N.)
Formation	Temporarily flooded cold-deciduous forest (I.B.2.N.d.)
Alliance	*Acer saccharinum* Temporarily Flooded Forest Alliance (A.279)
Alliance (English name)	Silver Maple Temporarily Flooded Forest Alliance
Association	*Acer saccharinum - Ulmus americana* Forest
Association (English name)	Silver Maple - American Elm Forest
Ecological System(s):	Laurentian-Acadian Floodplain Forest (CES201.587). Central Appalachian Floodplain (CES202.608). Mississippi River Riparian Forest (CES203.190). North-Central Interior Floodplain (CES202.694). South-Central Interior Large Floodplain (CES202.705).

GLOBAL DESCRIPTION

Concept Summary: This silver maple - elm - cottonwood forest community is found throughout the midwestern United States and parts of the eastern United States. Stands occur on large, regularly flooded floodplains. The canopy cover is more-or-less closed and dominated by *Acer saccharinum*. Codominants may include *Platanus occidentalis, Betula nigra*, and rarely *Acer saccharum*. Associated species may include *Ulmus americana, Ulmus rubra, Acer negundo, Salix nigra, Celtis occidentalis, Carya cordiformis, Juglans nigra*, and *Fraxinus pennsylvanica*. The shrub and sapling layer is often open (<25% cover). Species that may be present include *Sambucus nigra* spp. *canadensis, Rubus occidentalis*, or *Lindera benzoin*. Woody and herbaceous vines can be prominent, including among the woody vines *Parthenocissus quinquefolia, Toxicodendron radicans*, and *Vitis riparia*. Herbaceous vine species include *Apios americana, Amphicarpaea bracteata*, and *Echinocystis lobata*. Herbaceous

grasses, forbs, and ferns dominate the ground layer, including *Symphyotrichum lateriflorum (= Aster lateriflorus), Boehmeria cylindrica, Erythronium americanum, Solidago gigantea, Cinna arundinacea, Leersia virginica, Elymus virginicus, Impatiens pallida, Laportea canadensis, Matteuccia struthiopteris, Onoclea sensibilis, Pilea pumila, Urtica dioica*, and others. A variety of exotics may be present, including *Lysimachia* spp., *Microstegium vimineum, Polygonum cuspidatum, Rosa multiflora*, and *Lonicera japonica*.

Environmental Description: This community occurs on temporarily flooded soils along major rivers and smaller perennial streams. Soils may be well-drained and sandy, more loamy on infrequently flooded bottomlands and levees, or deep silts on stabilized sites along larger rivers. The structure and composition of the type is influenced by the flooding regime. Floods leave river-deposited debris on the forest floor, ice scars on trees, and abandoned channels that retain water at or above the level of the main river channel.

Vegetation Description: The canopy cover is more-or-less closed and dominated by *Acer saccharinum*. Codominants may include *Platanus occidentalis, Betula nigra*, and rarely *Acer saccharum*. Associated species may include *Ulmus americana, Ulmus rubra, Acer negundo, Salix nigra, Celtis occidentalis, Carya cordiformis, Juglans nigra*, and *Fraxinus pennsylvanica*. The shrub and sapling layer is often open (<25% cover). Species that may be present include *Sambucus nigra* spp. *canadensis, Rubus occidentalis*, or *Lindera benzoin*. Woody and herbaceous vines can be prominent, including among the woody vines *Parthenocissus quinquefolia, Toxicodendron radicans*, and *Vitis riparia*. Herbaceous vine species include *Apios americana, Amphicarpaea bracteata*, and *Echinocystis lobata*. Herbaceous grasses, forbs, and ferns dominate the ground layer, including *Symphyotrichum lateriflorum (= Aster lateriflorus), Boehmeria cylindrica, Erythronium americanum, Solidago gigantea, Cinna arundinacea, Leersia virginica, Elymus virginicus, Impatiens pallida, Laportea canadensis, Matteuccia struthiopteris, Onoclea sensibilis, Pilea pumila, Urtica dioica*, and others. A variety of exotics may be present, including *Lysimachia* spp., *Microstegium vimineum, Polygonum cuspidatum, Rosa multiflora*, and *Lonicera japonica* (MNNHP 1993, Anderson 1996, Central Appalachian Ecoregional Team pers. comm. 1998).

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Acer saccharinum* (silver maple)
Herb (field)	Vine/Liana	*Parthenocissus quinquefolia* (Virginia creeper)
		Toxicodendron radicans (eastern poison-ivy)
Herb (field)	Graminoid	*Leersia virginica* (whitegrass)

Characteristic Species: *Acer negundo, Acer saccharinum, Alliaria petiolata, Conium maculatum, Elymus virginicus, Glechoma hederacea, Humulus japonicus, Populus deltoides, Urtica dioica* ssp. *Gracilis.*

Other Noteworthy Species: Information not available.

USFWS Wetland System: Palustrine.

DISTRIBUTION

Range: This association is found throughout the midwestern United States and in the mid-Atlantic region of the eastern United States, ranging from Delaware, New Jersey, and Pennsylvania west to Minnesota, and south to Arkansas.

States/Provinces: AR, DE, IA:SU, IL, IN, KY, MI, MN, MO, NJ, OH, ON, PA, TN, WI:S3.

Federal Lands: NPS (Delaware Water Gap, Effigy Mounds, New River Gorge); USFS (Ozark?).

CONSERVATION STATUS
Rank: G4? (3-Oct-1996).
Reasons: There has been significant conversion of stands to agriculture, hydrologic modifications due to river dams, etc., and siltation caused by modified flooding regimes.

CLASSIFICATION INFORMATION
Status: Standard.
Confidence: 2 – Moderate.
Comments: This type includes stands where *Acer saccharinum* represents the majority of trees (>50% cover or basal area?). This type is most clearly expressed on larger rivers. To some degree this type is more northern, separable from the more southern type *Acer saccharinum - Celtis laevigata - Carya illinoinensis* Forest (CEGL002431), but this distinction is not yet well resolved. In the southern parts of its range, this type may overlap with *Platanus occidentalis - Acer saccharinum - Juglans nigra - Ulmus rubra* Forest (CEGL007334), but that type is generally a higher terrace, small stream type. Compare this type with SAF cover type 62 (Eyre 1980). In Minnesota stands with less than either 50% cottonwood or silver maple and not in northwestern Minnesota tend to occur here (i.e., a mixed floodplain forest), as do silver maple stands with a supercanopy of cottonwoods. In southwestern Minnesota, stands with only some swamp white oak go here. If swamp white oak is dominant the stands probably belong with either an association in the *Quercus palustris - (Quercus bicolor)* Seasonally Flooded Forest Alliance (A.329), or *Quercus macrocarpa - Quercus bicolor - Carya laciniosa / Leersia* spp. - *Cinna* spp. Forest (CEGL002098), at least in the Midwest. *Fraxinus pennsylvanica* is a typical codominant in this type. In Wisconsin, this type may better be named *Acer saccharinum - Fraxinus pennsylvanica - Betula nigra* Forest (E. Epstein pers. comm. 1999).
Similar Associations:
- *Acer (rubrum, saccharinum) - Fraxinus* spp. - *Ulmus americana* Forest (CEGL005038)--grades into this community in backwater swamps.
- *Acer saccharinum - (Populus deltoides) / Matteuccia struthiopteris - Laportea canadensis* Forest (CEGL006147)--is somewhat more northern, lacking *Platanus* and *Betula nigra*.
- *Acer saccharinum - Acer negundo / Ageratina altissima - Laportea canadensis - (Elymus virginicus)* Forest (CEGL006217).
- *Acer saccharinum - Betula nigra / Cephalanthus occidentalis* Forest (CEGL007810).
- *Acer saccharinum - Celtis laevigata - Carya illinoinensis* Forest (CEGL002431)--is more southern.
- *Acer saccharinum* Temporarily Flooded Forest [Placeholder] (CEGL007304).
- *Fagus grandifolia - Quercus* spp. - *Acer rubrum - Juglans nigra* Forest (CEGL005014)--in the eastern part of its range on the mesic side.
- *Fraxinus pennsylvanica - Ulmus americana - (Acer negundo, Tilia americana)* Northern Forest (CEGL002089)--in the western part of its range on the mesic side.
- *Fraxinus pennsylvanica - Ulmus* spp. - *Celtis occidentalis* Forest (CEGL002014).
- *Platanus occidentalis - Acer saccharinum - Juglans nigra - Ulmus rubra* Forest (CEGL007334)--may overlap in southern parts of the range of CEGL002586.
- *Populus deltoides - Salix nigra* Forest (CEGL002018)--grades into this community on the wetter side.
- *Quercus macrocarpa - Quercus bicolor - Carya laciniosa / Leersia* spp. - *Cinna* spp. Forest (CEGL002098).

Related Concepts:

- Silver Maple - American Elm: 62 (Eyre 1980) B.
- Silver maple - American elm - cottonwood floodplain forest (CAP pers. comm. 1998) ?

SOURCES

Description Authors: D. Faber-Langendoen, mod. L. A. Sneddon, E. Largay, S. C. Gawler.

References: Anderson 1996, CAP pers. comm. 1998, Eyre 1980, Fike 1999, INAI unpubl. data, MNNHP 1993, Midwestern Ecology Working Group n.d., Podniesinski and Wagner 2002, TDNH unpubl. data, WINHIP unpubl. data.

Figure A1. An example of Silver Maple Floodplain Forest in Delaware Water Gap National Recreation Area.

Figure A2. An example of Silver Maple Floodplain Forest in Upper Delaware Scenic and Recreational River.

COMMON NAME (PARK-SPECIFIC): SUGAR MAPLE FLOODPLAIN FOREST

SYNONYMS

NVC English Name: **Sugar Maple - Carolina Ash / American Hornbeam / Mayapple Forest**

NVC Scientific Name: ***Acer saccharum - Fraxinus americana / Carpinus caroliniana / Podophyllum peltatum* Forest**

NVC Identifier: **CEGL006459**

LOCAL INFORMATION

Environmental Description: This association occurs on low to mid terraces of the Delaware River and low terraces of major tributaries. The soils appear to be primarily alluvial in origin and include Barbour fine sandy loam, Galway loam, Pope silt loam, and undifferentiated alluvium. These soils tend to be slightly acidic to alkaline. Stands on lower terraces may flood occasionally, but the period of inundation is short.

Vegetation Description: The canopy height varies from 20 to 35 m with total cover from 70 to 90%. The dominant canopy tree is sugar maple (*Acer saccharum*). White ash (*Fraxinus americana*) is a common associate and may be codominant in some stands. Other minor associate species include black cherry (*Prunus serotina*), bitternut hickory (*Carya cordiformis*), American beech (*Fagus grandifolia*), American basswood (*Tilia americana*), pignut hickory (*Carya glabra*), and American elm (*Ulmus americana*). The subcanopy can vary from 5 to 25 m in height with total cover ranging from sparse (5%) up to 30%. Sugar maple is often the only species in the subcanopy, or sometimes occurs with American hornbeam (*Carpinus caroliniana*) as a minor associate. The tall-shrub layer is 2–5 m in height and is usually sparse (<10% cover) or absent. The most characteristic tall shrubs/saplings are northern spicebush (*Lindera benzoin*) and sugar maple. The short-shrub layer, less than 2 m in height, may also be sparse (under 5% total cover) or have up to 30% cover. Common short-shrub/sapling species include Japanese barberry (*Berberis thunbergii*), northern spicebush, and sugar maple. The herbaceous layer can be quite variable with respect to cover, ranging from as little as 20% to over 80%. The herbaceous layer is usually less than 1 m in height. The herbaceous layer is often diverse but is often dominated by invasive herbs, especially garlic mustard (*Alliaria petiolata*), ground ivy (*Glechoma hederacea*), Nepalese browntop (*Microstegium vimineum*), and oriental ladysthumb (*Polygonum caespitosum*). Common native herbs include silver false spleenwort (*Deparia acrostichoides*), Christmas fern (*Polystichum acrostichoides*), stickywilly (*Galium aparine*), sensitive fern (*Onoclea sensibilis*), whitegrass (*Leersia virginica*), and mayapple (*Podophyllum peltatum*).

Most Abundant Species:

Stratum	Lifeform	Species
Tree (canopy & subcanopy)	Broad-leaved deciduous tree	*Acer saccharum* (sugar maple)
Tree canopy	Broad-leaved deciduous tree	*Fraxinus americana* (white ash)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Lindera benzoin* (northern spicebush)
Tall shrub/sapling	Broad-leaved deciduous shrub	*Acer saccharum* (sugar maple)
Short shrub/sapling	Broad-leaved deciduous shrub	*Berberis thunbergii* (Japanese barberry)
Herb (field)	Forb	*Alliaria petiolata* (garlic mustard)
		Glechoma hederacea (ground ivy)
		Polygonum caespitosum (oriental ladysthumb)
Herb (field)	Graminoid	*Leersia virginica* (whitegrass)
		Microstegium vimineum (Nepalese browntop)

Stratum	Lifeform	Species
Herb (field)	Fern or fern ally	*Deparia acrostichoides* (silver false spleenwort) *Polystichum acrostichoides* (Christmas fern)

Characteristic Species: *Acer saccharum* (sugar maple), *Caulophyllum thalictroides* (blue cohosh), *Deparia acrostichoides* (silver false spleenwort), *Fraxinus americana* (white ash), *Galium aparine* (stickywilly), *Lindera benzoin* (northern spicebush), *Onoclea sensibilis* (sensitive fern), *Podophyllum peltatum* (mayapple), *Polystichum acrostichoides* (Christmas fern).

Other Noteworthy Species: Information not available.

Subnational Distribution with Crosswalk Data:

State	SRank	Conf	SName	Reference
NY	S2S3*	1	Floodplain Forest	Edinger et al. 2002
PA	SNR		[not crosswalked]	

Local Range: This association appears to be restricted primarily to floodplain terraces of the Delaware River and its major tributaries.

Classification Comments: This association is characterized by the dominance of *Acer saccharum* (sugar maple) in nearly all strata. It differs from Central Appalachian Northern Forest in that the latter does not occur on floodplain terraces. It differs from other floodplain forest communities in that *Platanus occidentalis* (American sycamore), *Betula nigra* (river birch), and *Acer saccharinum* (silver maple) are rare or absent.

Other Comments: Information not available.

Local Description Authors: G. S. Podniesinski (PNHP).

Plots: UPDE.AA.470 (Perles et al. 2007).

Upper Delaware Scenic and Recreational River Inventory Notes: Information not available.

GLOBAL INFORMATION

NVC CLASSIFICATION

Physiognomic Class	Forest (I)
Physiognomic Subclass	Deciduous forest (I.B.)
Physiognomic Group	Cold-deciduous forest (I.B.2.)
Physiognomic Subgroup	Natural/Semi-natural cold-deciduous forest (I.B.2.N.)
Formation	Temporarily flooded cold-deciduous forest (I.B.2.N.d.)
Alliance	*Acer saccharum* - *Carya cordiformis* Temporarily Flooded Forest Alliance (A.302)
Alliance (English name)	Sugar Maple - Bitternut Hickory Temporarily Flooded Forest Alliance
Association	*Acer saccharum* - *Fraxinus americana / Carpinus caroliniana / Podophyllum peltatum* Forest
Association (English name)	Sugar Maple - Carolina Ash / American Hornbeam / Mayapple Forest
Ecological System(s):	Central Appalachian River Floodplain (CES202.608).

GLOBAL DESCRIPTION

Concept Summary: These rich floodplain forests are found on slightly elevated alluvial terraces and active floodplains of larger rivers in the mid-Atlantic states, interior to the Coastal Plain. The setting is a raised river terrace; however, this forest may occur very close to the

riverbank if the water channel is well-entrenched. The alluvial soils are slightly acidic to alkaline and less regularly inundated than the soils supporting floodplain forests dominated by silver maple or sycamore. Stands on lower terraces may flood occasionally, but the period of inundation is short. The canopy is closed to somewhat open, and a subcanopy is often present. Shrubs are typically sparse but may range up to about 30% cover. The herb layer is well-developed, fairly diverse, and seasonally variable, with spring ephemerals giving way to taller ferns, graminoids and forbs. Bryoids are very minor. The canopy dominants are usually some combination of *Acer saccharum* (sugar maple), *Fraxinus americana* (white ash), and sometimes *Carya cordiformis* (bitternut hickory). Canopy associates include *Quercus rubra* (northern red oak), *Juglans nigra* (black walnut), *Prunus serotina* (black cherry), *Fraxinus nigra* (black ash), *Liriodendron tulipifera* (tuliptree), *Ulmus americana* (American elm), *Tilia americana* (American basswood), and *Fagus grandifolia* (American beech). *Carpinus caroliniana* (American hornbeam) is often present as a small tree, along with *Acer saccharum* (sugar maple). *Lindera benzoin* (northern spicebush) is the most common shrub; *Asimina triloba* (pawpaw) is characteristic in the southern portion of this type's range. Vines such as *Toxicodendron radicans* (eastern poison-ivy) and *Parthenocissus quinquefolia* (Virginia creeper) are frequent but usually at low cover. The herb layer usually features spring ephemerals, including *Claytonia virginica* (Virginia springbeauty), *Dicentra canadensis* (squirrel corn), and *Erythronium americanum* (dogtooth violet), followed by a mixture of ferns, forbs and graminoids. Characteristic species include *Arisaema triphyllum* (Jack in the pulpit), *Caulophyllum thalictroides* (blue cohosh), *Carex laxiculmis* (spreading sedge), *Deparia acrostichoides* (silver false spleenwort), *Elymus virginicus* (Virginia wildrye), *Elymus riparius* (riverbank wildrye), *Galium aparine* (stickywilly), *Onoclea sensibilis* (sensitive fern), and *Podophyllum peltatum* (mayapple). Exotic species, such as *Microstegium vimineum* (Nepalese browntop), *Glechoma hederacea* (ground ivy), and *Alliaria petiolata* (garlic mustard), may be abundant, especially in disturbed areas. These terrace forests are related to lower floodplain forests, e.g. *Platanus occidentalis - Acer negundo - Juglans nigra / Asimina triloba / Mertensia virginica* Forest (CEGL004073), but distinguished by the reduced importance of *Acer saccharinum* (silver maple) and *Platanus occidentalis* (American sycamore); they differ from enriched upland hardwood forests, e.g., *Acer (nigrum, saccharum) - Tilia americana / Asimina triloba / Jeffersonia diphylla - Caulophyllum thalictroides* Forest (CEGL008412), in their alluvial soils and flooding regime.

Environmental Description: These rich floodplain forests are found on slightly elevated alluvial terraces of mid-sized to larger rivers. The setting is a raised river terrace; however, this forest may occur very close to the riverbank if the water channel is well-entrenched. The alluvial soils are slightly acidic to alkaline. Stands on lower terraces may flood occasionally, but the period of inundation is short. Along the Potomac River west of Washington, DC, this community occupies alluvial fill overlying terraces interpreted as the Penholoway and Wicomico. It is often the higher of paired alluvial benches downstream of defending bedrock outcrops on major islands, with *Platanus occidentalis - Acer negundo - Juglans nigra / Asimina triloba / Mertensia virginica* Forest (CEGL004073) occupying the lower bench. Soils are generally deep sandy loams, loamy sands or sands and are likely Inceptisols. The mean flooding recurrence interval along the Potomac is 15 to 30 years.

Vegetation Description: The canopy is closed to somewhat open, and a subcanopy is often present. Shrubs are typically sparse but may range up to about 30% cover. The herb layer is well-developed, fairly diverse, and seasonally variable, with spring ephemerals giving way to taller ferns, graminoids and forbs. Bryoids are very minor. The canopy dominants are usually some

combination of *Acer saccharum* (sugar maple), *Fraxinus americana* (white ash), and sometimes *Carya cordiformis* (bitternut hickory). Canopy associates include *Quercus rubra* (northern red oak), *Juglans nigra* (black walnut), *Prunus serotina* (black cherry), *Fraxinus nigra* (black ash), *Liriodendron tulipifera* (tuliptree), *Ulmus americana* (American elm), *Tilia americana* (American basswood), *Celtis occidentalis* (common hackberry), and *Fagus grandifolia* (American beech). *Carpinus caroliniana* (American hornbeam) is often present as a small tree, along with *Acer saccharum* (sugar maple) and *Acer negundo* (boxelder). *Lindera benzoin* (northern spicebush) is the most common shrub; *Asimina triloba* (pawpaw) is characteristic in the southern portion of this type's range. Vines such as *Toxicodendron radicans* (eastern poison-ivy) and *Parthenocissus quinquefolia* (Virginia creeper) are frequent but usually at low cover. The herb layer usually features spring ephemerals, including *Claytonia virginica* (Virginia springbeauty), *Dicentra canadensis* (squirrel corn), and *Erythronium americanum* (dogtooth violet), followed by a mixture of ferns, forbs and graminoids. Characteristic species include *Arisaema triphyllum* (Jack in the pulpit), *Caulophyllum thalictroides* (blue cohosh), *Carex laxiculmis* (spreading sedge), *Deparia acrostichoides* (silver false spleenwort), *Elymus virginicus* (Virginia wildrye), *Elymus riparius* (riverbank wildrye), *Galium aparine* (stickywilly), *Onoclea sensibilis* (sensitive fern), and *Podophyllum peltatum* (mayapple). *Matteuccia struthiopteris* (ostrich fern) may form local dominance patches in this type along the Potomac River in Maryland and Virginia. Exotic species, such as *Microstegium vimineum* (Nepalese browntop), *Glechoma hederacea* (ground ivy), and *Alliaria petiolata* (garlic mustard), may be abundant, especially in disturbed areas.

Most Abundant Species:

Stratum	Lifeform	Species
Tree (canopy & subcanopy)	Broad-leaved deciduous tree	*Acer saccharum* (sugar maple)
Tree canopy	Broad-leaved deciduous tree	*Fraxinus americana* (white ash)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Lindera benzoin* (northern spicebush)
Tall shrub/sapling	Broad-leaved deciduous shrub	*Acer saccharum* (sugar maple)
Herb (field)	Graminoid	*Microstegium vimineum* (Nepalese browntop)

Characteristic Species: *Acer saccharum* (sugar maple), *Arisaema triphyllum* (Jack in the pulpit), *Fraxinus americana* (white ash), *Lindera benzoin* (northern spicebush), *Onoclea sensibilis* (sensitive fern), *Podophyllum peltatum* (mayapple).

Other Noteworthy Species: Information not available.

USFWS Wetland System: Palustrine.

DISTRIBUTION

Range: This association is known from the mid-Atlantic states from Pennsylvania and New Jersey south to the James River in Virginia.

States/Provinces: MD, NJ:S2S3, NY, PA, VA.

Federal Lands: NPS (C&O Canal, Delaware Water Gap, George Washington Parkway, Upper Delaware); USFS (Jefferson).

CONSERVATION STATUS

Rank: G3? (5-Oct-2006).

Reasons: This type is fairly widely distributed in the mid-Atlantic states, but it occurs in small patches in restricted environmental settings that are typically cleared for agriculture, and intact examples are not well-documented.

CLASSIFICATION INFORMATION

Status: Standard.

Confidence: 2 - Moderate.

Comments: This community has been drastically reduced from its original extent, as it makes excellent fertile farmland. Originally it was probably a large-patch type.

Similar Associations:

- *Acer saccharum - Fraxinus* spp. - *Tilia americana / Matteuccia struthiopteris - Ageratina altissima* Forest (CEGL006114).
- *Acer saccharum - Juglans cinerea / Carpinus caroliniana / Matteuccia struthiopteris* Forest (CEGL006430).
- *Liriodendron tulipifera - Fraxinus* spp. */ Lindera benzoin - Viburnum prunifolium / Podophyllum peltatum* Forest (CEGL006314).
- *Tilia americana - Acer saccharum - Acer nigrum / Laportea canadensis* Forest (CEGL006405).

Related Concepts:

- Palustrine Broad-leaved Deciduous Forested Wetland, Seasonally Flooded (PFO1C) (Cowardin et al. 1979) ?
- Sugar Maple - Basswood: 26 (Eyre 1980) B

SOURCES

Description Authors: S. C. Gawler; mod. G. P. Fleming.

References: Cowardin et al. 1979, Eastern Ecology Working Group n.d., Eyre 1980, Harrison 2004, Harrison and Stango 2003, Lea 2000, Perles et al. 2007, Thomson et al. 1999.

Figure A3. An example of Sugar Maple Floodplain Forest in Delaware Water Gap National Recreation Area.

COMMON NAME (PARK-SPECIFIC): BITTERNUT HICKORY LOWLAND FOREST

SYNONYMS
NVC English Name: **Bitternut Hickory - Black Cherry / White Snakeroot Forest**
NVC Scientific Name: ***Carya cordiformis - Prunus serotina / Ageratina altissima* Forest**
NVC Identifier: **CEGL006445**

LOCAL INFORMATION

Environmental Description: This forest association typically occurs on low to mid-level floodplain terraces adjacent to the Upper Delaware River or its major tributaries. Soils are derived from alluvial deposits and consist of well-drained, somewhat moist, fine sandy loams and silt. While definitive flood frequency is unknown, the association is likely to be flooded to some degree seasonally and less frequently than American sycamore (*Platanus occidentalis*)-dominated floodplain forests, which occur on lower, fringing terraces.

Vegetation Description: The somewhat open canopy of this floodplain forest is dominated by bitternut hickory (*Carya cordiformis*), which constitutes at least 25% relative cover in the canopy. Associates in the canopy and subcanopy are black cherry (*Prunus serotina*), sugar maple (*Acer saccharum*), black oak (*Quercus velutina*), American basswood (*Tilia americana*), and white ash (*Fraxinus americana*). American sycamore (*Platanus occidentalis*) can occur sporadically but is more common on lower terrace steps, closer to the river. The most common tall shrubs, which can form dense patches, are American hornbeam (*Carpinus caroliniana*), hawthorn (*Crataegus* sp.), and slippery elm (*Ulmus rubra*). Japanese barberry (*Berberis thunbergii*) is a very common short-shrub invasive in this community and can form a nearly impenetrable understory. Ostrich fern (*Matteuccia struthiopteris*) is a characteristic herb that grows in association with a mix of graminoids and ferns that vary according to microtopographic setting. Garlic mustard (*Alliaria petiolata*) is also a common invasive species.

Most Abundant Species:

Stratum	Lifeform	Species
Tree (canopy & subcanopy)	Broad-leaved deciduous tree	*Carya cordiformis* (bitternut hickory)
Tall shrub/sapling	Broad-leaved deciduous tree	*Carpinus caroliniana* (American hornbeam)
Short shrub/sapling	Broad-leaved deciduous shrub	*Berberis thunbergii* (Japanese barberry)
Herb (field)	Forb	*Alliaria petiolata* (garlic mustard), *Polygonum virginianum* (jumpseed)
Herb (field)	Fern or fern ally	*Matteuccia struthiopteris* (ostrich fern)

Characteristic Species: *Acer saccharum* (sugar maple), *Carpinus caroliniana* (American hornbeam), *Carya cordiformis* (bitternut hickory), *Prunus serotina* (black cherry).

Other Noteworthy Species:

Species	GRank	Type	Note
Alliaria petiolata (garlic mustard)		plant	very common invasive exotic
Berberis thunbergii (Japanese barberry)		plant	very common invasive exotic

Subnational Distribution with Crosswalk Data:

State	SRank	Conf	SName	Reference
NY	S2S3*	1	Floodplain Forest	Edinger et al. 2002
PA	S3		[not crosswalked]	

Local Range: Potentially occurs throughout Upper Delaware Scenic and Recreational River on channel islands and floodplain terraces. Along the Delaware Water Gap National Recreational Area, this association likely occurs throughout the park on mid to high floodplain terraces of the

Delaware River. It appears to be restricted to small patches of well-drained loamy fine sand to fine sandy loam.
Classification Comments: A mid- to low terrace floodplain forest dominated by bitternut hickory.
Other Comments: Common invasives: *Berberis thunbergii* (Japanese barberry), *Alliaria petiolata* (garlic mustard), *Microstegium vimineum* (Nepalese browntop).
Local Description Authors: A.L. Feldmann (NYNHP).
Plots: L02, G21.
Upper Delaware Scenic and Recreational River Inventory Notes: Information not available.

GLOBAL INFORMATION

NVC CLASSIFICATION

Physiognomic Class	Forest (I)
Physiognomic Subclass	Deciduous forest (I.B.)
Physiognomic Group	Cold-deciduous forest (I.B.2.)
Physiognomic Subgroup	Natural/Semi-natural cold-deciduous forest (I.B.2.N.)
Formation	Temporarily flooded cold-deciduous forest (I.B.2.N.d.)
Alliance	*Acer saccharum* - *Carya cordiformis* Temporarily Flooded Forest Alliance (A.302)
Alliance (English name)	Sugar Maple - Bitternut Hickory Temporarily Flooded Forest Alliance
Association	*Carya cordiformis* - *Prunus serotina / Ageratina altissima* Forest
Association (English name)	Bitternut Hickory - Black Cherry / White Snakeroot Forest
Ecological System(s):	Central Appalachian River Floodplain (CES202.608).

GLOBAL DESCRIPTION

Concept Summary: This association is characterized by the dominance or codominance of *Carya cordiformis* (bitternut hickory) on mid to high floodplain terraces. Soils are derived from alluvial deposits and consist of fine sandy loams and loamy fine sand. Codominant or associate canopy species include *Quercus rubra* (northern red oak), *Juglans cinerea* (butternut), *Prunus serotina* (black cherry), *Ulmus americana* (American elm), *Fraxinus americana* (white ash), and *Acer saccharinum* (silver maple). The canopy is usually somewhat open, occasionally closed, and about 20 m in height. The subcanopy cover is usually 20 to 30%. Composition of the subcanopy is similar to the canopy layer and may also include *Acer rubrum* (red maple) and *Acer saccharum* (sugar maple). The tall-shrub and short-shrub layers are usually sparse and include occasional saplings of canopy and subcanopy species, as well as scattered individuals of *Rosa multiflora* (multiflora rose), *Lonicera morrowii* (Morrow's honeysuckle), *Berberis thunbergii* (Japanese barberry), *Rubus occidentalis* (black raspberry), and *Rubus flagellaris* (northern dewberry). The herbaceous layer is weedy, with invasive exotic species common or dominant, including *Microstegium vimineum* (Nepalese browntop), *Alliaria petiolata* (garlic mustard), and *Glechoma hederacea* (ground ivy). Common native species include *Ageratina altissima var. altissima* (white snakeroot), *Hydrophyllum virginianum* (Shawnee salad), and *Carex* (sedge) spp.
Environmental Description: This association occurs on mid to high floodplain terraces of mid- to large-sized rivers. It is currently documented from the Delaware and Upper Delaware, and Cheat rivers and probably occurs on other rivers within the region. Flood frequency is unknown, but it is likely flooded less often than *Platanus occidentalis* (American sycamore) and *Acer*

saccharinum (silver maple) forests found on lower floodplain terraces. Soils on these stabilized terraces are derived from alluvial deposits and consist of fine sandy loams and loamy fine sand.
Vegetation Description: This association is characterized by the dominance or codominance of *Carya cordiformis* (bitternut hickory). Codominant or associate canopy species include *Quercus rubra* (northern red oak), *Juglans cinerea* (butternut), *Prunus serotina* (black cherry), *Ulmus americana* (American elm), *Ulmus rubra* (slippery elm), *Fraxinus americana* (white ash), and occasionally *Acer saccharinum* (silver maple). The canopy is usually somewhat open, occasionally closed, and about 20 m in height. The subcanopy cover is usually 20 to 30%. Composition of the subcanopy is similar to the canopy layer and may also include *Acer rubrum* (red maple), *Acer saccharum* (sugar maple), and *Carpinus caroliniana* (American hornbeam). The tall-shrub and short-shrub layers are usually sparse and include occasional saplings of canopy and subcanopy species, as well as scattered individuals of *Rosa multiflora* (multiflora rose), *Lonicera morrowii* (Morrow's honeysuckle), *Berberis thunbergii* (Japanese barberry), *Lindera benzoin* (northern spicebush), *Cornus amomum* (silky dogwood), *Rubus occidentalis* (black raspberry), and *Rubus flagellaris* (northern dewberry). The herbaceous layer is weedy, with invasive exotic species common or dominant, including *Microstegium vimineum* (Nepalese browntop), *Alliaria petiolata* (garlic mustard), and *Glechoma hederacea* (ground ivy). Common native species include *Ageratina altissima var. altissima* (white snakeroot), *Hydrophyllum virginianum* (Shawnee salad), *Matteuccia struthiopteris* (ostrich fern), *Polygonum virginianum* (jumpseed), *Claytonia virginica* (Virginia springbeauty), and *Carex* (sedge) spp.
Most Abundant Species:

Stratum	Lifeform	Species
Tree (canopy & subcanopy)	Broad-leaved deciduous tree	*Carya cordiformis* (bitternut hickory)
		Prunus serotina (black cherry)
Tree subcanopy	Broad-leaved deciduous tree	*Acer saccharum* (sugar maple)
		Ulmus americana (American elm)
Tall shrub/sapling	Broad-leaved deciduous shrub	*Carya cordiformis* (bitternut hickory)
		Lonicera morrowii (Morrow's honeysuckle)
		Prunus serotina (black cherry)
Short shrub/sapling	Broad-leaved deciduous shrub	*Berberis thunbergii* (Japanese barberry)
		Rosa multiflora (multiflora rose)
Herb (field)	Forb	*Ageratina altissima* var. *altissima* (white snakeroot)
		Alliaria petiolata (garlic mustard)
		Glechoma hederacea (ground ivy)
		Hydrophyllum virginianum (Shawnee salad)
Herb (field)	Graminoid	*Microstegium vimineum* (Nepalese browntop)

Characteristic Species: *Acer saccharum* (sugar maple), *Ageratina altissima* var. *altissima* (white snakeroot), *Carya cordiformis* (bitternut hickory), *Hydrophyllum virginianum* (Shawnee salad), *Prunus serotina* (black cherry), *Ulmus americana* (American elm).
Other Noteworthy Species: Information not available.
USFWS Wetland System: Not applicable.

DISTRIBUTION
Range: This type is currently documented from northern New Jersey, New York, and Pennsylvania, south to northern West Virginia.
States/Provinces: NJ, NY, PA:S3, WV.
Federal Lands: NPS (Delaware Water Gap, Upper Delaware).

CONSERVATION STATUS
Rank: GNR (7-Feb-2006).
Reasons: Information not available.

CLASSIFICATION INFORMATION
Status: Standard.
Confidence: 3 - Weak.
Comments: Information not available.
Similar Associations: Information not available.
Related Concepts:

- Successional floodplain forest, aka Terrace floodplain forest (Vanderhorst 2001a) =

SOURCES
Description Authors: S. C. Gawler, mod. E. Largay and S. C. Gawler.
References: Eastern Ecology Working Group n.d., Vanderhorst 2001a, Vanderhorst and Streets 2006.

Figure A4. An example of Bitternut Hickory Lowland Forest in Delaware Water Gap National Recreation Area.

Figure A5. An example of Bitternut Hickory Lowland Forest in Upper Delaware Scenic and Recreational River.

COMMON NAME (PARK-SPECIFIC): RIVER BIRCH LOW FLOODPLAIN FOREST

SYNONYMS
NVC English Name: **River Birch - American Sycamore / Orange Jewelweed Forest**
NVC Scientific Name: ***Betula nigra - Platanus occidentalis / Impatiens capensis* Forest**
NVC Identifier: **CEGL006184**

LOCAL INFORMATION

Environmental Description: This riparian woodland association typically occurs on low terrace floodplains of major tributaries to the Upper Delaware River. It also can occur on islands, bars, and low terrace shorelines of the Upper Delaware itself. The low terraces are usually immediately adjacent to the river channel and subject to frequent flooding. The substrate is typically moderately well-drained, stony, recent alluvium consisting of sand, silt and/or gravel.
Vegetation Description: The open woodland canopy of this community is characterized by river birch (*Betula nigra*) dominance (this species is important in all woody strata) with American sycamore (*Platanus occidentalis*), silver maple (*Acer saccharinum*), black walnut (*Juglans nigra*), bitternut hickory (*Carya cordiformis*), and green ash (*Fraxinus pennsylvanica*) as occasional associates. Boxelder (*Acer negundo*) is somewhat common in the subcanopy and tall-shrub strata. Dogwoods, including redosier dogwood (*Cornus sericea)*, gray dogwood (*Cornus racemosa*), and silky dogwood (*Cornus amomum*), blackberries, such as Allegheny blackberry (*Rubus allegheniensis*) and dwarf red blackberry (*Rubus pubescens*), and multiflora rose (*Rosa multiflora*) make up the short-shrub layer. Eastern poison ivy (*Toxicodendron radicans*) and Virginia creeper (*Parthenocissus quinquefolia*) are common woody vines. There can be a dense herbaceous layer dominated by graminoids; the most common species are rough bluegrass (*Poa trivialis*), Wiegand's wildrye (*Elymus wiegandii*), and reed canarygrass (*Phalaris arundinacea*).
Most Abundant Species:

Stratum	Lifeform	Species
Tree (canopy & subcanopy)	Broad-leaved deciduous tree	*Betula nigra* (river birch)
Short shrub/sapling	Broad-leaved deciduous shrub	*Cornus sericea* (redosier dogwood)
Herb (field)	Vine/Liana	*Toxicodendron radicans* (eastern poison ivy)
Herb (field)	Graminoid	*Elymus wiegandii* (Wiegand's wildrye)
		Phalaris arundinacea (reed canarygrass)
		Poa trivialis (rough bluegrass)

Characteristic Species: *Betula nigra* (river birch), *Phalaris arundinacea* (reed canarygrass).
Other Noteworthy Species:

Species	GRank	Type	Note
Elymus wiegandii (Wiegand's wildrye)		plant	
Phalaris arundinacea (reed canarygrass)		plant	
Poa trivialis (rough bluegrass)		plant	exotic
Toxicodendron radicans (eastern poison ivy)		plant	

Subnational Distribution with Crosswalk Data:

State	SRank	Conf	SName	Reference
NY	S2S3*	1	Floodplain Forest	Edinger et al. 2002
PA	S4*	3	Sycamore - (River Birch) - Box-elder Floodplain Forest	Fike 1999

Local Range: This type can occur throughout Upper Delaware Scenic and Recreational River on low terrace floodplains and island heads adjacent to the river or its tributaries. The only examples of this association observed during this study were near the southern end of the park.
Classification Comments: A floodplain woodland strongly dominated by river birch.

Other Comments: Information not available.
Local Description Authors: A. L. Feldmann (NYNHP).
Plots: T10, U24, UPDE.AA.32, UPDE.AA. 48, UPDE.AA.202, UPDE.AA.514.
Upper Delaware Scenic and Recreational River Inventory Notes: Information not available.

GLOBAL INFORMATION

NVC CLASSIFICATION

Physiognomic Class	Forest (I)
Physiognomic Subclass	Deciduous forest (I.B.)
Physiognomic Group	Cold-deciduous forest (I.B.2.)
Physiognomic Subgroup	Natural/Semi-natural cold-deciduous forest (I.B.2.N.)
Formation	Temporarily flooded cold-deciduous forest (I.B.2.N.d.)
Alliance	*Betula nigra - (Platanus occidentalis)* Temporarily Flooded Forest Alliance (A.280)
Alliance (English name)	River Birch - (American Sycamore) Temporarily Flooded Forest Alliance
Association	*Betula nigra - Platanus occidentalis / Impatiens capensis* Forest
Association (English name)	River Birch - American Sycamore / Orange Jewelweed Forest
Ecological System(s):	Central Appalachian River Floodplain (CES202.608). Northern Atlantic Coastal Plain Stream and River (CES203.070).

GLOBAL DESCRIPTION

Concept Summary: This Mid-Atlantic floodplain forest of large and moderately large rivers occurs on sandy, gravelly, well-drained soils of levees, gravel bars, braided channels and other areas of frequent flooding. The tree canopy is well-developed and dominated by *Betula nigra* (river birch) and *Platanus occidentalis* (American sycamore), with associates including *Acer negundo* (boxelder) and occasionally *Acer saccharinum* (silver maple) and *Fraxinus pennsylvanica* (green ash). The shrub layer can include *Cornus amomum* (silky dogwood), *Cornus sericea* (red-osier dogwood), and *Lindera benzoin* (northern spicebush). The vine and herb layers are lush and diverse and may include *Boehmeria cylindrica* (small-spike false nettle), *Elymus hystrix* (eastern bottlebrush grass), *Stellaria pubera* (star chickweed), *Impatiens capensis* (jewelweed), *Impatiens pallida* (pale touch-me-not), *Laportea canadensis* (Canadian woodnettle), *Pilea pumila* (Canadian clearweed), *Toxicodendron radicans* (eastern poison-ivy), *Parthenocissus quinquefolia* (Virginia creeper), *Vitis rotundifolia* (muscadine) or *Vitis riparia* (riverbank grape), *Chasmanthium latifolium* (Indian woodoats), *Podophyllum peltatum* (mayapple), *Polygonum virginianum* (jumpseed), *Apocynum cannabinum* (Indianhemp), and *Urtica* (nettle) sp. Exotic species are typical and may include *Lysimachia* (yellow loosestrife) sp., *Microstegium vimineum* (Nepalese browntop), *Lonicera japonica* (Japanese honeysuckle), *Lonicera morrowii* (Morrow's honeysuckle), *Polygonum cuspidatum* (Japanese knotweed), *Phalaris arundinacea* (reed canarygrass), and *Alliaria petiolata* (garlic mustard).
Environmental Description: This Mid-Atlantic floodplain forest of large and moderately large rivers occurs on sandy, gravelly, well-drained soils of levees, gravel bars, braided channels and other areas of frequent flooding.
Vegetation Description: The tree canopy is well-developed and dominated by *Betula nigra* (river birch) and *Platanus occidentalis* (American sycamore), with associates including *Acer*

negundo (boxelder) and occasionally *Acer saccharinum* (silver maple) and *Fraxinus pennsylvanica* (green ash). The shrub layer can include *Cornus amomum* (silky dogwood), *Cornus sericea* (red-osier dogwood), and *Lindera benzoin* (northern spicebush). The vine and herb layers are lush and diverse and may include *Boehmeria cylindrica* (small-spike false nettle), *Elymus hystrix* (eastern bottlebrush grass), *Stellaria pubera* (star chickweed), *Impatiens capensis* (jewelweed), *Impatiens pallida* (pale touch-me-not), *Laportea canadensis* (Canadian woodnettle), *Pilea pumila* (Canadian clearweed), *Toxicodendron radicans* (eastern poison-ivy), *Parthenocissus quinquefolia* (Virginia creeper), *Vitis rotundifolia* (muscadine) or *Vitis riparia* (riverbank grape), *Chasmanthium latifolium* (Indian woodoats), *Podophyllum peltatum* (mayapple), *Polygonum virginianum* (jumpseed), *Apocynum cannabinum* (Indianhemp), and *Urtica* (nettle) sp. Exotic species are typical and may include *Lysimachia* (yellow loosestrife) sp., *Microstegium vimineum* (Nepalese browntop), *Lonicera japonica* (Japanese honeysuckle), *Lonicera morrowii* (Morrow's honeysuckle), *Polygonum cuspidatum* (Japanese knotweed), *Phalaris arundinacea* (reed canarygrass), and *Alliaria petiolata* (garlic mustard).

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Betula nigra* (river birch)
		Platanus occidentalis (American sycamore)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Cornus amomum* (silky dogwood)
		Toxicodendron radicans (eastern poison-ivy)
Shrub/sapling (tall & short)	Vine/Liana	*Parthenocissus quinquefolia* (Virginia creeper)
		Vitis rotundifolia (muscadine)
Herb (field)	Forb	*Boehmeria cylindrica* (small-spike false nettle)
		Impatiens capensis (jewelweed)

Characteristic Species: *Betula nigra* (river birch), *Impatiens capensis* (jewelweed), *Platanus occidentalis* (American sycamore).

Other Noteworthy Species:

Species	GRank	Type	Note
Alliaria petiolata (garlic mustard)		plant	exotic
Lonicera japonica (Japanese honeysuckle)		plant	exotic
Lonicera morrowii (Morrow's honeysuckle)		plant	exotic
Microstegium vimineum (Nepalese browntop)		plant	exotic
Phalaris arundinacea (reed canarygrass)		plant	exotic
Polygonum cuspidatum (Japanese knotweed)		plant	exotic

USFWS Wetland System: Palustrine.

DISTRIBUTION

Range: This community is common in the Mid-Atlantic states.
States/Provinces: DE, MD, NJ, NY, PA, WV?
Federal Lands: NPS (Upper Delaware).

CONSERVATION STATUS

Rank: GNR (1-Dec-1997).
Reasons: Information not available.

CLASSIFICATION INFORMATION

Status: Standard.
Confidence: 2 - Moderate.
Comments: Information not available.

Similar Associations:

- *Betula nigra - Acer rubrum - (Liquidambar styraciflua, Platanus occidentalis)* Successional Forest (CEGL006976).
- *Betula nigra - Platanus occidentalis* Forest (CEGL002086).
- *Platanus occidentalis - (Liquidambar styraciflua, Liriodendron tulipifera) / Asimina triloba* Forest (CEGL006603).
- *Platanus occidentalis - Betula nigra - Salix (caroliniana, nigra)* Woodland (CEGL003896)--on more exposed, heavily scoured shores that support stunted *Betula nigra* and *Platanus occidentalis*.
- *Platanus occidentalis - Fraxinus pennsylvanica* Forest (CEGL006036)--represented by more northern species.

Related Concepts:

- *Platanus occidentalis - Acer negundo / Asarum canadense* Forest (Bartgis 1986) B
- Sycamore - river birch - jewelweed floodplain forest (CAP, pers. comm., 1998) ?

SOURCES

Description Authors: L. A. Sneddon, mod. E. Largay.

References: Bartgis 1986, Bowman 2000, CAP pers. comm. 1998, Eastern Ecology Working Group n.d., Edinger et al. 2002, Fike 1999, Harrison 2004, Podniesinski and Wagner 2002, Thomson et al. 1999.

Figure A6. An example of River Birch Low Floodplain Forest in Upper Delaware Scenic and Recreational River.

COMMON NAME (PARK-SPECIFIC): SYCAMORE - MIXED HARDWOOD FLOODPLAIN FOREST

SYNONYMS
NVC English Name: **American Sycamore - Green Ash Forest**
NVC Scientific Name: ***Platanus occidentalis - Fraxinus pennsylvanica* Forest**
NVC Identifier: **CEGL006036**

LOCAL INFORMATION

Environmental Description: This association typically occurs on low terrace floodplains of major tributaries to the Upper Delaware River. It also can occur on islands, bars, and low terrace shorelines of the Upper Delaware itself. The low terraces are usually immediately adjacent to the river channel and subject to frequent flooding. The substrate is typically moderately well-drained, very stony, recent alluvium consisting of sand, silt and/or gravel.
Vegetation Description: The somewhat open to closed tree canopy layer of this successional floodplain forest type is diagnostically dominated by American sycamore (*Platanus occidentalis*). Birches, such as sweet birch (*Betula lenta*), yellow birch (*Betula alleghaniensis*), and river birch (*Betula nigra*), black willow (*Salix nigra*), northern red oak (*Quercus rubra*), green ash (*Fraxinus pennsylvanica*), and white ash (*Fraxinus americana*) can be associates, as can sugar maple (*Acer saccharum*) and American basswood (*Tilia americana*) on richer sites. At some sites, eastern white pine (*Pinus strobus*) can be common in the canopy. The subcanopy and tall-shrub layers can be variable, too, according to site conditions. Typical subcanopy and tall-shrub species, in addition to those in the canopy, are American hornbeam (*Carpinus caroliniana*), common ninebark (*Physocarpus opulifolius*), American elm (*Ulmus americana*), slippery elm (*Ulmus rubra*), American witchhazel (*Hamamelis virginiana*), and common winterberry (*Ilex verticillata*). Many of the same species also appear, in lower abundance, as short shrubs. On disturbed sites, black locust (*Robinia pseudoacacia*), black cherry (*Prunus serotina*), and black walnut (*Juglans nigra*) can be common in the canopy or subcanopy, and species such as white ash, American hornbeam, and elm may be more abundant than in higher quality, intact stands. Vines make up an important part of the flora and are codominated by Virginia creeper (*Parthenocissus quinquefolia*) and eastern poison ivy (*Toxicodendron radicans*). Ground flora consists of a mix of disturbance-tolerant species, such as Nepalese browntop (*Microstegium vimineum*), Japanese knotweed (*Polygonum cuspidatum*), and garlic mustard (*Alliaria petiolata*), and typical woodland or floodplain herbs, including fringed loosestrife (*Lysimachia ciliata*), Indianhemp (*Apocynum cannabinum*), deertongue (*Dichanthelium clandestinum*), feathery false lily of the valley (*Maianthemum racemosum*), upright sedge (*Carex stricta*), common ladyfern (*Athyrium filix-femina*), spotted ladysthumb (*Polygonum persicaria*), swamp smartweed (*Polygonum hydropiperoides*), and big bluestem (*Andropogon gerardii*).
Most Abundant Species:

Stratum	Lifeform	Species
Tree (canopy & subcanopy)	Broad-leaved deciduous shrub	*Physocarpus opulifolius* (common ninebark)
Tree canopy	Broad-leaved deciduous tree	*Platanus occidentalis* (American sycamore)
Tree subcanopy	Broad-leaved deciduous tree	*Carpinus caroliniana* (American hornbeam)
Herb (field)	Vine/Liana	*Parthenocissus quinquefolia* (Virginia creeper)
		Toxicodendron radicans (eastern poison ivy)

Stratum	Lifeform	Species
Herb (field)	Forb	*Apocynum cannabinum* (Indianhemp)
		Lysimachia ciliata (fringed loosestrife)
Herb (field)	Graminoid	*Microstegium vimineum* (Nepalese browntop)

Characteristic Species: *Acer saccharum* (sugar maple), *Carpinus caroliniana* (American hornbeam), *Parthenocissus quinquefolia* (Virginia creeper), *Physocarpus opulifolius* (common ninebark), *Platanus occidentalis* (American sycamore), *Toxicodendron radicans* (eastern poison-ivy).

Other Noteworthy Species:

Species	GRank	Type	Note
Alliaria petiolata (garlic mustard)		plant	common invasive
Microstegium vimineum (Nepalese browntop)		plant	common invasive
Polygonum cuspidatum (Japanese knotweed)		plant	common invasive

Subnational Distribution with Crosswalk Data:

State	SRank	Conf	SName	Reference
NY	S2S3*	1	Floodplain Forest	Edinger et al. 2002
PA	S4*	3	Sycamore - (River Birch) - Box-elder Floodplain Forest	Fike 1999

Local Range: This association is common along the entire length of the Upper Delaware River. This forest type is also found in the floodplain of Bushkill Creek, Flat Brook, other major tributaries, and the Delaware River.

Classification Comments: This association is distinguished from other floodplain forests by the dominance of *Platanus occidentalis* (American sycamore).

Other Comments: Information not available.

Local Description Authors: A. L. Feldmann (NYNHP).

Plots: T01, T07.

Upper Delaware Scenic and Recreational River Inventory Notes: Information not available.

GLOBAL INFORMATION

NVC CLASSIFICATION

Physiognomic Class	Forest (I)
Physiognomic Subclass	Deciduous forest (I.B.)
Physiognomic Group	Cold-deciduous forest (I.B.2.)
Physiognomic Subgroup	Natural/Semi-natural cold-deciduous forest (I.B.2.N.)
Formation	Temporarily flooded cold-deciduous forest (I.B.2.N.d.)
Alliance	*Platanus occidentalis* - (*Fraxinus pennsylvanica, Celtis laevigata, Acer saccharinum*) Temporarily Flooded Forest Alliance (A.288)
Alliance (English name)	American Sycamore - (Green Ash, Sugarberry, Silver Maple) Temporarily Flooded Forest Alliance
Association	*Platanus occidentalis - Fraxinus pennsylvanica* Forest
Association (English name)	American Sycamore - Green Ash Forest
Ecological System(s):	Central Appalachian River Floodplain (CES202.608).

GLOBAL DESCRIPTION

Concept Summary: This floodplain forest of the northeastern United States, primarily in the northern Piedmont, is a broadly defined successional or young version of medium-gradient river floodplain forest occurring on coarse alluvial substrates. The canopy is closed to somewhat open and usually dominated by *Platanus occidentalis* (American sycamore). *Populus deltoides*

(eastern cottonwood), *Acer saccharinum* (silver maple), and *Ulmus americana* (American elm) are usually present but not common; occasional associates include *Acer negundo* (boxelder), *Fraxinus pennsylvanica* (green ash), *Juglans cinerea* (butternut), *Carya cordiformis* (bitternut hickory), *Celtis occidentalis* (common hackberry), *Acer saccharum* (sugar maple), and *Acer rubrum* (red maple). Shrubs or subcanopy are variable depending on geography and can include *Betula nigra* (river birch), *Carpinus caroliniana* (American hornbeam), *Salix nigra* (black willow), *Lindera benzoin* (northern spicebush), or *Alnus serrulata* (hazel alder), plus exotic invasives such as *Rosa multiflora* (multiflora rose), *Berberis thunbergii* (Japanese barberry), and *Lonicera morrowii* (Morrow's honeysuckle). The herbaceous layer tends to be sparse to locally abundant and can include *Matteuccia struthiopteris* (ostrich fern), *Osmunda cinnamomea* (cinnamon fern), *Onoclea sensibilis* (sensitive fern), *Geum canadense* (white avens), *Impatiens pallida* (pale touch-me-not), *Boehmeria cylindrica* (small-spike false nettle), *Urtica dioica* (stinging nettle), *Solidago rugosa* (wrinkleleaf goldenrod), *Hydrophyllum virginianum* (Shawnee salad), *Carex bromoides* (bromelike sedge), *Ageratina altissima* (white snakeroot), plus vine species *Toxicodendron radicans* (eastern poison-ivy) and *Parthenocissus quinquefolia* (Virginia creeper). There is typically a very high component of disturbance-tolerant exotic species such as *Lysimachia nummularia* (creeping jenny), *Glechoma hederacea* (ground ivy), *Microstegium vimineum* (Nepalese browntop), *Hesperis matronalis* (dames rocket), *Aegopodium podagraria* (bishop's goutweed), *Polygonum cuspidatum* (Japanese knotweed), and *Alliaria petiolata* (garlic mustard).

Environmental Description: Early- to-mid successional forest occurs on cobble or sand substrates of floodplain islands or cobble shores of moderate- to high-energy rivers.

Vegetation Description: The canopy is closed to somewhat open and usually dominated by *Platanus occidentalis* (American sycamore). *Populus deltoides* (eastern cottonwood), *Acer saccharinum* (silver maple), and *Ulmus americana* (American elm) are usually present but not common; occasional associates include *Acer negundo* (boxelder), *Fraxinus pennsylvanica* (green ash), *Juglans cinerea* (butternut), *Carya cordiformis* (bitternut hickory), *Celtis occidentalis* (common hackberry), *Acer saccharum* (sugar maple), and *Acer rubrum* (red maple). Shrubs or subcanopy are variable depending on geography and can include *Betula nigra* (river birch), *Carpinus caroliniana* (American hornbeam), *Salix nigra* (black willow), *Lindera benzoin* (northern spicebush), or *Alnus serrulata* (hazel alder), plus exotic invasives such as *Rosa multiflora* (multiflora rose), *Berberis thunbergii* (Japanese barberry), and *Lonicera morrowii* (Morrow's honeysuckle). The herbaceous layer tends to be sparse to locally abundant and can include *Matteuccia struthiopteris* (ostrich fern), *Osmunda cinnamomea* (cinnamon fern), *Onoclea sensibilis* (sensitive fern), *Geum canadense* (white avens), *Impatiens pallida* (pale touch-me-not), *Boehmeria cylindrica* (small-spike false nettle), *Urtica dioica* (stinging nettle), *Solidago rugosa* (wrinkleleaf goldenrod), *Hydrophyllum virginianum* (Shawnee salad), *Carex bromoides* (bromelike sedge), *Ageratina altissima* (white snakeroot), plus vine species *Toxicodendron radicans* (eastern poison-ivy) and *Parthenocissus quinquefolia* (Virginia creeper). There is typically a very high component of disturbance-tolerant exotic species such as *Lysimachia nummularia* (creeping jenny), *Glechoma hederacea* (ground ivy), *Microstegium vimineum* (Nepalese browntop), *Hesperis matronalis* (dames rocket), *Aegopodium podagraria* (bishop's goutweed), *Polygonum cuspidatum* (Japanese knotweed), and *Alliaria petiolata* (garlic mustard).

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Platanus occidentalis* (American sycamore)
Short shrub/sapling	Broad-leaved deciduous shrub	*Lindera benzoin* (northern spicebush)
Herb (field)	Forb	*Boehmeria cylindrica* (small-spike false nettle)
Herb (field)	Fern or fern ally	*Onoclea sensibilis* (sensitive fern)
		Osmunda cinnamomea (cinnamon fern)

Characteristic Species: *Acer saccharinum* (silver maple), *Circaea lutetiana* ssp. *canadensis* (broadleaf enchanter's nightshade), *Elymus virginicus* (Virginia wildrye), *Onoclea sensibilis* (sensitive fern), *Osmunda cinnamomea* (cinnamon fern), *Parthenocissus quinquefolia* (Virginia creeper), *Platanus occidentalis* (American sycamore), *Polygonum sagittatum* (arrowleaf tearthumb), *Populus deltoides* (eastern cottonwood), *Ulmus americana* (American elm).

Other Noteworthy Species:

Species	GRank	Type	Note
Aegopodium podagraria (bishop's goutweed)		plant	exotic
Alliaria petiolata (garlic mustard)		plant	exotic
Glechoma hederacea (ground ivy)		plant	exotic
Hesperis matronalis (dames rocket)		plant	exotic
Lysimachia nummularia (creeping jenny)		plant	exotic
Microstegium vimineum (Nepalese browntop)		plant	exotic
Polygonum cuspidatum (Japanese knotweed)		plant	exotic

USFWS Wetland System: Palustrine.

DISTRIBUTION

Range: This association ranges from New England south to Pennsylvania.
States/Provinces: CT, DC, DE:S3S4, MA, NH, NJ, NY, PA, RI, VA?, VT.
Federal Lands: NPS (Delaware Water Gap, Rock Creek, Upper Delaware, Valley Forge).

CONSERVATION STATUS

Rank: G4? (20-Jun-2006).
Reasons: Total acreage (rangewide) is limited. Good-quality examples are uncommon. Threats include development and filling, alteration in flooding regimes, excessive beaver activity, and encroachment by aggressive nonnative plant species. Further data are needed to define the rank.

CLASSIFICATION INFORMATION

Status: Standard.
Confidence: 2 - Moderate.
Comments: This type is not tracked as a separate floodplain element in Vermont.
Similar Associations:

- *Acer saccharinum - (Populus deltoides) / Matteuccia struthiopteris - Laportea canadensis* Forest (CEGL006147)--is characterized by a stronger dominance of both *Acer saccharinum* and *Matteuccia struthiopteris* and has fewer early-successional species.
- *Betula nigra - Platanus occidentalis / Impatiens capensis* Forest (CEGL006184)--southern species present, plus canopy with *Betula nigra*.

Related Concepts: Information not available.

SOURCES

Description Authors: S. L. Neid, mod. S. C. Gawler.

References: Clancy 1996, Eastern Ecology Working Group n.d., Edinger et al. 2002, Enser 1999, Fike 1999, Frye and Quinn 1979, Kearsley 1999b, Metzler and Barrett 2001, Newbold 1994, Newbold et al. 1988, Nichols et al. 2001, Overlease 1978, Overlease 1987, Russell and Schuyler 1988, Sperduto 2000a, Sperduto 2000b, Swain and Kearsley 2000, Thompson and Sorenson 2000, WPC and TNC 2002, Wistendahl 1958.

Figure A7. An example of Sycamore - Mixed Hardwood Floodplain Forest in Delaware Water Gap National Recreation Area.

Figure A8. An example of Sycamore - mixed hardwood Floodplain Forest in Upper Delaware Scenic and Recreational River.

COMMON NAME (PARK-SPECIFIC): SYCAMORE - MIXED HARDWOOD RIVERINE SHRUBLAND

SYNONYMS

NVC English Name: **River Birch - Sycamore - (Sandbar Willow, Carolina Willow) Shrubland**

NVC Scientific Name: ***Betula nigra - Platanus occidentalis - Salix (interior, caroliniana)* Shrubland**

NVC Identifier: **CEGL003896**

LOCAL INFORMATION

Environmental Description: This sycamore-dominated riverine shrubland typically occurs on cobble bars and sand/gravel bars adjacent to or contiguous with the shoreline of the Delaware River. This type can also occur on the upstream ends of islands. They are subject to frequent floods, high stream velocity and ice-scour, though these disturbances are often less intense than those experienced by Sycamore (Willow) - Mixed Hardwood Riverine Dwarf-shrubland.

Vegetation Description: This community is characterized by a substantial layer of tall shrubs (2–5 m in height) dominated by sycamore (*Platanus occidentalis*) covering at least 25% of the area. River birch (*Betula nigra*) or silver maple (*Acer saccharinum*) can also be codominant in the tall-shrub layer. Individual sycamores may also be scattered in a sparse tree canopy that is 5–10 m in height. Black willow (*Salix nigra*), sycamore and river birch are dominant in sparse short-shrub layer, with silver maple and black ash (*Fraxinus nigra*). The herbaceous layer ranges from sparse to moderately dense and can contain a wide variety of typical wetland and prairie species. Common species include marshpepper knotweed (*Polygonum hydropiper*), reed canarygrass (*Phalaris arundinacea*), switchgrass (*Panicum virgatum*), whitegrass (*Leersia virginica*), Pennsylvania smartweed (*Polygonum pensylvanicum*), deertongue (*Dichanthelium clandestinum*), upland bentgrass (*Agrostis perennans*), swamp milkweed (*Asclepias incarnata*), smallspike false nettle (*Boehmeria cylindrica*), sensitive fern (*Onoclea sensibilis*), Canadian clearweed (*Pilea pumila*), and swamp smartweed (*Polygonum hydropiperoides*). This association is highly susceptible to colonization by purple loosestrife (*Lythrum salicaria*), Japanese knotweed (*Polygonum cuspidatum*), multiflora rose (*Rosa multiflora*), purple crownvetch (*Coronilla varia*), and other invasive plants. Vines such as riverbank grape (*Vitis riparia*) and eastern poison ivy (*Toxicodendron radicans*) are often found throughout this tall sycamore-dominated shrubland.

Most Abundant Species:

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous shrub	*Platanus occidentalis* (American sycamore)
		Betula nigra (river birch)
Short shrub/sapling	Broad-leaved deciduous shrub	*Salix nigra* (black willow)
		Platanus occidentalis (American sycamore)
		Betula nigra (river birch)
Herb (field)	Vine/Liana	*Vitis riparia* (riverbank grape)
Herb (field)	Forb	*Lythrum salicaria* (purple loosestrife)
		Polygonum hydropiper (marshpepper knotweed)
		Polygonum pensylvanicum (Pennsylvania smartweed)
Herb (field)	Graminoid	*Leersia virginica* (whitegrass)
		Panicum virgatum (switchgrass)
		Phalaris arundinacea (reed canarygrass)

Characteristic Species: *Platanus occidentalis, Betula nigra, Salix nigra, Leersia virginica, Panicum virgatum, Phalaris arundinacea, Polygonum hydropiper.*
Other Noteworthy Species: Information not available.
Subnational Distribution with Crosswalk Data:

State	State Rank	Confidence	State Name	Reference
NJ	SNR	1	Birch - Willow Riverbank Shrubland	Walz et al. 2006
PA	S4	1	River Birch - Sycamore Floodplain Scrub	Fike 1999

Local Range: This vegetation type is common in the Delaware River within the park.
Classification Comments: This association is distinguished from other riparian types by the substantial tall-shrub layer of *Platanus occidentalis*, often with *Betula nigra*. The height of the shrubs (2–5 m) differentiates this type from Sycamore (Willow) - Mixed Hardwood Riverine Dwarf-shrubland in which shrubs are less than 2 m in height. Also, the shrubs in Sycamore (Willow) - Mixed Hardwood Riverine Dwarf-shrubland remain stunted because they typically receive more frequent or more intense scour than Sycamore - Mixed Hardwood Riverine Shrubland.
Other Comments: None.
Local Description Authors: S. J. Perles (PNHP).
Plots and Data Sources: DEWA.103, DEWA.106, DEWA.110; Fike 1999, Perles et al 2004.
Delaware Water Gap National Recreation Area Inventory Notes: Information not available.

GLOBAL INFORMATION

NVC CLASSIFICATION

Physiognomic Class	Shrubland (III)
Physiognomic Subclass	Deciduous shrubland (III.B.)
Physiognomic Group	Cold-deciduous shrubland (III.B.2.)
Physiognomic Subgroup	Natural/Semi-natural cold-deciduous shrubland (III.B.2.N.)
Formation	Temporarily flooded cold-deciduous shrubland (III.B.2.N.d.)
Alliance	*Betula nigra* Temporarily Flooded Shrubland Alliance (A.951)
Alliance (English name)	River Birch Temporarily Flooded Shrubland Alliance
Association	*Betula nigra - Platanus occidentalis - Salix (interior, caroliniana)* Shrubland
Association (English name)	River Birch - Sycamore - (Sandbar Willow, Carolina Willow) Shrubland
Ecological System(s):	Central Appalachian Riparian (CES202.609). South-Central Interior Small Stream and Riparian (CES202.706).

GLOBAL DESCRIPTION

Concept Summary: This early-successional shrub community of riverbank floodplains and river gravel bars and islands occurs in the High Allegheny Plateau, Central Appalachians, and Lower New England ecoregions. It is subject to relatively frequent and powerful flooding and ice-scour and occurs on sand, gravel or cobble deposits. It is dominated by stunted and often battered trees (less than 5 m tall), primarily *Platanus occidentalis, Betula nigra*, and/or *Acer saccharinum*, but also including *Acer negundo, Fraxinus* spp., *Populus deltoides*, and *Ulmus americana*. *Betula nigra* is characteristic and often dominant. Associates include *Cornus amomum, Salix nigra, Salix interior (= Salix exigua), Salix caroliniana, Salix sericea, Alnus serrulata*, and sometimes *Cephalanthus occidentalis* or *Physocarpus opulifolius*. The herbaceous layer ranges from sparse to moderately dense and can contain a wide variety of typical wetland

and prairie species. Characteristic herbs include *Apocynum cannabinum, Polygonum virginianum, Polygonum hydropiper, Polygonum pensylvanicum, Polygonum hydropiperoides, Eupatorium* spp., *Asclepias incarnata, Pilea pumila, Hypericum* spp., *Bidens* spp., *Sorghastrum nutans, Andropogon gerardii, Phalaris arundinacea, Dichanthelium clandestinum, Leersia virginica, Panicum virgatum*, and *Justicia americana*. Vines such as *Vitis riparia* and *Toxicodendron radicans* are often found throughout this association. Exotics such as *Lythrum salicaria, Polygonum cuspidatum, Coronilla varia*, and *Rosa multiflora* are a frequent problem.

Environmental Description: This early-successional community occurs on riverbank floodplains and river gravel bars and islands subject to frequent flooding and ice-scour. It occurs on sand, gravel or cobble deposits.

Vegetation Description: This shrubby floodplain community is dominated by stunted and often battered trees (less than 5 m tall), primarily *Platanus occidentalis, Betula nigra*, and/or *Acer saccharinum*, but also including *Acer negundo, Fraxinus* spp., *Populus deltoides*, and *Ulmus americana*. *Betula nigra* is characteristic and often dominant. Associates include *Cornus amomum, Salix nigra, Salix interior (= Salix exigua), Salix caroliniana, Salix sericea, Alnus serrulata*, and sometimes *Cephalanthus occidentalis* or *Physocarpus opulifolius*. The herbaceous layer ranges from sparse to moderately dense and can contain a wide variety of typical wetland and prairie species. Characteristic herbs include *Apocynum cannabinum, Polygonum virginianum, Polygonum hydropiper, Polygonum pensylvanicum, Polygonum hydropiperoides, Eupatorium* spp., *Asclepias incarnata, Pilea pumila, Hypericum* spp., *Bidens* spp., *Sorghastrum nutans, Andropogon gerardii, Phalaris arundinacea, Dichanthelium clandestinum, Leersia virginica, Panicum virgatum*, and *Justicia americana*. Vines such as *Vitis riparia* and *Toxicodendron radicans* are often found throughout this association. Exotics such as *Lythrum salicaria, Polygonum cuspidatum, Coronilla varia*, and *Rosa multiflora* are a frequent problem.

Most Abundant Species:

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Betula nigra* (river birch)
		Platanus occidentalis (American sycamore)
Herb (field)	Vine/Liana	*Vitis riparia* (riverbank grape)
Herb (field)	Forb	*Lythrum salicaria* (purple loosestrife)
		Polygonum hydropiper (marshpepper knotweed)
		Polygonum pensylvanicum (Pennsylvania smartweed)
Herb (field)	Graminoid	*Leersia virginica* (whitegrass)
		Panicum virgatum (switchgrass)
		Phalaris arundinacea (reed canarygrass)

Characteristic Species: *Acer saccharinum, Betula nigra, Leersia virginica, Panicum virgatum, Phalaris arundinacea, Platanus occidentalis, Polygonum hydropiper, Salix nigra.*

Other Noteworthy Species: Information not available.

USFWS Wetland System: Palustrine.

DISTRIBUTION

Range: This association is found in the High Allegheny Plateau and Central Appalachian ecoregions, and peripherally in the Lower New England ecoregion, from West Virginia, Maryland (and possibly Virginia) north to New York. It is also attributed to the Western Allegheny Plateau.
States/Provinces: MD, NJ, NY, PA, VA, WV.
Federal Lands: NPS (Delaware Water Gap).

CONSERVATION STATUS

Rank: G4G5 (1-Dec-1997).
Reasons: Information not available.

CLASSIFICATION INFORMATION

Status: Standard.
Confidence: 2 – Moderate.
Comments: *Salix interior* is listed as "rare" in Maryland and Virginia (Kartesz 1999).
Similar Associations:

- *Betula nigra - Platanus occidentalis / Impatiens capensis* Forest (CEGL006184).
- *Platanus occidentalis - (Betula nigra, Salix* spp.*)* Temporarily Flooded Woodland [Provisional]
- (CEGL003725).

Related Concepts:

- Black willow - mixed hardwood riverine shrubland (Perles et al. 2004) ?
- Mixed hardwood riverine shrubland (Perles et al. 2004) ?
- River birch (sycamore) - mixed hardwood riverine shrubland (Perles et al. 2004) ?
- River birch - willow thickets (CAP pers. comm. 1998) ?
- Silver maple (river birch) - mixed hardwood riverine shrubland (Perles et al. 2004) ?
- Sycamore - mixed hardwood riverine shrubland (Perles et al. 2004) ?

SOURCES

Description Authors: S. L. Neid, mod. S. C. Gawler.
References: CAP pers. comm. 1998, Eastern Ecology Working Group n.d., Edinger et al. 2002, Fike 1999, Harrison 2004, Kartesz 1999, Perles et al. 2004.

Figure A9. An example of Sycamore - Mixed Hardwood Riverine Shrubland in Delaware Water Gap National Recreation Area.

COMMON NAME (PARK-SPECIFIC): SYCAMORE (WILLOW) - MIXED HARDWOOD RIVERINE DWARF SHRUBLAND

SYNONYMS

NVC English Name: **Black Willow / Reed Canarygrass - Indianhemp Temporarily Flooded Shrubland**

NVC Scientific Name: ***Salix nigra / Phalaris arundinacea - Apocynum cannabinum* Temporarily Flooded Shrubland**

NVC Identifier: **CEGL006065**

LOCAL INFORMATION

Environmental Description: Most occurrences of this association are located on low terraces and bars attached to riverbanks of the Delaware River; however, the type can occur on islands as well. The substrate is predominantly cobbles along with sand and gravel. Due to flooding, high stream velocity and ice-scour to which these areas are frequently exposed, the majority of the shrubs remain short-statured (<2 m in height). This community occurs between Riverine Scour Vegetation and the floodplain forest along low terraces and toward island heads.

Vegetation Description: This association is characterized by a moderately dense to dense short-shrub layer less than 2 m in height. The species composition of the short-shrub layer is mixed and varied, with no one species consistently dominating. Stunted individuals of black willow (*Salix nigra*) may be codominant, along with one or more other species of willow (*Salix eriocephala, Salix sericea*) or sycamore (*Platanus occidentalis*). Other typical woody species are silver maple (*Acer saccharinum*), eastern cottonwood (*Populus deltoides*), river birch (*Betula nigra*), and red maple (*Acer rubrum*). Individual tall shrubs (2–5 m in height) of the same species may be scattered throughout the shrubland. The herbaceous layer can be sparse to dense and contains a wide diversity of herbaceous and graminoid species. Some common species are reed canarygrass (*Phalaris arundinacea*), Indianhemp (*Apocynum cannabinum*), American water-willow (*Justicia americana*), deertongue (*Dichanthelium clandestinum*), marshpepper knotweed (*Polygonum hydropiper*), big bluestem (*Andropogon gerardii*), switchgrass (*Panicum virgatum*), wingstem (*Verbesina alternifolia*), upland bentgrass (*Agrostis perennans*), and Virginia wildrye (*Elymus virginicus*). This community is also frequently colonized by purple loosestrife (*Lythrum salicaria*).

Most Abundant Species:

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Salix* spp. (willow)
		Platanus occidentalis (American sycamore)
Herb (field)	Forb	*Apocynum cannabinum* (Indianhemp)
		Lythrum salicaria (purple loosestrife)
		Polygonum hydropiper (marshpepper knotweed)
Herb (field)	Graminoid	*Phalaris arundinacea* (reed canarygrass)

Characteristic Species: *Salix* spp., *Platanus occidentalis, Phalaris arundinacea.*

Other Noteworthy Species: Information not available.

Subnational Distribution with Crosswalk Data:

State	State Rank	Confidence	State Name	Reference
NJ	SNR	2	Willow River-Bar Shrubland	Walz et al. 2006
PA	S4	1	Black Willow Shrub/Scrub Wetland	Fike 1999

Local Range: This vegetation type occurs throughout the Delaware River.

Classification Comments: This association is identified by the presence of a substantial short-shrub layer of *Salix* spp. and/or *Platanus occidentalis*. The height of the shrubs (<2 m in height) differentiates this type from Sycamore - Mixed Hardwood Riverine Shrubland in which shrubs are 2–5 m in height. Also, the shrubs in Sycamore (Willow) - Mixed Hardwood Riverine Dwarf-shrubland remain stunted because they typically receive more frequent or more intense scour than the tall-shrub community.
Other Comments: None.
Local Description Authors: S. J. Perles (PNHP).
Plots and Data Sources: DEWA.105; Fike 1999, Perles et al 2004.
Delaware Water Gap National Recreation Area Inventory Notes: Information not available.

GLOBAL INFORMATION

NVC CLASSIFICATION

Physiognomic Class	Shrubland (III)
Physiognomic Subclass	Deciduous shrubland (III.B.)
Physiognomic Group	Cold-deciduous shrubland (III.B.2.)
Physiognomic Subgroup	Natural/Semi-natural cold-deciduous shrubland (III.B.2.N.)
Formation	Temporarily flooded cold-deciduous shrubland (III.B.2.N.d.)
Alliance	*Salix nigra* Temporarily Flooded Shrubland Alliance (A.948)
Alliance (English name)	Black Willow Temporarily Flooded Shrubland Alliance
Association	*Salix nigra / Phalaris arundinacea - Apocynum cannabinum* Temporarily Flooded Shrubland
Association (English name)	Black Willow / Reed Canarygrass - Indianhemp Temporarily Flooded Shrubland
Ecological System(s):	Laurentian - Acadian Wet Meadow - Shrub Swamp (CES201.582). Central Appalachian Riparian (CES202.609).

GLOBAL DESCRIPTION

Concept Summary: This community is a willow shrubland of low riverbanks along moderate- to high-energy rivers in the northeastern U.S. and High Allegheny Plateau. It occurs on cobble substrates with sand and gravel in areas that are flooded only during high-water events, but receive winter ice-scour. It occupies an intermediate position along a disturbance gradient between open, herbaceous cobble shores and higher floodplain forests. *Salix nigra* is often dominant or codominant with other willows or dogwoods forming a dense shrub layer. Less frequent shrubs and tree saplings include *Salix eriocephala, Salix lucida, Salix sericea, Alnus incana, Alnus serrulata, Cornus amomum, Cornus sericea (= Cornus stolonifera), Spiraea alba* var. *latifolia, Platanus occidentalis, Acer rubrum, Acer saccharinum*, and *Populus deltoides*. The herbaceous layer is typically sparse with variable composition, including *Carex torta, Panicum dichotomiflorum, Panicum virgatum, Dichanthelium clandestinum (= Panicum clandestinum), Echinochloa crus-galli, Elymus virginicus, Phalaris arundinacea, Calamagrostis canadensis, Apocynum cannabinum (= Apocynum sibiricum), Agrostis* spp., *Solidago gigantea, Solidago rugosa, Eupatorium maculatum, Lysimachia terrestris, Polygonum* spp., and *Bidens* spp. Invasive, exotic species can be problematic in this community, including *Polygonum cuspidatum, Lythrum salicaria, Tussilago farfara*, and *Cynanchum louiseae*.

Environmental Description: This community occurs on low riverbanks along moderate- to high-energy rivers on cobble substrates within a sand or gravel matrix.
Vegetation Description: *Salix nigra* is often dominant or codominant with other willows or dogwoods forming a dense shrub layer. Less frequent shrubs and tree saplings include *Salix eriocephala, Salix lucida, Salix sericea, Alnus incana, Alnus serrulata, Cornus amomum, Cornus sericea (= Cornus stolonifera), Spiraea alba* var. *latifolia, Platanus occidentalis, Acer rubrum, Acer saccharinum*, and *Populus deltoides*. The herbaceous layer is typically sparse with variable composition, including *Carex torta, Panicum dichotomiflorum, Panicum virgatum, Dichanthelium clandestinum (= Panicum clandestinum), Echinochloa crus-galli, Elymus virginicus, Phalaris arundinacea, Calamagrostis canadensis, Apocynum cannabinum (= Apocynum sibiricum), Agrostis* spp., *Solidago gigantea, Solidago rugosa, Eupatorium maculatum, Lysimachia terrestris, Polygonum* spp., and *Bidens* spp. Invasive, exotic species can be problematic in this community, including *Polygonum cuspidatum, Lythrum salicaria, Tussilago farfara*, and *Cynanchum louiseae*.
Most Abundant Species:

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Salix nigra* (black willow)
Herb (field)	Forb	*Apocynum cannabinum* (Indianhemp)
		Polygonum hydropiper (marshpepper knotweed)
Herb (field)	Graminoid	*Phalaris arundinacea* (reed canarygrass)

Characteristic Species: *Cornus amomum, Dichanthelium clandestinum, Phalaris arundinacea, Platanus occidentalis.*
Other Noteworthy Species: Information not available.
USFWS Wetland System: Palustrine.

DISTRIBUTION
Range: This association occurs in the eastern United States from New Hampshire and Vermont south to Pennsylvania and New Jersey.
States/Provinces: CT, MA, MD?, ME, NH:S3, NJ, NY?, PA, VT.
Federal Lands: NPS (Delaware Water Gap); USFWS (Great Meadows).

CONSERVATION STATUS
Rank: G4? (20-Jun-2006).
Reasons: This community is not well-documented but occurs over a large range and is a frequent component of floodplain systems.

CLASSIFICATION INFORMATION
Status: Standard.
Confidence: 3 – Weak.
Comments: Information not available.
Similar Associations:
- Salix caroliniana Temporarily Flooded Shrubland (CEGL003899).
- Salix interior - Salix eriocephala Sandbar Shrubland (CEGL005078).

Related Concepts: Information not available.

SOURCES
Description Authors: S. L. Neid, mod. S. C. Gawler.
References: Eastern Ecology Working Group n.d., Fike 1999, Gawler 2002, Metzler and Barrett 2001, Nichols et al. 2001, Perles et al 2004.

Figure A10. An example of Sycamore (Willow) - Mixed Hardwood Riverine Dwarf Shrubland in Delaware Water Gap National Recreation Area.

COMMON NAME (PARK-SPECIFIC): SYCAMORE FLOODPLAIN FOREST

SYNONYMS
NVC English Name: **Sycamore - Green Ash Forest**
NVC Scientific Name: ***Platanus occidentalis - Fraxinus pennsylvanica* Forest**
NVC Identifier: **CEGL006036**

LOCAL INFORMATION

Environmental Description: This association typically occurs on low terrace floodplains of major tributaries to the Delaware River, such as Bushkill Creek and Flat Brook. It also can occur on islands, bars, and low terrace shorelines of the Delaware River. The low terraces are usually immediately adjacent to the river channel and subject to frequent flooding. The substrate is typically somewhat poorly drained sand, silt and/or loam.
Vegetation Description: The characteristic vegetation for this floodplain forest is a canopy clearly dominated by sycamore (*Platanus occidentalis*). Sycamore composes 50–90% of the canopy, with occasional associates of green ash (*Fraxinus pennsylvanica*), white ash (*Fraxinus americana*), common hackberry (*Celtis occidentalis*), eastern cottonwood (*Populus deltoides*), and American elm (*Ulmus americana*). The canopy trees typically extend 20–25 m in height, while subcanopy trees range in height from 8–12 m. The sparse to moderately dense subcanopy contains red maple (*Acer rubrum*), white ash, green ash, American elm, and river birch (*Betula nigra*). The tall- and short-shrub layers often contain northern spicebush (*Lindera benzoin*); however, they are highly susceptible to invasion by the exotic species multiflora rose (*Rosa multiflora*), Morrow's honeysuckle (*Lonicera morrowii*), and Japanese barberry (*Berberis thunbergii*). The herbaceous layer is typically moderately dense; common species include smallspike false nettle (*Boehmeria cylindrica*), arrowleaf tearthumb (*Polygonum sagittatum*), Virginia wildrye (*Elymus virginicus*), ostrich fern (*Matteuccia struthiopteris*), wild garlic (*Allium vineale*), Shawnee salad (*Hydrophyllum virginianum*), Jack in the pulpit (*Arisaema triphyllum*), white snakeroot (*Ageratina altissima* var. *altissima*), spotted ladysthumb (*Polygonum persicaria*), broadleaf enchanter's nightshade (*Circaea lutetiana* ssp. *canadensis*), bromelike sedge (*Carex bromoides*), and sensitive fern (*Onoclea sensibilis*). The herbaceous layer can be dominated by the invasive species garlic mustard (*Alliaria petiolata*) and Japanese stiltgrass (*Microstegium vimineum*). Vines such as eastern poison ivy (*Toxicodendron radicans*) and Virginia creeper (*Parthenocissus quinquefolia*) are also common.
Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Platanus occidentalis* (American sycamore)
Tree subcanopy	Broad-leaved deciduous tree	*Acer rubrum* (red maple)
		Fraxinus pennsylvanica (green ash)
Short shrub/sapling	Broad-leaved deciduous shrub	*Lindera benzoin* (northern spicebush)
Herb (field)	Vine/Liana	*Parthenocissus quinquefolia* (Virginia creeper)
Herb (field)	Forb	*Alliaria petiolata* (garlic mustard)
		Boehmeria cylindrica (smallspike false nettle)
		Polygonum sagittatum (arrowleaf tearthumb)
Herb (field)	Graminoid	*Elymus virginicus* (Virginia wildrye)
		Microstegium vimineum (Japanese stiltgrass)
Herb (field)	Fern or fern ally	*Onoclea sensibilis* (sensitive fern)

Characteristic Species: *Platanus occidentalis, Fraxinus pennsylvanica, Acer rubrum, Circaea lutetiana* ssp. *canadensis, Onoclea sensibilis.*

Other Noteworthy Species: Information not available.
Subnational Distribution with Crosswalk Data:

State	State Rank	Confidence	State Name	Reference
NJ	SNR	2	Riverine Floodplain Forest (Early-Successional Type)	Walz et al. 2006
PA	S4	1	Sycamore (River Birch) - Box-elder floodplain forest	Fike 1999

Local Range: This forest type is found in the floodplain of Bushkill Creek, Flat Brook, other major tributaries and the Delaware River.
Classification Comments: Sycamore Floodplain Forest is distinguished from Sycamore - Mixed Hardwood Floodplain Forest by the clear dominance of *Platanus occidentalis* covering 50–90% of the canopy in the former. In Sycamore - Mixed Hardwood Floodplain Forest, *Platanus occidentalis* is only codominant, sharing the canopy with a mix of other species. Also, Sycamore Floodplain Forest occurs on lower elevation terraces, typically immediately adjacent to the water's channel, with somewhat poorly drained finer textured substrate and a higher flood frequency. Sycamore - Mixed Hardwood Floodplain Forest occurs on slightly higher elevation mid terraces, with moderately well-drained coarser substrates and less frequent flood events.
Other Comments: None.
Local Description Authors: S. J. Perles (PNHP).
Plots and Data Sources: DEWA.237, DEWA.242; Fike 1999, Podniesinski and Wagner 2002.
Delaware Water Gap National Recreation Area Inventory Notes: Information not available.

GLOBAL INFORMATION

NVC CLASSIFICATION

Physiognomic Class	Forest (I)
Physiognomic Subclass	Deciduous forest (I.B.)
Physiognomic Group	Cold-deciduous forest (I.B.2.)
Physiognomic Subgroup	Natural/Semi-natural cold-deciduous forest (I.B.2.N.)
Formation	Temporarily flooded cold-deciduous forest (I.B.2.N.d.)
Alliance	*Platanus occidentalis - (Fraxinus pennsylvanica, Celtis laevigata, Acer saccharinum)* Temporarily Flooded Forest Alliance (A.288)
Alliance (English name)	Sycamore - (Green Ash, Sugarberry, Silver Maple) Temporarily Flooded Forest Alliance
Association	*Platanus occidentalis - Fraxinus pennsylvanica* Forest
Association (English name)	Sycamore - Green Ash Forest
Ecological System(s):	Information not available.

GLOBAL DESCRIPTION

Concept Summary: This floodplain forest of the northeastern United States, primarily in the northern Piedmont, is a broadly defined successional or young version of medium-gradient river floodplain forest occurring on coarse alluvial substrates. The canopy is closed to somewhat open and usually dominated by *Platanus occidentalis*. *Populus deltoides, Acer saccharinum,* and *Ulmus americana* are usually present but not common; occasional associates include *Acer negundo, Fraxinus pennsylvanica, Juglans cinerea, Carya cordiformis, Celtis occidentalis,* and *Acer rubrum*. Shrubs or subcanopy are variable depending on geography and can include *Betula nigra, Carpinus caroliniana, Salix nigra, Lindera benzoin,* or *Alnus serrulata,* plus exotic invasives such as *Rosa multiflora, Berberis thunbergii,* and *Lonicera morrowii*. The herbaceous layer tends to be sparse to locally abundant and can include *Matteuccia struthiopteris, Osmunda*

cinnamomea, Onoclea sensibilis, Geum canadense, Impatiens pallida, Boehmeria cylindrica, Urtica dioica, Solidago rugosa, Hydrophyllum virginianum, Carex bromoides, Ageratina altissima (= Eupatorium rugosum), plus vine species *Toxicodendron radicans* and *Parthenocissus quinquefolia*. There is typically a very high component of disturbance-tolerant exotic species such as *Lysimachia nummularia, Glechoma hederacea, Microstegium vimineum, Hesperis matronalis, Aegopodium podagraria, Polygonum cuspidatum*, and *Alliaria petiolata*.
Environmental Description: Early- to-mid successional forest occurs on cobble or sand substrates of floodplain islands or cobble shores of moderate- to high-energy rivers.
Vegetation Description: The canopy is closed to somewhat open and usually dominated by *Platanus occidentalis*. *Populus deltoides, Acer saccharinum*, and *Ulmus americana* are usually present but not common; occasional associates include *Acer negundo, Fraxinus pennsylvanica, Juglans cinerea, Carya cordiformis, Celtis occidentalis*, and *Acer rubrum*. Shrubs or subcanopy are variable depending on geography and can include *Betula nigra, Carpinus caroliniana, Salix nigra, Lindera benzoin*, or *Alnus serrulata*, plus exotic invasives such as *Rosa multiflora, Berberis thunbergii*, and *Lonicera morrowii*. The herbaceous layer tends to be sparse to locally abundant and can include *Matteuccia struthiopteris, Osmunda cinnamomea, Onoclea sensibilis, Geum canadense, Impatiens pallida, Boehmeria cylindrica, Urtica dioica, Solidago rugosa, Hydrophyllum virginianum, Carex bromoides, Ageratina altissima (= Eupatorium rugosum)*, plus vine species *Toxicodendron radicans* and *Parthenocissus quinquefolia*. There is typically a very high component of disturbance-tolerant exotic species such as *Lysimachia nummularia, Glechoma hederacea, Microstegium vimineum, Hesperis matronalis, Aegopodium podagraria, Polygonum cuspidatum*, and *Alliaria petiolata*.
Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Platanus occidentalis* (American sycamore)
Short shrub/sapling	Broad-leaved deciduous shrub	*Lindera benzoin* (northern spicebush)
Herb (field)	Forb	*Boehmeria cylindrica* (smallspike false nettle)
Herb (field)	Fern or fern ally	*Onoclea sensibilis* (sensitive fern)
		Osmunda cinnamomea (cinnamon fern)

Characteristic Species: *Acer saccharinum, Circaea lutetiana* ssp. *canadensis, Elymus virginicus, Onoclea sensibilis, Osmunda cinnamomea, Parthenocissus quinquefolia, Platanus occidentalis, Polygonum sagittatum, Populus deltoides, Ulmus americana.*
Other Noteworthy Species: Information not available.
USFWS Wetland System: Palustrine.

DISTRIBUTION
Range: This association ranges from New England south to Pennsylvania.
States/Provinces: CT, DC, DE:S3S4, MA, NH, NJ, NY, PA, RI, VA?, VT.
Federal Lands: NPS (Delaware Water Gap, Rock Creek, Valley Forge).

CONSERVATION STATUS
Rank: G4? (20-Jun-2006).
Reasons: Total acreage (rangewide) is limited. Good-quality examples are uncommon. Threats include development and filling, alteration in flooding regimes, excessive beaver activity, and encroachment by aggressive nonnative plant species. Further data are needed to define the rank.

CLASSIFICATION INFORMATION
Status: Standard.
Confidence: 2 – Moderate.

Comments: This type is not tracked as a separate floodplain element in Vermont.
Similar Associations:

- *Acer saccharinum - (Populus deltoides) / Matteuccia struthiopteris - Laportea canadensis* Forest (CEGL006147)--is characterized by a stronger dominance of both *Acer saccharinum* and *Matteuccia struthiopteris* and has fewer early-successional species.
- *Betula nigra - Platanus occidentalis / Impatiens capensis* Forest (CEGL006184)--southern species present, plus canopy with *Betula nigra*.

Related Concepts: Information not available.

SOURCES
Description Authors: S. L. Neid, mod. S. C. Gawler.
References: Clancy 1996, Eastern Ecology Working Group n.d., Edinger et al. 2002, Enser 1999, Fike 1999, Frye and Quinn 1979, Kearsley 1999b, Metzler and Barrett 2001, Newbold 1994, Newbold et al. 1988, Nichols et al. 2001, Overlease 1978, Overlease 1987, Podniesinski and Wagner 2002, Russell and Schuyler 1988, Sperduto 2000a, Sperduto 2000b, Swain and Kearsley 2000, Thompson and Sorenson 2000, Wistendahl 1958.

Figure A11. An example of Sycamore Floodplain Forest in Delaware Water Gap National Recreation Area.

COMMON NAME (PARK-SPECIFIC): WATER-WILLOW EMERGENT BED

SYNONYMS
NVC English Name: **American Water-willow Herbaceous Vegetation**
NVC Scientific Name: ***Justicia americana* Herbaceous Vegetation**
NVC Identifier: **CEGL004286**

LOCAL INFORMATION

Environmental Description: This association is found at the heads of islands, along the edges of bars, banks, terraces, and spits, and in shallow sections of the river channel in the Delaware River. The lower portions of the plants' stems are under water for most of the year, with the tops of the plants emerging above the flowing water. These beds are entirely submerged by most flood events. During extreme low water periods, the soil below the beds can be exposed, showing a varied mixture of sand, gravel, and cobbles, often with deposits of silt and muck.
Vegetation Description: American water-willow (*Justicia americana*) is the dominant species in this association and is often the only species present in a colonial bed. Since American water-willow spreads by rhizomes, the species can form extensive monocultural colonies. Many other herbaceous species may be associates, including rice cutgrass (*Leersia oryzoides*), water knotweed (*Polygonum amphibium*), spikerushes (*Eleocharis* spp.), waterweed (*Elodea* sp.), common threesquare (*Schoenoplectus pungens*), and field horsetail (*Equisetum arvense*). The invasive exotic purple loosestrife (*Lythrum salicaria*) may be common in this vegetation type. Scattered shrub seedlings of black willow (*Salix nigra*), river birch (*Betula nigra*), silver maple (*Acer saccharinum*), or sycamore (*Platanus occidentalis*) may also be present.
Most Abundant Species:

Stratum	Lifeform	Species
Herb (field)	Forb	*Justicia americana* (American water-willow)

Characteristic Species: *Justicia americana*, *Leersia oryzoides*, *Polygonum amphibium.*
Other Noteworthy Species: Information not available.
Subnational Distribution with Crosswalk Data:

State	State Rank	Confidence	State Name	Reference
NJ	SNR	1	Water-willow Rocky Bar and Shore	Walz et al. 2006
PA	S5	1	Water-willow (*Justicia americana*) - Smartweed Riverbed	Fike 1999

Local Range: This vegetation type is common throughout the Delaware River.
Classification Comments: This type is distinguished by the clear dominance of *Justicia americana* which is partially submerged for most of the year.
Other Comments: None.
Local Description Authors: S. J. Perles (PNHP).
Plots and Data Sources: DEWA.101, DEWA.104; Fike 1999, Perles et al 2004.
Delaware Water Gap National Recreation Area Inventory Notes: Information not available.

GLOBAL INFORMATION

NVC CLASSIFICATION

Physiognomic Class	Herbaceous Vegetation (V)
Physiognomic Subclass	Perennial forb vegetation (V.B.)
Physiognomic Group	Temperate or subpolar perennial forb vegetation (V.B.2.)
Physiognomic Subgroup	Natural/Semi-natural temperate or subpolar perennial forb vegetation (V.B.2.N.)
Formation	Temporarily flooded temperate perennial forb vegetation (V.B.2.N.d.)
Alliance	*Justicia americana* Temporarily Flooded Herbaceous Alliance (A.1657)
Alliance (English name)	American Water-willow Temporarily Flooded Herbaceous Alliance
Association	*Justicia americana* Herbaceous Vegetation
Association (English name)	American Water-willow Herbaceous Vegetation
Ecological System(s):	Central Appalachian Floodplain (CES202.608). Central Appalachian Riparian (CES202.609). South-Central Interior Small Stream and Riparian (CES202.706). Southern Piedmont Small Floodplain and Riparian Forest (CES202.323). Ozark-Ouachita Riparian (CES202.703). Cumberland Riverscour (CES202.036). South-Central Interior Large Floodplain (CES202.705).

GLOBAL DESCRIPTION

Concept Summary: This association is found primarily in the Piedmont, Central Appalachians, Cumberland Plateau, Interior Low Plateau, Ozarks, Ouachita Mountains, and adjacent provinces. Stands occur on the shoals or bars of rocky streams and riverbeds. It provides habitat in some portions of its range for globally rare dragonflies and herbs. *Justicia americana* is the characteristic dominant. *Saururus cernuus* is often present and may be codominant. Other herbaceous species that may be present include *Leersia oryzoides, Lemna minor, Orontium aquaticum, Podostemum ceratophyllum, Scirpus* sp., *Schoenoplectus pungens, Cyperus* spp., *Eleocharis* spp., *Diodia teres, Gratiola brevifolia*, and *Xyris difformis* var. *difformis*. Exotics include *Lythrum salicaria* and *Lysimachia vulgaris*. A sparse canopy layer, which can include *Carpinus caroliniana* ssp. *caroliniana, Salix interior, Fagus grandifolia*, and *Fraxinus pennsylvanica*, among other species, may be present. Scattered shrub seedlings of *Salix nigra, Betula nigra, Acer saccharinum*, or *Platanus occidentalis* may also be present.

Environmental Description: This association occurs on the shoals or bars of rocky streams and riverbeds, or gravelly sands. The beds are entirely submerged by most flood events. During extreme low water periods, the soil below the beds can be exposed, showing a varied mixture of sand, gravel and cobbles, often with deposits of silt and muck.

Vegetation Description: *Justicia americana* is the characteristic dominant and may be the only species present in a colonial bed. *Saururus cernuus* is often present and may be codominant. Other herbaceous species that may be present include *Leersia oryzoides, Lemna minor, Orontium aquaticum, Podostemum ceratophyllum, Scirpus* sp., *Schoenoplectus pungens, Cyperus* spp., *Elodea* sp., *Eleocharis* spp., *Equisetum arvense, Diodia teres, Gratiola brevifolia*, and *Xyris*

difformis var. *difformis*. Exotics include *Lythrum salicaria* and *Lysimachia vulgaris*. In some areas, *Justicia* usually grows in nearly pure patches, so that few other species are associated with it. *Bidens* spp., *Cuscuta gronovii, Mimulus ringens, Polygonum* spp., *Rumex* spp., and *Salix interior* can occur (Anderson 1982). A sparse canopy layer may be present, which can include *Carpinus caroliniana, Fagus grandifolia*, and *Fraxinus pennsylvanica*, among others. Scattered shrub seedlings of *Salix nigra, Betula nigra, Acer saccharinum*, or *Platanus occidentalis* may also be present. In the Cumberland Plateau of Alabama, *Justicia americana* is present in dense patches with some interspersion of other species, including *Pilea pumila, Boehmeria cylindrica, Eclipta prostrata (= Eclipta alba), Juncus coriaceus, Mikania scandens, Ludwigia palustris, Leersia* sp., and *Bidens* sp. Schmalzer and DeSelm (1982) discuss *Orontium aquaticum* growing along streambanks or in shallow riffles "along or with" *Justicia americana* in the Obed River in the Cumberland Plateau of Tennessee.

Most Abundant Species:

Stratum	Lifeform	Species
Herb (field)	Forb	*Justicia americana* (American water-willow)

Characteristic Species: *Justicia americana, Leersia oryzoides, Polygonum amphibium, Saururus cernuus, Schoenoplectus pungens.*

Other Noteworthy Species: Information not available.

USFWS Wetland System: Palustrine.

DISTRIBUTION

Range: This type is found primarily in the Piedmont, Interior Low Plateau, Cumberland Plateau, Ozarks, Ouachita Mountains, and adjacent provinces. It ranges from Alabama, Georgia and the Carolinas west to Arkansas and Oklahoma and north to Ohio, Pennsylvania, and Delaware.

States/Provinces: AL, AR, GA, KY, MD?, NC, NJ, OH:S4, OK, PA, SC?, TN, VA?, WV.

Federal Lands: NPS (Big South Fork, Delaware Water Gap, Little River Canyon?, Mammoth Cave, Natchez Trace, New River Gorge, Obed, Stones River); USFS (Bankhead, Cherokee, Daniel Boone, Oconee?, Ouachita, Ozark, Pisgah, Sumter?, Uwharrie).

CONSERVATION STATUS

Rank: G4G5 (12-Sep-1997).

Reasons: Information not available.

CLASSIFICATION INFORMATION

Status: Standard.

Confidence: 2 – Moderate.

Comments: This type, in Ohio, often forms pure patches, but consistent identification may require a simple cutoff rule, such as at least 50% cover of *Justicia* (Anderson 1982). However, Anderson (1996) no longer recognizes this type.

Similar Associations:

- *Hymenocallis coronaria* - *Justicia americana* Herbaceous Vegetation (CEGL004285).

Related Concepts:

- Aquatic Types (Schmalzer and DeSelm 1982) B
- IIE3a. Riverside Shoal and Stream Bar Complex (Allard 1990) B
- Lizard's tail emergent bed (Perles et al. 2004) ?
- Rocky Bar and Shore (Water Willow Subtype) (Schafale 1998b) ?
- Water willow emergent bed (Perles et al. 2004) ?

SOURCES

Description Authors: A. S. Weakley, mod. D. Faber-Langendoen and S. C. Gawler.

References: Allard 1990, Anderson 1982, Anderson 1996, Fike 1999, Fleming et al. 2001, Harrison 2004, Hoagland 1997, Hoagland 2000, Major et al. 1999, McCoy 1958, Nelson 1986, OHNHD unpubl. data, Palmer-Ball et al. 1988, Peet et al. unpubl. data 2002, Penfound 1953, Perles et al. 2004, Schafale 1998b, Schafale 2002, Schafale and Weakley 1990, Schmalzer and DeSelm 1982, Schotz pers. comm., Southeastern Ecology Working Group n.d., TDNH unpubl. data.

Figure A12. An example of Water-willow Emergent Bed in Delaware Water Gap National Recreation Area.

Figure A13. An example of Water-willow Emergent Bed in Delaware Water Gap National Recreation Area.

COMMON NAME (PARK-SPECIFIC): RIVERINE SCOUR VEGETATION

SYNONYMS
NVC English Name: **Fringed Loosestrife - Indianhemp Sparse Vegetation**
NVC Scientific Name: ***Lysimachia ciliata - Apocynum cannabinum* Sparse Vegetation**
NVC Identifier: **CEGL006554**

LOCAL INFORMATION

Environmental Description: This type is associated with the Delaware River in a wide variety of riverine settings. Island heads, bars, spits, low terraces, and shorelines can support this broadly defined vegetation type. The underlying substrate varies greatly, although it is often cobbles and sand, with thin deposits of silt, muck, or organic matter. Species composition also varies greatly from site to site. The unifying factor that bridges the differences in environmental factors and species composition is the frequent scour that these sites experience. This vegetation type establishes in areas of the active channel that are underwater for the majority of the year and are exposed only at low water or in drought years. Therefore, these areas are subjected to high water velocities, floods, and ice-scour more frequently than the other riparian communities (with the exception of emergent beds). The constant scour removes established vegetation and maintains or creates exposed sediments or cobbles. Water, air, and animals are constantly dispersing new seeds and plant propagules to these areas. This causes the continual flux in species composition that is characteristic of this community.

Vegetation Description: Frequent disturbance of these areas creates conditions that promote continual colonization by a wide variety of plants. After a disturbance, herbaceous and graminoid species may establish sparsely across bare substrate. As more time elapses between disturbance events, vegetation can become dense, completely covering the area. The species composition of the community varies depending upon the available seedbank, surrounding vegetation, type of substrate, ecoregion, and hydrologic conditions. Some common species include water knotweed (*Polygonum amphibium*), spikerushes (*Eleocharis* spp.), sensitive fern (*Onoclea sensibilis*), American water-willow (*Justicia americana*), Virginia marsh St. Johnswort (*Triadenum virginicum*), tussock sedge (*Carex stricta*), spotted joe-pyeweed (*Eupatorium maculatum*), eastern marsh fern (*Thelypteris palustris*), chufa flatsedge (*Cyperus esculentus*), Indianhemp (*Apocynum cannabinum*), fringed loosestrife (*Lysimachia ciliata*), smallspike false nettle (*Boehmeria cylindrica*), common marsh bedstraw (*Galium palustre*), whitegrass (*Leersia virginica*), marshpepper knotweed (*Polygonum hydropiper*), swamp smartweed (*Polygonum hydropiperoides*), reed canarygrass (*Phalaris arundinacea*), poverty rush (*Juncus tenuis*), common threesquare (*Schoenoplectus pungens*), wild mint (*Mentha arvensis*), groundnut (*Apios americana*), flat-top goldentop (*Euthamia graminifolia*), American hogpeanut (*Amphicarpaea bracteata*), big bluestem (*Andropogon gerardii*), switchgrass (*Panicum virgatum*), and common sneezeweed (*Helenium autumnale*). Numerous other species can be present. The invasive exotic purple loosestrife (*Lythrum salicaria*) can be abundant in this community type. Scattered short and tall shrubs may be present, including river birch (*Betula nigra*), silver maple (*Acer saccharinum*), sycamore (*Platanus occidentalis*), willows (*Salix* spp.), and/or red maple (*Acer rubrum*).

Most Abundant Species:

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Betula nigra* (river birch)
		Platanus occidentalis (American sycamore)
Herb (field)	Forb	*Lythrum salicaria* (purple loosestrife)
		Mentha arvensis (wild mint)
		Polygonum amphibium (water knotweed)
Herb (field)	Graminoid	*Carex stricta* (tussock sedge)
		Phalaris arundinacea (reed canarygrass)
		Eleocharis spp. (spikerushes)
Herb (field)	Fern or fern ally	*Onoclea sensibilis* (sensitive fern)

Characteristic Species: This vegetation type characteristically includes wide variation in species composition between sites. See the Vegetation Description above for common species.

Other Noteworthy Species: Information not available.

Subnational Distribution with Crosswalk Data:

State	State Rank	Confidence	State Name	Reference
NJ	SNR	2	Loosestrife - Dogbane Scoured Rivershore	Walz et al. 2006
PA	S4	2	No crosswalk	Fike 1999

Local Range: This type is common within the Delaware River.

Classification Comments: Calcareous Riverside Outcrop and Calcareous Riverside Seep is distinguished from Riverine Scour Vegetation by the presence of exposed calcareous bedrock along the shoreline of the river that often provides habitat for rare species. Riverine Scour Vegetation occurs in a wide variety of riverine settings and on various substrates, although not bedrock.

Other Comments: None.

Local Description Authors: S. J. Perles (PNHP).

Plots and Data Sources: DEWA.99, DEWA.100, DEWA.102, DEWA.218; Perles et al 2004.

Delaware Water Gap National Recreation Area Inventory Notes: Information not available.

GLOBAL INFORMATION

NVC CLASSIFICATION

Physiognomic Class	Sparse Vegetation (VII)
Physiognomic Subclass	Boulder, gravel, cobble, or talus sparse vegetation (VII.B.)
Physiognomic Group	Sparsely vegetated rock flats (VII.B.2.)
Physiognomic Subgroup	Natural/Semi-natural sparsely vegetated rock flats (VII.B.2.N.)
Formation	Cobble/gravel beaches and shores (VII.B.2.N.b.)
Alliance	Cobble/Gravel Shore Sparsely Vegetated Alliance (A.1850)
Alliance (English name)	Cobble/Gravel Shore Sparsely Vegetated Alliance
Association	*Lysimachia ciliata* - *Apocynum cannabinum* Sparse Vegetation
Association (English name)	Fringed Loosestrife - Indianhemp Sparse Vegetation
Ecological System(s):	Central Appalachian Riparian (CES202.609).

GLOBAL DESCRIPTION

Concept Summary: Island heads, bars, spits, low terraces, and riverbanks are all home to this broadly defined community. The underlying substrate also varies greatly, although it is often cobbles and sand, with thin deposits of silt, muck or organic matter. Species composition also varies greatly from site to site. The unifying factor that bridges the differences in environmental factors and species composition is the frequent scour that these sites experience. This community

establishes in areas of the active channel that are underwater for the majority of the year and are exposed only at low water or in drought years. Therefore, these areas are subjected to high water velocities, floods and ice-scour more frequently than other herbaceous communities or shrublands (with the exception of emergent beds). The constant scour removes established vegetation and maintains or creates exposed sediments, cobbles or bedrock. New seeds and plant propagules are constantly being dispersed to these areas by water, air and animals. This causes a continual flux in species composition that is characteristic of this community. Typical species are a mix of annuals and perennials, including *Lysimachia ciliata, Lysimachia vulgaris, Lysimachia nummularia, Senecio* spp., *Eupatorium* spp., other Asteraceae spp., *Convolvulus* spp., *Phyla lanceolata,, Justicia americana, Cyperus esculentus, Boehmeria cylindrica, Polygonum* spp., *Apocynum cannabinum, Betula nigra,* and *Platanus occidentalis*. This community is defined mainly by its setting and disturbance regime.

Environmental Description: sland heads, bars, spits, low terraces, and riverbanks are all home to this broadly defined community. The underlying substrate also varies greatly, although it is often cobbles and sand, with thin deposits of silt, muck or organic matter. Species composition also varies greatly from site to site. The unifying factor that bridges the differences in environmental factors and species composition is the frequent scour that these sites experience. This community establishes in areas of the active channel that are underwater for the majority of the year and are exposed only at low water or in drought years. Therefore, these areas are subjected to high water velocities, floods and ice-scour more frequently than other herbaceous communities or shrublands (with the exception of emergent beds). The constant scour removes established vegetation and maintains or creates exposed sediments, cobbles or bedrock. New seeds and plant propagules are constantly being dispersed to these areas by water, air and animals. This causes a continual flux in species composition that is characteristic of this community.

Vegetation Description: Typical species are a mix of annuals and perennials including *Lysimachia ciliata, Lysimachia vulgaris, Lysimachia nummularia, Senecio* sp., Asteraceae spp., *Eupatorium* spp., *Convolvulus* spp., *Phyla lanceolata, Justicia americana, Cyperus esculentus, Boehmeria cylindrica, Polygonum* spp., *Apocynum cannabinum, Betula nigra, Platanus occidentalis*. This community is defined mainly by its setting and disturbance regime.

Most Abundant Species:

Stratum	Lifeform	Species
Herb (field)	Forb	*Lysimachia ciliata* (fringed loosestrife)

Characteristic Species: *Apocynum cannabinum, Lysimachia ciliata, Polygonum amphibium.*

Other Noteworthy Species: Information not available.

USFWS Wetland System: Palustrine.

DISTRIBUTION

Range: The full distribution of this type is not well-known. It is currently documented only from Pennsylvania and New Jersey but believed to range further. Lack of samples and inherent variability are challenges.

States/Provinces: NJ, PA.

Federal Lands: NPS (Delaware Water Gap, Johnstown Flood).

CONSERVATION STATUS

Rank: GNR (8-Jul-1999).

Reasons: Information not available.

CLASSIFICATION INFORMATION
Status: Standard.
Confidence: 3 – Weak.
Comments: Information not available.
Similar Associations: Information not available.
Related Concepts: Information not available.

SOURCES
Description Authors: E. Largay, mod. S. C. Gawler.
References: Eastern Ecology Working Group n.d., Fike 1999, Perles et al. 2004.

Figure A14. An example of Riverine Scour Vegetation in Delaware Water Gap National Recreation Area.

Figure A15. An example of Riverine Scour Vegetation in Delaware Water Gap National Recreation Area.

COMMON NAME (PARK-SPECIFIC): BIG BLUESTEM - INDIANGRASS RIVERINE GRASSLAND

SYNONYMS

NVC English Name: **Sand Cherry / Big Bluestem - Yellow Indiangrass Herbaceous Vegetation**

NVC Scientific Name: ***Prunus pumila / Andropogon gerardii - Sorghastrum nutans* Herbaceous Vegetation**

NVC Identifier: **CEGL006518**

LOCAL INFORMATION

Environmental Description: This community type occurs on sand/gravel deposits along shorelines and on islands in the Delaware River. These sites are subject to flooding and ice-scour which removes woody vegetation and maintains a graminoid- and herbaceous-dominated vegetation.

Vegetation Description: The typical aspect is that of a tall prairie-like grassland. The dominant species are big bluestem (*Andropogon gerardii*), Indiangrass (*Sorghastrum nutans*), switchgrass (*Panicum virgatum*), and little bluestem (*Schizachyrium scoparium*). Other herbaceous species include Indianhemp (*Apocynum cannabinum*), hairy lespedeza (*Lespedeza hirta*), reed canarygrass (*Phalaris arundinacea*), wrinkleleaf goldenrod (*Solidago rugosa*), field pennycress (*Thlaspi arvense*), prairie fleabane (*Erigeron strigosus*), and common yarrow (*Achillea millefolium*). The invasive species spotted knapweed (*Centaurea biebersteinii*) can also be present. Woody species may become established within the grassland matrix. Common species include willows (*Salix* spp.), sycamore (*Platanus occidentalis*), ashes (*Fraxinus* spp.), boxelder (*Acer negundo*), and river birch (*Betula nigra*). Vines may also be present, including Virginia creeper (*Parthenocissus quinquefolia*), eastern poison ivy (*Toxicodendron radicans*), fox grape (*Vitis labrusca*), and riverbank grape (*Vitis riparia*).

Most Abundant Species:

Stratum	Lifeform	Species
Herb (field)	Forb	*Apocynum cannabinum* (Indianhemp)
		Lespedeza hirta (hairy lespedeza)
Herb (field)	Graminoid	*Andropogon gerardii* (big bluestem)
		Panicum virgatum (switchgrass)
		Schizachyrium scoparium (little bluestem)
		Sorghastrum nutans (Indiangrass)

Characteristic Species: *Andropogon gerardii, Sorghastrum nutans, Panicum virgatum, Schizachyrium scoparium, Prunus pumila* var. *depressa.*

Other Noteworthy Species: *Prunus pumila* var. *depressa.*

Subnational Distribution with Crosswalk Data:

State	State Rank	Confidence	State Name	Reference
NJ	S2?	2	Riverside Prairie Grassland	Walz et al. 2006
PA	S3	1	Big Bluestem - Indian Grass River Grassland	Fike 1999

Local Range: This vegetation is found occasionally along the Delaware River.

Classification Comments: This type can be distinguished from other riparian types by the dominance of *Andropogon gerardii, Sorghastrum nutans, Panicum virgatum*, and *Schizachyrium scoparium* that form a tall prairie-like grassland.

Other Comments: None.
Local Description Authors: S. J. Perles (PNHP).
Plots and Data Sources: DEWA.107; Fike 1999.
Delaware Water Gap National Recreation Area Inventory Notes: Information not available.

GLOBAL INFORMATION

NVC CLASSIFICATION

Physiognomic Class	Herbaceous Vegetation (V)
Physiognomic Subclass	Perennial graminoid vegetation (V.A.)
Physiognomic Group	Temperate or subpolar grassland (V.A.5.)
Physiognomic Subgroup	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N.)
Formation	Temporarily flooded temperate or subpolar grassland (V.A.5.N.j.)
Alliance	*Andropogon gerardii - (Sorghastrum nutans)* Temporarily Flooded Herbaceous Alliance (A.1337)
Alliance (English name)	Big Bluestem - (Yellow Indiangrass) Temporarily Flooded Herbaceous Alliance
Association	*Prunus pumila / Andropogon gerardii - Sorghastrum nutans* Herbaceous Vegetation
Association (English name)	Sand Cherry / Big Bluestem - Yellow Indiangrass Herbaceous Vegetation
Ecological System(s):	Information not available.

GLOBAL DESCRIPTION

Concept Summary: These are tall alluvial grasslands in the temperate region of the northeastern United States. They are found on sandy point bars and linear deposits along semi-stable rivershores subject to periodic flooding. Ice build-up during the winter can scour the rivershore in spring, limiting woody growth. The substrate is cobble, gravel or coarse sediment with interstices of alluvial sand and silt. Bare cobble is exposed in some areas. Herbaceous plants dominate, and may form a dense cover; scattered shrubs may grow among them, but are generally kept short by the annual flooding. Bryophytes are absent or at most sparse. The dominant plants are tall grasses such as *Sorghastrum nutans, Andropogon gerardii, Schizachyrium scoparium*, and *Panicum virgatum*. Characteristic herbs include *Helianthemum canadense, Helianthus divaricatus, Asclepias tuberosa*, and *Lespedeza capitata*. *Spiraea alba, Rosa virginiana*, and *Prunus pumila* are common shrubs. Other herbaceous associates include *Anemone virginiana, Calamagrostis canadensis, Eupatorium maculatum, Lycopus uniflorus, Phalaris arundinacea, Scleria triglomerata*, and *Symphyotrichum novi-belgii*. This association differs from more northerly riverside ice meadows in being dominated by prairie grasses (*Andropogon gerardii, Sorghastrum nutans*) rather than by *Calamagrostis canadensis*.
Environmental Description: These are tall alluvial grasslands in the temperate region of the northeastern United States. They are found on sandy point bars and linear deposits along semi-stable rivershores subject to periodic flooding. Ice build-up during the winter can scour the rivershore in spring, limiting woody growth. The substrate is cobble, gravel or coarse sediment with interstices of alluvial sand and silt. Bare cobble is exposed in some areas.
Vegetation Description: Herbaceous plants dominate and may form a dense cover; scattered shrubs may grow among them but are generally kept short by annual flooding. Bryophytes are

absent or at most sparse. The dominant plants are tall grasses such as *Sorghastrum nutans, Andropogon gerardii, Schizachyrium scoparium*, and *Panicum virgatum*. Characteristic herbs include *Helianthemum canadense, Helianthus divaricatus, Apocynum cannabinum, Asclepias tuberosa, Lespedeza hirta*, and *Lespedeza capitata*. *Spiraea alba, Rosa virginiana*, and *Prunus pumila* are common shrubs. Other herbaceous associates include *Anemone virginiana, Calamagrostis canadensis, Eupatorium maculatum, Solidago rugosa, Achillea millefolium, Lycopus uniflorus, Phalaris arundinacea, Scleria triglomerata*, and *Symphyotrichum novi-belgii*.

Most Abundant Species:

Stratum	Lifeform	Species
Herb (field)	Forb	*Apocynum cannabinum* (Indianhemp)
		Lespedeza hirta (hairy lespedeza)
Herb (field)	Graminoid	*Andropogon gerardii* (big bluestem)
		Panicum virgatum (switchgrass)
		Schizachyrium scoparium (little bluestem)
		Sorghastrum nutans (Indiangrass)

Characteristic Species: *Andropogon gerardii*, *Panicum virgatum*, *Prunus pumila* var. *depressa*, *Sorghastrum nutans.*

Other Noteworthy Species: Information not available.

USFWS Wetland System: Palustrine.

DISTRIBUTION

Range: Information not available.

States/Provinces: CT, MA, NH, NJ, NY, PA, VT.

Federal Lands: NPS (Delaware Water Gap).

CONSERVATION STATUS

Rank: GNR (6-Jul-1999).

Reasons: Information not available.

CLASSIFICATION INFORMATION

Status: Standard.

Confidence: 3 - Weak.

Comments: Information not available.

Similar Associations: Information not available.

Related Concepts:

- Willow - Indian grass riverine shrubland (Perles et al. 2004) B

SOURCES

Description Authors: S. C. Gawler.

References: Eastern Ecology Working Group n.d., Edinger et al. 2002, Fike 1999, Metzler and Barrett 2001, Nichols et al. 2001, Perles et al. 2004, Thompson and Sorenson 2000.

Figure A16. An example of Big Bluestem - Indiangrass Riverine Grassland in Delaware Water Gap National Recreation Area.

Figure A17. An example of Big Bluestem - Indiangrass Riverine Grassland in Delaware Water Gap National Recreation Area.

COMMON NAME (PARK-SPECIFIC): HAIRYFRUIT SEDGE WETLAND

SYNONYMS

NVC English Name: **Hairy-fruit Sedge - Bulrush species - Giant Goldenrod Herbaceous Vegetation**

NVC Scientific Name: ***Carex trichocarpa* - *Scirpus* spp. - *Solidago gigantea* Herbaceous Vegetation [Provisional]**

NVC Identifier: **CEGL006447**

LOCAL INFORMATION

Environmental Description: This association is found occasionally in small patches on mainstem islands in the Delaware River, as well as on the floodplains of major tributaries where tree canopy is lacking, especially portions of Flat Brook. Typical soils include the coarse loamy to sandy Fredon-Halsey complex, which are somewhat poorly to very poorly drained glacio-fluvial deposits (characteristic along Flat Brook). This community is routinely flooded during most high-water events and commonly occurs on low flats associated with the active floodplain, either directly adjacent to the channel or in association with backwater depressions and sloughs.

Vegetation Description: Hairyfruit sedge (*Carex trichocarpa*) is the dominant species in this association. Shrubs may be present but at less than 25% cover, including multiflora rose (*Rosa multiflora*), silky dogwood (*Cornus amomum*), and Allegheny blackberry (*Rubus allegheniensis*). Other common herbaceous species include giant goldenrod (*Solidago gigantea*), smallspike false nettle (*Boehmeria cylindrica*), deertongue (*Dichanthelium clandestinum*), reed canarygrass (*Phalaris arundinacea*), stinging nettle (*Urtica dioica*), knotweeds (*Polygonum* spp.), and woolgrass (*Scirpus cyperinus*). Vines may be present at low cover including black bindweed (*Polygonum convolvulus*) and devil's darning needles (*Clematis virginiana*).

Most Abundant Species:

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous shrub	*Cornus amomum* (silky dogwood)
		Rosa multiflora (multiflora rose)
Herb (field)	Forb	*Boehmeria cylindrica* (smallspike false nettle)
		Solidago gigantea (giant goldenrod)
Herb (field)	Graminoid	*Carex trichocarpa* (hairyfruit sedge)
		Dichanthelium clandestinum (deertongue)

Characteristic Species: *Carex trichocarpa, Boehmeria cylindrica, Solidago gigantea, Cornus amomum.*

Other Noteworthy Species: Information not available.

Subnational Distribution with Crosswalk Data:

State	State Rank	Confidence	State Name	Reference
NJ	SNR	2	Riverside Hairy-fruit Sedge Flat	Walz et al. 2006
PA	S3	1	No crosswalk	Fike 1999

Local Range: This vegetation type is occasional throughout the park on the floodplain of the Delaware River and major tributaries.

Classification Comments: This type is distinguished by the clear dominance of *Carex trichocarpa* and low shrub cover (<25%).

Other Comments: None.
Local Description Authors: G. S. Podniesinski (PNHP).
Plots and Data Sources: DEWA.50; Accuracy Assessment Observation Points DEWA.178, DEWA.591, DEWA.551.
Delaware Water Gap National Recreation Area Inventory Notes: Information not available.

GLOBAL INFORMATION

NVC CLASSIFICATION

Physiognomic Class	Herbaceous Vegetation (V)
Physiognomic Subclass	Perennial graminoid vegetation (V.A.)
Physiognomic Group	Temperate or subpolar grassland (V.A.5.)
Physiognomic Subgroup	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N.)
Formation	Temporarily flooded temperate or subpolar grassland (V.A.5.N.j.)
Alliance	Carex torta Temporarily Flooded Herbaceous Alliance (A.1340)
Alliance (English name)	Twisted Sedge Temporarily Flooded Herbaceous Alliance
Association	*Carex trichocarpa* - *Scirpus* spp. - *Solidago gigantea* Herbaceous Vegetation [Provisional]
Association (English name)	Hairy-fruit Sedge - Bulrush species - Giant Goldenrod Herbaceous Vegetation
Ecological System(s):	Central Appalachian Floodplain (CES202.608).

GLOBAL DESCRIPTION

Concept Summary: This linear association occurs in small patches on floodplain edges and islands where tree canopy is lacking, on mid-Atlantic medium- to large-sized rivers. This community is routinely flooded during most high-water events and commonly occurs on low flats associated with the active floodplain, either directly adjacent to the channel or in association with backwater depressions and sloughs. *Carex trichocarpa* is the dominant species in this association. It typically forms a band 5–10 m wide and about 50 m long. Shrubs may be present but at less than 25% cover, including *Rosa multiflora, Cornus amomum*, and *Rubus allegheniensis*. Other common herbaceous species include *Solidago gigantea, Boehmeria cylindrica, Dichanthelium clandestinum, Phalaris arundinacea, Urtica dioica, Polygonum* spp., and *Scirpus cyperinus*. Vines may be present at low cover, including *Polygonum convolvulus* and *Clematis virginiana*.
Environmental Description: This association is found occasionally in small patches on floodplain edges and islands where tree canopy is lacking. Typical soils include the coarse loamy to sandy somewhat poorly to very poorly drained glacio-fluvial deposits. This community is routinely flooded during most high-water events and commonly occurs on low flats associated with the active floodplain, either directly adjacent to the channel or in association with backwater depressions and sloughs.
Vegetation Description: *Carex trichocarpa* is the dominant species in this association. Shrubs may be present but at less than 25% cover, including *Rosa multiflora, Cornus amomum*, and *Rubus allegheniensis*. Other common herbaceous species include *Solidago gigantea, Boehmeria cylindrica, Dichanthelium clandestinum, Phalaris arundinacea, Urtica dioica, Polygonum* spp., and *Scirpus cyperinus*. Vines may be present at low cover, including *Polygonum convolvulus* and *Clematis virginiana*.

Most Abundant Species:

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Carex trichocarpa* (hairyfruit sedge)

Characteristic Species: *Boehmeria cylindrica*, *Carex trichocarpa*, *Cornus amomum*, *Dichanthelium clandestinum*, *Solidago gigantea*.
Other Noteworthy Species: Information not available.
USFWS Wetland System: Palustrine.

DISTRIBUTION

Range: This community occurs in northern New Jersey and northeastern Pennsylvania and possibly elsewhere.
States/Provinces: NJ, PA.
Federal Lands: NPS (Delaware Water Gap).

CONSERVATION STATUS

Rank: GNR (7-Feb-2006).
Reasons: Information not available.

CLASSIFICATION INFORMATION

Status: Provisional.
Confidence: 2 – Moderate.
Comments: Described from Delaware Water Gap, where distinct although narrow and linear; occurrence elsewhere in the northeastern U.S. needs to be documented.
Similar Associations: Information not available.
Related Concepts: Information not available.

SOURCES

Description Authors: S. C. Gawler.
References: Eastern Ecology Working Group n.d.

Figure A18. An example of Hairy-fruit Sedge Wetland in Upper Delaware Scenic and Recreational River.

Figure A19. An example of Hairyfruit Sedge Wetland in Delaware Water Gap National Recreation Area.

COMMON NAME (PARK-SPECIFIC): CALCAREOUS RIVERSIDE SEEP

SYNONYMS
NVC English Name: **Tufted Hairgrass - Little Green Sedge Herbaceous Vegetation**
NVC Scientific Name: ***Deschampsia caespitosa - Carex viridula* Herbaceous Vegetation**
NVC Identifier: **CEGL006969**

LOCAL INFORMATION

Environmental Description: This vegetation type occurs along the shoreline of the Delaware River where winter ice-scouring, limestone bedrock, and natural seepage co-occur. This association occurs on alluvial deposits combined with cobble substrate in which weathered bedrock has been broken into distinct rocks of various sizes. The seeps are generated in areas where groundwater flows out and over the cobble substrate, supporting many calciphiles and rare species. Winter ice-scour that removes tall vegetation and woody plants maintains predominantly herbaceous vegetation. The early-successional floristic assemblages include species able to regenerate from buried rootstocks or from seeds dispersed along the shoreline. Seasonal and annual variation in water levels is another important process affecting the vegetation. Calcareous Riverside Seep is often found interspersed with Calcareous Riverside Outcrop along the shoreline of the Delaware River.

Vegetation Description: Vegetation can be dense, robust, and diverse. These sites are dominated by grasses, including tufted hairgrass (*Deschampsia caespitosa*), slender wedgescale (*Sphenopholis intermedia*), and big bluestem (*Andropogon gerardii*). Numerous sedges may be present, such as little green sedge (*Carex viridula*), blister sedge (*Carex vesicaria*), bottlebrush sedge (*Carex hystericina*), woolly sedge (*Carex pellita*), limestone meadow sedge (*Carex granularis*), owlfruit sedge (*Carex stipata*), broom sedge (*Carex scoparia*) and fox sedge (*Carex vulpinoidea*). Characteristic rare species include little green sedge, rough bentgrass (*Agrostis scabra*), flatstem spikerush (*Eleocharis compressa*), muskflower (*Mimulus moschatus*), panicled bulrush (*Scirpus microcarpus*), crookedstem aster (*Symphyotrichum prenanthoides*), smallhead rush (*Juncus brachycephalus*), and shining ladies'-tresses (*Spiranthes lucida*). A wide variety of associated species may be present, including annual agricultural weeds, old-field species, and plants common in Riverine Scour Vegetation. Some of the numerous common associates include spreading dogbane (*Apocynum androsaemifolium*), garden yellowrocket (*Barbarea vulgaris*), horsetails (*Equisetum* spp.), American water horehound (*Lycopus americanus*), ragged robin (*Lychnis flos-cuculi*), true forget-me-not (*Myosotis scorpioides*), sensitive fern (*Onoclea sensibilis*), fen grass of Parnassus (*Parnassia glauca*), common plantain (*Plantago major*), creeping buttercup (*Ranunculus repens*), watercress (*Rorippa nasturtium-aquaticum*), and common threesquare (*Schoenoplectus pungens*). Scattered shrubs may be present, such as smooth rose (*Rosa blanda*), sycamore (*Platanus occidentalis*), common ninebark (*Physocarpus opulifolius*), river birch (*Betula nigra*), silver maple (*Acer saccharinum*), red maple (*Acer rubrum*), willows (*Salix* spp.), and alders (*Alnus* spp.). These sites are susceptible to invasion by purple loosestrife (*Lythrum salicaria*) and Japanese stiltgrass (*Microstegium vimineum*).

Most Abundant Species:

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Andropogon gerardii* (big bluestem)
		Carex viridula (little green sedge)
		Deschampsia caespitosa (tufted hairgrass)
		Sphenopholis intermedia (slender wedgescale)
		Carex spp. (sedges)

Characteristic Species: *Deschampsia caespitosa, Carex viridula.*

Other Noteworthy Species: *Agrostis scabra, Carex viridula, Eleocharis compressa, Juncus brachycephalus, Mimulus moschatus, Scirpus microcarpus, Spiranthes lucida, Symphyotrichum prenanthoides.*

Subnational Distribution with Crosswalk Data:

State	State Rank	Confidence	State Name	Reference
NJ	S1	1	Calcareous Riverside Seep	Walz et al. 2006

Local Range: There are three locations of this type of river shoreline along the New Jersey side of the Delaware River within the park.

Classification Comments: Calcareous Riverside Seep occurs interspersed with Calcareous Riverside Outcrop, however, it is restricted to areas of groundwater seepage and contains plants that are dependent on the groundwater seepage. By contrast, the Calcareous Riverside Outcrop does not contain groundwater seepage and its plants are generally xerophilic. The Calcareous Riverside Seep is distinguished from Riverine Scour Vegetation by the groundwater flowing out and over cobbled limestone substrate and the presence of numerous rare species (may be ephemeral).

Other Comments: None.

Local Description Authors: S. J. Perles (PNHP).

Plots and Data Sources: Accuracy Assessment Observation Point DEWA.616; Shank and Shreiner 1999, Breden 1989.

Delaware Water Gap National Recreation Area Inventory Notes: Information not available.

GLOBAL INFORMATION

NVC CLASSIFICATION

Physiognomic Class	Herbaceous Vegetation (V)
Physiognomic Subclass	Perennial graminoid vegetation (V.A.)
Physiognomic Group	Temperate or subpolar grassland (V.A.5.)
Physiognomic Subgroup	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N.)
Formation	Seasonally flooded temperate or subpolar grassland (V.A.5.N.k.)
Alliance	*Deschampsia caespitosa* Seasonally Flooded Herbaceous Alliance (A.1408)
Alliance (English name)	Tufted Hairgrass Seasonally Flooded Herbaceous Alliance
Association	*Deschampsia caespitosa* - *Carex viridula* Herbaceous Vegetation
Association (English name)	Tufted Hairgrass - Little Green Sedge Herbaceous Vegetation
Ecological System(s):	Central Appalachian Riparian (CES202.609)

GLOBAL DESCRIPTION

Concept Summary: This calcareous riverside seep community occurs along sections of river shoreline where winter ice-scouring, limestone outcrops, and natural seepage co-occur. The community is typically characterized by open, sparsely vegetated sections of smooth limestone outcrops that extend for variable lengths from the woodland edge to the river edge or areas of

fractured ("latticed") limestone supporting denser vegetation in the crevices. Typically, sites have a north-northwest exposure and are fully exposed to late-day sun. The slope of the outcrops ranges from a gentle incline rising from the river shoreline to a 28-degree incline at the most steeply sloped sites. Species composition is variable and diverse, but the most frequent species are *Symphyotrichum lanceolatum (= Aster lanceolatus), Deschampsia caespitosa, Carex viridula, Lythrum salicaria*, and *Phalaris arundinacea*. Other characteristic species include *Apios americana, Apocynum cannabinum (= Apocynum sibiricum), Artemisia vulgaris, Barbarea vulgaris, Doellingeria umbellata, Eleocharis* spp., *Eupatorium perfoliatum, Galium boreale, Hypericum mutilum, Juncus canadensis, Juncus dudleyi, Lobelia siphilitica, Lychnis flos-cuculi, Lycopus americanus, Lysimachia ciliata, Myosotis scorpioides, Parnassia glauca, Plantago major, Poa* spp., *Prunella vulgaris, Ranunculus repens, Rubus odoratus, Scirpus microcarpus, Spiranthes lucida, Viola* spp., and *Zizia aurea*. Several species of *Carex* are often present, including *Carex granularis, Carex hystericina, Carex pellita (= Carex lanuginosa), Carex scoparia, Carex stipata, Carex vesicaria, Carex viridula*, and *Carex vulpinoidea*. Sparse shrubs may be present, mostly at the upslope end near the forest transition; they include *Alnus incana, Platanus occidentalis, Salix* spp., *Ulmus rubra, Cornus amomum, Rosa palustris*, and *Spiraea alba*.

Environmental Description: This calcareous riverside seep community occurs along sections of river shoreline where winter ice-scouring, limestone outcrops, and natural seepage co-occur. The substrate is alluvial deposits combined with cobbled substrate in which weathered bedrock has been broken into distinct rocks of various sizes. The seeps are generated in areas where groundwater flows out and over the cobbled substrate, supporting many calciphiles and rare species. Winter ice-scour that removes tall vegetation and woody plants maintains predominantly herbaceous vegetation. The early-successional floristic assemblages include species able to regenerate from buried rootstocks or from seeds dispersed along the shoreline. Seasonal and annual variation in water levels is another important process affecting the vegetation. Typically, sites have a north-northwest exposure and are fully exposed to late-day sun. The slope of the outcrops ranges from a gentle incline rising from the river shoreline to a 28-degree incline at the most steeply sloped sites.

Vegetation Description: Species composition is variable and diverse, but the most frequent species are *Deschampsia caespitosa, Andropogon gerardii, Sphenopholis intermedia, Symphyotrichum lanceolatum (= Aster lanceolatus), Carex viridula*, and *Phalaris arundinacea*. Other characteristic species include *Agrostis scabra, Apios americana, Apocynum cannabinum (= Apocynum sibiricum), Artemisia vulgaris, Barbarea vulgaris, Doellingeria umbellata, Eleocharis compressa, Eupatorium perfoliatum, Galium boreale, Hypericum mutilum, Juncus canadensis, Juncus brachycephalus, Juncus dudleyi, Lobelia siphilitica, Lychnis flos-cuculi, Lycopus americanus, Lysimachia ciliata, Myosotis scorpioides, Parnassia glauca, Plantago major, Poa* spp., *Prunella vulgaris, Ranunculus repens, Salix interior, Scirpus microcarpus, Spiranthes lucida, Symphyotrichum prenanthoides, Viola* spp., and *Zizia aurea*. Several species of *Carex* are often present, including *Carex granularis, Carex hystericina, Carex pellita (= Carex lanuginosa), Carex scoparia, Carex stipata, Carex vesicaria, Carex viridula*, and *Carex vulpinoidea*. Scattered shrubs may be present, such as *Rosa blanda, Platanus occidentalis, Ulmus rubra, Physocarpus opulifolius, Betula nigra, Acer saccharinum, Acer rubrum, Spiraea alba, Salix* spp., and *Alnus* spp. These sites are susceptible to invasion by *Lythrum salicaria* and *Microstegium vimineum*.

Most Abundant Species:

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Andropogon gerardii* (big bluestem)
		Carex viridula (little green sedge)
		Deschampsia caespitosa (tufted hairgrass)
		Sphenopholis intermedia (slender wedgescale)

Characteristic Species: *Carex viridula, Doellingeria umbellata, Parnassia glauca, Spiranthes lucida.*
Other Noteworthy Species: Information not available.
USFWS Wetland System: Palustrine.

DISTRIBUTION
Range: Information not available.
States/Provinces: NJ.
Federal Lands: NPS (Delaware Water Gap).

CONSERVATION STATUS
Rank: GNR (8-Nov-2000).
Reasons: Information not available.

CLASSIFICATION INFORMATION
Status: Standard.
Confidence: 3 – Weak.
Comments: Community description based on report completed by Leslie Shank in 1999. All study sites were located in New Jersey along the Delaware River. This is community encompasses a wide range of species assemblages. The classification of this type is based on information from a very limited area and must be treated of low confidence pending further inventory and data collection.
Similar Associations:

- *Andropogon gerardii - Campanula rotundifolia - Solidago simplex* Sparse Vegetation (CEGL006284)--occurring on alluvial ledges rather than seeps.

Related Concepts: Information not available.

SOURCES
Description Authors: S. C. Gawler.
References: Breden 1989, Eastern Ecology Working Group n.d., Shank and Shreiner 1999.

Figure A20. An example of Calcareous Riverside Seep in Delaware Water Gap National Recreation Area.

COMMON NAME (PARK-SPECIFIC): NORTHERN RIVERSIDE ROCK OUTCROP

SYNONYMS

NVC English Name: **Big Bluestem - Bluebell Bellflower - Sticky Goldenrod Sparse Vegetation**

NVC Scientific Name: ***Andropogon gerardii - Campanula rotundifolia - Solidago simplex* Sparse Vegetation**

NVC Identifier: **CEGL006284**

LOCAL INFORMATION

Environmental Description: This vegetation type occurs along the shoreline of the Upper Delaware River where winter ice-scouring, shale bedrock outcrops, and natural seepage co-occur. The substrate consists of open, flood-scoured flat to nearly flat bedrock exposures that extend for variable lengths from the woodland edge to the river edge. Species are distributed patchily due to microsite conditions that range from dry to moist (seepage areas) and the sparse vegetation, when present, establishes in crevices and in thin soil over bedrock.

Vegetation Description: Herbaceous species typically dominate this association, but shrubs can be present in areas with somewhat good soil development. Gray alder (*Alnus incana*), silky dogwood (*Cornus amomum*), white meadowsweet (*Spiraea alba*), and river birch (*Betula nigra*) are most common; sandcherry (*Prunus pumila*), American sycamore (*Platanus occidentalis*), Carolina rose (*Rosa carolina*), and others can also be present. Big bluestem (*Andropogon gerardii*) is the most abundant native herb; purple loosestrife (*Lythrum salicaria*) is a common invasive exotic species. Many herbs can be present sparsely in the thin soil of crevices, including white panicle aster (*Symphyotrichum lanceolatum*), eastern marsh fern (*Thelypteris palustris*), flat-top goldentop (*Euthamia graminifolia*), flaxleaf whitetop aster (*Ionactis linariifolius*), weak rush (*Juncus debilis*), American water-willow (*Justicia americana*), brownish beaksedge (*Rhynchospora capitellata*), switchgrass (*Panicum virgatum*), strawcolored flatsedge (*Cyperus strigosus*), toothed flatsedge (*Cyperus dentatus*), early goldenrod (*Solidago juncea*), golden hedgehyssop (*Gratiola aurea*), slender fimbry (*Fimbristylis autumnalis*), purpleleaf willowherb (*Epilobium coloratum*), and Allegheny monkeyflower (*Mimulus ringens*).

Most Abundant Species:

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Spiraea alba* (white meadowsweet)
Herb (field)	Graminoid	*Andropogon gerardii* (big bluestem)

Characteristic Species: *Andropogon gerardii* (big bluestem).

Other Noteworthy Species:

Species	GRank	Type	Note
Euthamia graminifolia (flat-top goldentop)		plant	
Lythrum salicaria (purple loosestrife)		plant	exotic noxious weed

Subnational Distribution with Crosswalk Data:

State	SRank	Conf	Sname	Reference
NY	S3S4*	1	Shoreline Outcrop	Edinger et al. 2002
PA	SNR		[Not crosswalked]	

Local Range: These outcrops can occur on the shores of the Upper Delaware River throughout Upper Delaware Scenic and Recreational River, but they are more common in the southern part of the park.

Classification Comments: Information not available.

Other Comments: Information not available.

Local Description Authors: A. L. Feldmann (NYNHP).
Plots: U15, U18, U22, U25.
Upper Delaware Scenic and Recreational River Inventory Notes: Information not available.

GLOBAL INFORMATION

NVC CLASSIFICATION

Physiognomic Class	Sparse Vegetation (VII)
Physiognomic Subclass	Consolidated rock sparse vegetation (VII.A.)
Physiognomic Group	Sparsely vegetated pavement (VII.A.2.)
Physiognomic Subgroup	Natural/Semi-natural sparsely vegetated pavement (VII.A.2.N.)
Formation	Pavement with sparse vascular vegetation (VII.A.2.N.a.)
Alliance	Open Pavement Sparsely Vegetated Alliance (A.1843)
Alliance (English name)	Open Pavement Sparsely Vegetated Alliance
Association	*Andropogon gerardii* - *Campanula rotundifolia* - *Solidago simplex* Sparse Vegetation
Association (English name)	Big Bluestem - Bluebell Bellflower - Sticky Goldenrod Sparse Vegetation
Ecological System(s):	Central Appalachian Stream and Riparian (CES202.609). Boreal Ice-Scour Rivershore (CES103.589).

GLOBAL DESCRIPTION

Concept Summary: This riverside rock outcrop community of the northeastern U.S. occurs on open flood-scoured bedrock exposures of major rivers, typically along river narrows. Emergent seepage is absent. Typically a gradient from dry acidic conditions higher on the bank to moist, fairly enriched conditions lower down may exist at any one site. This community is prone to flooding in the upper regions and deposition in the topographically lower areas. It is also prone to severe drought periods that may stress or kill some vegetation. Within the community, the species are distributed patchily, probably due to microsite conditions. The variability in species composition has not been measured, but it shows substantial variation from site to site and from year to year. Vegetation is typically sparse and occurs in the cracks and crevices of the bedrock. Typical vegetation is a mixture of riparian species, xeric-loving crevice plants, and calciphiles. Characteristic species include *Andropogon gerardii* (big bluestem), *Schizachyrium scoparium* (little bluestem), *Campanula rotundifolia* (bluebell bellflower), *Solidago simplex* (Mt. Albert goldenrod), *Toxicodendron radicans* (eastern poison-ivy), *Ionactis linariifolius* (flaxleaf whitetop aster), *Sisyrinchium montanum* (strict blue-eyed grass), *Packera paupercula* (balsam groundsel), and *Prunus pumila* (sandcherry). Other associates include *Anemone virginiana var. alba* (tall thimbleweed), *Symphyotrichum lateriflorum* (calico aster), *Carex crawei* (Crawe's sedge), *Carex crawfordii* (Crawford's sedge), *Potentilla arguta* (tall cinquefoil), *Campanula rotundifolia* (bluebell bellflower), *Arabis lyrata* (lyrate rockcress), *Aquilegia canadensis* (red columbine), *Cornus amomum* (silky dogwood), *Euthamia graminifolia* (flat-top goldentop), *Juncus debilis* (weak rush), and *Eupatorium perfoliatum* (common boneset), among others. *Astragalus robbinsii var. jesupii* (Jesup's milkvetch) occurs in limited areas along the upper Connecticut River. These sites are susceptible to invasion by *Lythrum salicaria* (purple loosestrife) and *Melilotus officinalis* (yellow sweetclover). This association is more temperate than the related *Campanula rotundifolia* - *Packera paupercula* - *(Aquilegia canadensis)* Sparse

Vegetation (CEGL006532), which occurs on near-boreal rivers and lacks prairie elements such as *Andropogon gerardii* (big bluestem).

Environmental Description: This sparse vegetation occurs on open flood-scoured bedrock exposures of major rivers, typically along river narrows. Emergent seepage is absent. Typically a gradient from dry acidic conditions higher on the bank to moist, fairly enriched conditions lower down may exist at any one site. This community is prone to flooding in the upper regions and deposition in the topographically lower areas. It is also prone to severe drought periods that may stress or kill some vegetation.

Vegetation Description: This community is essentially a rock outcrop with a bit of soil development in the lower reaches. Within the community, the species are distributed patchily, probably due to microsite conditions. The variability in species composition has not been measured but shows substantial variation both spatially and temporally. Vegetation is typically sparse and occurs in the cracks and crevices of the bedrock. Typical vegetation is a mixture of riparian species, xeric-loving crevice plants, and calciphiles. Characteristic species include *Andropogon gerardii* (big bluestem), *Schizachyrium scoparium* (little bluestem), *Campanula rotundifolia* (bluebell bellflower), *Solidago simplex* (Mt. Albert goldenrod), *Toxicodendron radicans* (eastern poison-ivy), *Ionactis linariifolius* (flaxleaf whitetop aster), *Sisyrinchium montanum* (strict blue-eyed grass), *Packera paupercula* (balsam groundsel), and *Prunus pumila* (sandcherry). Other associates include *Anemone virginiana var. alba* (tall thimbleweed), *Symphyotrichum lateriflorum* (calico aster), *Carex crawei* (Crawe's sedge), *Carex crawfordii* (Crawford's sedge), *Potentilla arguta* (tall cinquefoil), *Campanula rotundifolia*, *Arabis lyrata* (lyrate rockcress), *Aquilegia canadensis* (red columbine), *Cornus amomum* (silky dogwood), *Euthamia graminifolia* (flat-top goldentop), *Juncus debilis* (weak rush), and *Eupatorium* (thoroughwort) *perfoliatum*, among others. *Astragalus robbinsii var. jesupii* (Jesup's milkvetch) occurs in limited areas along the upper Connecticut River. These sites are susceptible to invasion by *Lythrum salicaria* (purple loosestrife) and *Melilotus officinalis* (yellow sweetclover).

Most Abundant Species:

Stratum	Lifeform	Species
Herb (field)	Forb	*Solidago simplex* (Mt. Albert goldenrod)
Herb (field)	Graminoid	*Andropogon gerardii* (big bluestem)

Characteristic Species: *Allium schoenoprasum* var. *sibiricum* (wild chives), *Andropogon gerardii* (big bluestem), *Astragalus robbinsii* var. *jesupii* (Jesup's milkvetch), *Campanula rotundifolia* (bluebell bellflower), *Ionactis linariifolius* (flaxleaf whitetop aster), *Packera paupercula* (balsam groundsel), *Prunus pumila* (sandcherry), *Schizachyrium scoparium* (little bluestem), *Solidago simplex* (Mt. Albert goldenrod), *Toxicodendron radicans* (eastern poison-ivy).

Other Noteworthy Species:

Species	GRank	Type	Note
Astragalus robbinsii var. *jesupii* (Jesup's milkvetch)	G5T1	plant	Federally listed endangered

USFWS Wetland System: Palustrine.

DISTRIBUTION

Range: This community is reported from Vermont, New Hampshire, Maine, Connecticut, New Jersey, Pennsylvania, and New York. It may also occur in Massachusetts.

States/Provinces: CT, MA, ME, NH, NJ, NY, PA, VT.

Federal Lands: NPS (Delaware Water Gap, Upper Delaware).

CONSERVATION STATUS

Rank: G2 (17-Nov-1997).

Reasons: There are probably fewer than 20 occurrences of this community rangewide. Individual occurrences tend to be small, so there are probably fewer than 500 acres rangewide. Currently five occurrences are documented in New Hampshire, with a total acreage of less than 20 acres. Similar vegetation is reported from Vermont, Maine, and New York, but these still need confirmation. This community is restricted to calcareous or basic bedrock outcrops along ice-scoured upper reaches of major rivers such as the Connecticut River in New Hampshire and Vermont, the Kennebec River in Maine, the Hudson River in New York, and the Delaware River in New Jersey.

CLASSIFICATION INFORMATION

Status: Standard.

Confidence: 2 - Moderate.

Comments: This community may occur in conjunction with seep communities. However, emergent seepage is absent as are the corresponding seepage and wetland plants found in riverside seeps. Sedges are notably lacking. This community differs from rock outcrop/rocky summit communities by the paucity of lichen and woody species intolerant of flooding and the presence of flood-tolerant species on lower, somewhat enriched reaches of the community, where regular erosion and deposition of silty sediments occur.

Similar Associations:

- *(Hypericum prolificum, Leucothoe racemosa) / Schizachyrium scoparium - Solidago simplex* var. *racemosa - Ionactis linariifolius* Sparse Vegetation (CEGL006491)
- *Campanula rotundifolia - Packera paupercula - (Aquilegia canadensis*) Sparse Vegetation (CEGL006532)
- D*eschampsia caespitosa - Carex viridula* Herbaceous Vegetation (CEGL006969)

Related Concepts:

- Riverine Lower Perennial Emergent Wetland, Seasonally Flooded (R2EMC) (Cowardin et al. 1979) ?
- Rivershore Grassland (Thompson 1996) ?
- Riverside Outcrop Community (Thompson 1996) ?
- SNE Riverside Outcrop Community (Rawinski 1984) ?

SOURCES

Description Authors: M. Anderson, mod. S. L. Neid, S. C. Gawler, E. Largay.

References: Breden 1989, Cowardin et al. 1979, Eastern Ecology Working Group n.d., Gawler 2002, Grossman et al. 1994, Metzler and Barrett 2001, Rawinski 1984, Shank and Shreiner 1999, Sperduto 1992, Swain and Kearsley 2001, Thompson 1996, Thompson and Sorenson 2000.

Figure A21. An example of Northern Riverside Rock Outcrop in Upper Delaware Scenic and Recreational River.

COMMON NAME (PARK-SPECIFIC): JAPANESE KNOTWEED HERBACEOUS VEGETATION

SYNONYMS
NVC English Name: **Japanese Knotweed Temporarily Flooded Herbaceous Vegetation**
NVC Scientific Name: ***Polygonum cuspidatum* Temporarily Flooded Herbaceous Vegetation**
NVC Identifier: **CEGL008472**

LOCAL INFORMATION

Environmental Description: This vegetation type occurs on islands and along the shoreline of the Delaware River. The substrate is typically silt loam or sandy loam, as in Delaware fine sandy loam or Pope fine sandy loam. These sites are subject to frequent floods and scour.
Vegetation Description: This vegetation type is typically a near monoculture of the invasive species Japanese knotweed (*Polygonum cuspidatum*), covering 50–100% of the area. Giant knotweed (*Polygonum sachalinense*) or a hybrid of Japanese knotweed and giant knotweed may also be present. Other typical riparian species can persist beneath and around the knotweed, including touch-me-nots (*Impatiens* spp.), garlic mustard (*Alliaria petiolata*), Japanese stiltgrass (*Microstegium vimineum*), reed canarygrass (*Phalaris arundinacea*), whitegrass (*Leersia virginica*), marshpepper knotweed (*Polygonum hydropiper*), swamp smartweed (*Polygonum hydropiperoides*), Jack-in-the-pulpit (*Arisaema triphyllum*), spotted ladysthumb (*Polygonum persicaria*), and smallspike false nettle (*Boehmeria cylindrica*).
Most Abundant Species:

Stratum	Lifeform	Species
Herb (field)	Forb	*Polygonum cuspidatum* (Japanese knotweed)

Characteristic Species: *Polygonum cuspidatum.*
Other Noteworthy Species: Information not available.
Subnational Distribution with Crosswalk Data:

State	State Rank	Confidence	State Name	Reference
NJ	SNA	2	Japanese Knotweed Rivershore	Walz et al. 2006
PA	SNA	1	No crosswalk	Fike 1999

Local Range: This vegetation type occurs on islands and along the shoreline of the Delaware River.
Classification Comments: This type is distinguished by the extremely high cover of *Polygonum cuspidatum*, covering greater than 50% of the area in a non-forested riparian setting.
Other Comments: None.
Local Description Authors: S. J. Perles (PNHP).
Plots and Data Sources: Accuracy Assessment Observation Points DEWA.155, DEWA.177, DEWA.993; Podniesinski and Wagner 2002, Perles et al 2004.
Delaware Water Gap National Recreation Area Inventory Notes: Information not available.

GLOBAL INFORMATION

NVC CLASSIFICATION

Physiognomic Class	Herbaceous Vegetation (V)
Physiognomic Subclass	Perennial forb vegetation (V.B.)
Physiognomic Group	Temperate or subpolar perennial forb vegetation (V.B.2.)
Physiognomic Subgroup	Natural/Semi-natural temperate or subpolar perennial forb vegetation (V.B.2.N.)
Formation	Temporarily flooded temperate perennial forb vegetation (V.B.2.N.d.)
Alliance	*Polygonum cuspidatum* Temporarily Flooded Herbaceous Alliance (A.2005)
Alliance (English name)	Japanese Knotweed Temporarily Flooded Herbaceous Alliance
Association	*Polygonum cuspidatum* Temporarily Flooded Herbaceous Vegetation
Association (English name)	Japanese Knotweed Temporarily Flooded Herbaceous Vegetation
Ecological System(s):	Information not available.

GLOBAL DESCRIPTION

Concept Summary: Examples of this vegetation type are significant (monocultural) stands of the exotic forb *Polygonum cuspidatum*, which are found in temporarily flooded habitats such as scour bars. These disturbed habitats flood very frequently and have lots of light and rocky or sandy soil. Stands of this vegetation may be dense and shrubby, or somewhat more open. Species diversity is low, as the patches of *Polygonum* shade out other plant species. This vegetation ranges across the Southeast north at least to Pennsylvania and New Jersey. In North Carolina, this vegetation is found on scour bars and low rocky banks of the Nolichucky and French Broad rivers. In Kentucky, *Polygonum cuspidatum* is found primarily along disturbed riverbanks and bars mostly in the Cumberland Plateau and Cumberland Mountains where it can form pure, dense stands.

Environmental Description: Stands of this type are found in temporarily flooded habitats such as scour bars. These disturbed areas flood very frequently and have lots of light and rocky or sandy soil. In North Carolina, it is found on scour bars and low rocky banks of the Nolichucky and French Broad rivers (B. Brown pers. comm. 2001). In Kentucky, *Polygonum cuspidatum* is found primarily along disturbed riverbanks and bars mostly in the Cumberland Plateau and Cumberland Mountains where it can form pure, dense stands (M. Evans pers. comm. 2001).

Vegetation Description: These are primarily monospecific stands of *Polygonum cuspidatum* with few other plant species. Some disturbance-oriented forbs may be present, such as *Impatiens* spp., *Phalaris arundinacea*, *Leersia virginica*, *Polygonum hydropiper*, *Polygonum hydropiperoides*, *Polygonum persicaria*, and *Boehmeria cylindrica*, along with seedlings of some woody plants (e.g., *Platanus occidentalis*, *Salix nigra*). The invasive exotic herbs *Alliaria petiolata* and *Microstegium vimineum* may be present.

Most Abundant Species:

Stratum	Lifeform	Species
Herb (field)	Forb	*Polygonum cuspidatum* (Japanese knotweed)

Characteristic Species: *Polygonum cuspidatum.*

Other Noteworthy Species: Information not available.

USFWS Wetland System: Palustrine.

DISTRIBUTION

Range: This vegetation is potentially found anywhere in the southeastern and mid-Atlantic United States where the exotic rhizomatous forb *Polygonum cuspidatum* has formed significant (monocultural) stands. This includes at least Alabama, Georgia, Kentucky, Maryland, New Jersey, North Carolina, Pennsylvania, South Carolina, Tennessee, and Virginia.
States/Provinces: AL, GA, KY, NC, NJ, PA, SC, TN, VA.
Federal Lands: NPS (Allegheny Portage Railroad, Delaware Water Gap); USFS (Cherokee?, Daniel Boone).

CONSERVATION STATUS

Rank: GNA (invasive) (31-May-2001).
Reasons: This vegetation is composed of and dominated by a species which is not native to North America.

CLASSIFICATION INFORMATION

Status: Standard.
Confidence: Information not available.
Comments: This species has also been treated as *Reynoutria japonica*.
Similar Associations: Information not available.
Related Concepts: Information not available.

SOURCES

Description Authors: M. Pyne, mod. S. C. Gawler.
References: Brown pers. comm., Evans pers. comm., Schafale pers. comm., Schotz pers. comm., Southeastern Ecology Working Group n.d., TDNH unpubl. data, Perles et al. 2004, Podniesinski and Wagner 2002.

Figure A22. An example of Japanese Knotweed Herbaceous Vegetation in Delaware Water Gap National Recreation Area.

COMMON NAME (PARK-SPECIFIC): REED CANARYGRASS RIVERINE GRASSLAND

SYNONYMS
NVC English Name: **Reed Canarygrass Eastern Herbaceous Vegetation**
NVC Scientific Name: ***Phalaris arundinacea* Eastern Herbaceous Vegetation**
NVC Identifier: **CEGL006044**

LOCAL INFORMATION

Environmental Description: This association is typically found on bars, shorelines, or islands in the Delaware River and smaller tributaries. These areas are exposed to frequent floods, high stream velocity and ice-scour. The substrate is typically coarse, composed of sand, gravel, and cobbles.

Vegetation Description: This association is characterized by thick herbaceous and graminoid vegetation dominated by reed canarygrass (*Phalaris arundinacea*). A diverse mix of other herbaceous and graminoid species also persists. Some common species are marshpepper knotweed (*Polygonum hydropiper*), stinging nettle (*Urtica dioica*), Canadian clearweed (*Pilea pumila*), watercress (*Rorippa nasturtium-aquaticum*), whitegrass (*Leersia virginica*), smallspike false nettle (*Boehmeria cylindrica*), fowl bluegrass (*Poa palustris*), wild mint (*Mentha arvensis*), and wingstem (*Verbesina alternifolia*). A few scattered willows (*Salix* spp.), sycamore (*Platanus occidentalis*), river birch (*Betula nigra*), and silky dogwood (*Cornus amomum*) may be present as short shrubs; however, their relative cover does not exceed 25%. Vines may also be present; common species include Virginia creeper (*Parthenocissus quinquefolia*), eastern poison ivy (*Toxicodendron radicans*), fox grape (*Vitis labrusca*), and riverbank grape (*Vitis riparia*).

Most Abundant Species:

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Rubus allegheniensis* (Allegheny blackberry)
		Spiraea tomentosa (steeplebush)
Herb (field)	Vine/Liana	*Toxicodendron radicans* (eastern poison-ivy)
		Vitis riparia (riverbank grape)
Herb (field)	Forb	*Pilea pumila* (Canadian clearweed)
		Polygonum hydropiper (marshpepper knotweed)
		Urtica dioica (stinging nettle)
Herb (field)	Graminoid	*Phalaris arundinacea* (reed canarygrass)

Characteristic Species: *Phalaris arundinacea.*

Other Noteworthy Species: Information not available.

Subnational Distribution with Crosswalk Data:

State	State Rank	Confidence	State Name	Reference
NJ	SNR	1	Reed Canarygrass Eastern Marsh	Walz et al. 2006
PA	S5	1	Bluejoint - Reed Canary Grass Marsh	Fike 1999

Local Range: This association is typically found on bars, shorelines, or islands in the Delaware River and smaller tributaries in the park.

Classification Comments: Reed Canarygrass Riverine Grassland is distinguished from other riparian types by the clear dominance of *Phalaris arundinacea*.

Other Comments: None.

Local Description Authors: S. J. Perles (PNHP).

Plots and Data Sources: DEWA.109, DEWA.111; Fike 1999, Perles et al 2004.

Delaware Water Gap National Recreation Area Inventory Notes: Information not available.

GLOBAL INFORMATION

NVC CLASSIFICATION

Physiognomic Class	Herbaceous Vegetation (V)
Physiognomic Subclass	Perennial graminoid vegetation (V.A.)
Physiognomic Group	Temperate or subpolar grassland (V.A.5.)
Physiognomic Subgroup	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N.)
Formation	Seasonally flooded temperate or subpolar grassland (V.A.5.N.k.)
Alliance	*Phalaris arundinacea* Seasonally Flooded Herbaceous Alliance (A.1381)
Alliance (English name)	Reed Canarygrass Seasonally Flooded Herbaceous Alliance
Association	*Phalaris arundinacea* Eastern Herbaceous Vegetation
Association (English name)	Reed Canarygrass Eastern Herbaceous Vegetation
Ecological System(s):	Central Interior Highlands and Appalachian Sinkhole and Depression Pond (CES202.018). North-Central Interior Floodplain (CES202.694). Laurentian - Acadian Wet Meadow - Shrub Swamp (CES201.582).

GLOBAL DESCRIPTION

Concept Summary: This association is found throughout the northeastern United States and Canada, but its distribution as a natural type is complicated elsewhere. It is native to the United States and Canada but is now more widely distributed and abundant because of local introductions from both local and European populations. The introduced strains may be more aggressive ecotypes than native strains. Stands are found in both minerotrophic basin wetlands as well as rivershores. *Phalaris arundinacea* has been widely used as a forage and hay crop, especially in marshes and floodplains, and it is used for wildlife food and for shoreline and ditch stabilization. Stands are dominated by *Phalaris arundinacea*, a 0.5- to 2-m tall perennial grass, which tends to occur in monocultures or associated with *Calamagrostis canadensis*. Other associates in the Northeast include *Viburnum nudum, Alnus incana* or *Alnus serrulata, Viburnum dentatum*, and *Agrostis gigantea*. Midwest associates include species characteristic of wet meadows. *Phalaris arundinacea* can displace native species over time. Further work is required to resolve the natural versus introduced nature of this type in the Southeast before a description can be completed.

Environmental Description: Stands are found in both minerotrophic basin wetlands as well as rivershores. The dominant species has been widely used as a forage and hay crop, especially in marshes and floodplains, and it is used for wildlife food and for shoreline and ditch stabilization (Barnes 1999).

Vegetation Description: Stands are dominated by *Phalaris arundinacea*, a 0.5- to 2-m tall perennial grass that is native to the United States and Canada, but which has also been introduced from European strains. The introduced strains may be more aggressive ecotypes than native strains (Barnes 1999). It tends to occur in monocultures or associated with *Calamagrostis canadensis*. Other associates in the Northeast include *Viburnum nudum, Salix* spp., *Alnus incana* or *Alnus serrulata, Viburnum dentatum, Poa palustris, Mentha arvensis, Leersia virginica*, and *Agrostis gigantea*. Midwest associates include species characteristic of wet meadows. *Phalaris arundinacea* can displace native species over time (Apfelbaum and Sams 1987, Barnes 1999,

and references therein). Further work is required to resolve the natural versus introduced nature of this type in the Southeast before a description can be completed.

Most Abundant Species:

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Phalaris arundinacea* (reed canarygrass)

Characteristic Species: *Phalaris arundinacea*.

Other Noteworthy Species: Information not available.

USFWS Wetland System: Palustrine.

DISTRIBUTION

Range: This association is found throughout the northeastern United States and Canada, but its distribution as a natural type is complicated elsewhere. It currently ranges from Virginia north to Vermont, east to Minnesota and south to Tennessee.

States/Provinces: CT, DE, IA, MA, MD, ME, MN, NH, NJ, NY, OH, ON, PA, RI, TN, VA, VT, WV.

Federal Lands: NPS (Allegheny Portage Railroad, Delaware Water Gap, Effigy Mounds, Eisenhower, Gettysburg); USFWS (Assabet River?, Great Meadows?, Great Swamp, Oxbow, Parker River).

CONSERVATION STATUS

Rank: GNA (invasive) (1-Dec-1997).

Reasons: Information not available.

CLASSIFICATION INFORMATION

Status: Standard.

Confidence: 2 – Moderate.

Comments: Type has a broad distribution; in fact, it is widespread throughout temperate areas of the northern hemisphere. It is native to the United States and Canada, but is now more widely distributed and abundant because of local introductions from both local and European populations (Apfelbaum and Sams 1987). It can invade a variety of habitats, suggesting that little unites these stands apart from the dominance of *Phalaris arundinacea*. However, that may be the only reasonable way to describe this type. This vegetation is documented from Shady Valley TNC Preserve, Johnson County, Tennessee, where it occupies channelized streams, impoundments, and fen restoration sites. In these examples, characteristic associates include *Juncus effusus*, *Carex lurida*, *Carex gynandra*, and *Alnus serrulata*.

Similar Associations:

- *Calamagrostis canadensis* - *Phalaris arundinacea* Herbaceous Vegetation (CEGL005174).
- *Phalaris arundinacea* Western Herbaceous Vegetation (CEGL001474).

Related Concepts:

- Palustrine Persistent Emergent Wetland (PEM1) (Cowardin et al. 1979) ?
- Reed canary grass riverine grassland (Perles et al. 2004) ?
- SNE low-energy riverbank community (Rawinski 1984) ?
- Shallow Emergent Marsh (Thompson 1996) ?
- Southern New England nutrient-poor streamside/lakeside marsh (Rawinski 1984) ?
- Southern New England nutrient-rich streamside/lakeside marsh (Rawinski 1984) ?

SOURCES

Description Authors: D. Faber-Langendoen, mod. S. C. Gawler.

References: Apfelbaum and Sams 1987, Barnes 1999, Cowardin et al. 1979, Edinger et al. 2002, Fike 1999, Metzler and Barrett 2001, Midwestern Ecology Working Group n.d., Perles et al. 2004, Rawinski 1984, Sperduto 2000a, Swain and Kearsley 2001, TDNH unpubl. data, Thompson 1996, Thompson and Sorenson 2000.

Figure A23. An example of Reed Canarygrass Riverine Grassland in Delaware Water Gap National Recreation Area.

Figure A24. An example of Reed Canarygrass Riverine Grassland in Delaware Water Gap National Recreation Area.

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Appendix B. Local and global descriptions for riparian plant associations that occur within the Bluestone National Scenic River, New River Gorge National River, and Gauley River National Recreation Area. These descriptions were adapted directly from the following two sources: Vanderhorst et al. 2007 and Vanderhorst et al. 2008.

COMMON NAME (PARK-SPECIFIC): SUCCESSIONAL BOX-ELDER FOREST

SYNONYMS
NVC English Name: **Box-elder Forest**
NVC Scientific Name: ***Acer negundo* Forest**
NVC Identifier: **CEGL005033**

LOCAL INFORMATION

Environmental Description: This association occurs on floodplains, terraces, and lower gorge slopes along the New River in areas cleared in the past by humans. Occurrences are mostly on higher floodplain terraces with less rocky soils which were used for agriculture or habitation. Soil textures in the two sampled plots are sand. Slopes range from nearly level to somewhat steep (mapping unit values range from 0.3 to 19 degrees, mean = 7 degrees). Elevations of mapped stands range from 307 to 384 m. Stands of this association are typically small patches which are imbedded in or adjacent to less disturbed floodplain forest *Platanus occidentalis - Fraxinus pennsylvanica / Carpinus caroliniana / Verbesina alternifolia* Forest (CEGL006458) or upland mixed mesophytic forest *Liriodendron tulipifera - Tilia americana var. heterophylla - Aesculus flava - Acer saccharum / Magnolia tripetala* Forest (CEGL005222).
Vegetation Description: This association is a successional forest or woodland dominated by *Acer negundo*. Additional tree species in the two sampled plots include *Acer saccharinum, Liriodendron tulipifera, Robinia pseudoacacia,* and *Ulmus americana*. *Lindera benzoin* is dominant in the shrub layer. The herb layer consists of a mixture of weedy exotics and native floodplain species, including *Ageratina altissima, Boehmeria cylindrica, Carex grayi, Glechoma hederacea, Lysimachia nummularia, Mertensia virginica, Prunella vulgaris,* and *Verbesina alternifolia*. Vascular plant species richness in the 2 sampled plots ranges from 23 to 26 (mean = 24.5).
Most Abundant Species:

Stratum	Lifeform	Species
Tree (canopy & subcanopy)	Broad-leaved deciduous tree	*Acer negundo* (box-elder)

Characteristic Species: *Acer saccharinum, Ageratina altissima, Boehmeria cylindrica, Carex grayi, Glechoma hederacea, Lindera benzoin, Liriodendron tulipifera, Lysimachia nummularia, Mertensia virginica, Prunella vulgaris, Robinia pseudoacacia, Ulmus americana, Verbesina alternifolia.*
Other Noteworthy Species: Information not available.
Subnational Distribution with Crosswalk Data:

State	State Rank	Confidence	State Name	Reference
WV	SNR	1		Vanderhorst 2001b

Local Range: This association is found along or near the New River.
Classification Comments: This association is a semi-natural successional community of disturbed sites at New River Gorge National River and other West Virginia sites.
Other Comments: Information not available.
Local Description Authors: J. P. Vanderhorst.
Plots: NERI.2, NERI.69.
New River Gorge National River Inventory Notes: Information not available.

GLOBAL INFORMATION

NVC CLASSIFICATION

Physiognomic Class	Forest (I)
Physiognomic Subclass	Deciduous forest (I.B.)
Physiognomic Group	Cold-deciduous forest (I.B.2.)
Physiognomic Subgroup	Natural/Semi-natural cold-deciduous forest (I.B.2.N.)
Formation	Temporarily flooded cold-deciduous forest (I.B.2.N.d.)
Alliance	Acer negundo Temporarily Flooded Forest Alliance (A.278)
Alliance (English name)	Box-elder Temporarily Flooded Forest Alliance
Association	*Acer negundo* Forest
Association (English name)	Box-elder Forest
Ecological System(s):	Central Appalachian Floodplain (CES202.608). East Gulf Coastal Plain Large River Floodplain Forest (CES203.489). Mississippi River Riparian Forest (CES203.190). South-Central Interior Large Floodplain (CES202.705). Atlantic Coastal Plain Large River Floodplain Forest (CES203.066).

GLOBAL DESCRIPTION

Concept Summary: This semi-open to closed-canopy forest is found on floodplains in the southern, eastern, and midwestern United States. Stands occur on large rivers in the active floodplain and on sandbars, and may form farther from the riverfront following disturbance. Occurrences are mostly on higher floodplain terraces with less rocky soils which were used for agriculture or habitation. They are typically temporarily flooded in the spring. These early-successional forests are dominated by *Acer negundo*. Other characteristic species include *Platanus occidentalis, Celtis laevigata, Acer rubrum, Liriodendron tulipifera, Robinia pseudoacacia, Liquidambar styraciflua, Acer saccharinum, Ulmus alata, Ulmus rubra, Carpinus caroliniana, Morus rubra*, and *Populus deltoides*. The shrub and herb layers range from sparse to relatively lush, and the vine component often is heavy.

Environmental Description: Stands occur on large rivers in the active floodplain and on sandbars, and may form farther from the riverfront following disturbance. Occurrences are mostly on higher floodplain terraces with less rocky soils which were used for agriculture or habitation. They are typically temporarily flooded in the spring and have sandy soils. In Kentucky, these forests may also occur in old fields.

Vegetation Description: These early-successional forests (sometimes woodlands) are dominated by *Acer negundo*. Other characteristic species include *Platanus occidentalis, Celtis laevigata, Acer rubrum, Liriodendron tulipifera, Robinia pseudoacacia, Liquidambar styraciflua, Acer saccharinum, Ulmus alata, Ulmus rubra, Carpinus caroliniana, Morus rubra*, and *Populus deltoides*. The shrub and herb layers range from sparse to relatively lush, and the vine component often is heavy. *Lindera benzoin* may be dominant in the shrub layer. The herb layer consists of a mixture of weedy exotics and native floodplain species, including *Ageratina altissima, Boehmeria cylindrica, Carex grayi, Glechoma hederacea, Lysimachia nummularia, Mertensia virginica, Prunella vulgaris*, and *Verbesina alternifolia*. The range, dynamics, and variability of this type are complicated by the "weedy" nature of *Acer negundo*, e.g., in Kentucky, *Acer negundo* may be dominant in old fields, with *Dichanthelium clandestinum* and

Carex spp. in the ground layer. Elsewhere in the Midwest, logged and grazed stands of *Fraxinus pennsylvanica* and *Ulmus americana* may be dominated by *Acer negundo*.

Most Abundant Species:

Stratum	Lifeform	Species
Tree (canopy & subcanopy)	Broad-leaved deciduous tree	*Acer negundo* (box-elder)

Characteristic Species: *Acer negundo, Acer saccharinum, Ageratina altissima, Boehmeria cylindrica, Carex grayi, Lindera benzoin, Liquidambar styraciflua, Mertensia virginica, Platanus occidentalis, Prunella vulgaris, Robinia pseudoacacia, Ulmus americana, Verbesina alternifolia.*

Other Noteworthy Species: Information not available.

USFWS Wetland System: Palustrine.

DISTRIBUTION

Range: This Acer negundo floodplain forest is found sporadically on floodplains in the southern, eastern, and midwestern United States, ranging from Maryland west to Iowa (and possibly southeastern South Dakota), south to Louisiana and possibly Texas, and east to Georgia. It occurs in the Piedmont region in Pennsylvania and in the Coastal Plain and Piedmont regions in New Jersey and Delaware.

States/Provinces: AL, AR, DE, GA, IA, KY, LA, MD, MO, MS, NJ, OK, PA, SC, SD?, TN, TX?, VA, WV.

Federal Lands: NPS (Chickamauga-Chattanooga, Mammoth Cave, Natchez Trace, New River Gorge, Ozark, Shiloh, Vicksburg); USFS (Daniel Boone, St. Francis); USFWS (Little River).

CONSERVATION STATUS

Rank: G4G5 (28-Mar-2003).

Reasons: As currently defined, this is a broad-ranging community type. However, the range, dynamics, and variability of this type are complicated by the "weedy" nature of Acer negundo. More information may be needed to clarify the extent to which this type represents purely natural vegetation. Some stands may develop following disturbance of other natural bottomland communities.

CLASSIFICATION INFORMATION

Status: Standard.

Confidence: 2 - Moderate.

Comments: The range, dynamics, and variability of this type is complicated by the 'weedy' nature of *Acer negundo*. For example, disturbed stands in the *Fraxinus pennsylvanica - Ulmus americana - Celtis (occidentalis, laevigata)* Temporarily Flooded Forest Alliance (A.286) often become dominated by *Acer negundo*. And in the upper Midwest *Acer negundo*-dominated stands are treated as part of the *Fraxinus pennsylvanica - (Ulmus americana) / Symphoricarpos occidentalis* Forest (CEGL002088). Thus, some consistency is needed in the application of this type across its range. In Arkansas, these forests can be pure *Acer negundo* or have *Acer rubrum* and *Platanus occidentalis* as associates (T. Foti pers. comm. 1999). Composition is variable. This type occurs along the Arkansas River in Arkansas (D. Zollner pers. comm. 1999). In Missouri, stands would probably be combined with *Betula nigra - Platanus occidentalis* Forest (CEGL002086) (M. Leahy pers. comm. 1999). In Kentucky, this may be found at the Licking River impoundment (Cave Run Lake). Narrower floodplains of smaller rivers and streams are not included in this association but are treated instead under *Acer negundo - (Platanus occidentalis, Populus deltoides)* Forest (CEGL004690).

Similar Associations:

- *Acer negundo - (Platanus occidentalis, Populus deltoides)* Forest (CEGL004690).
- *Betula nigra - Platanus occidentalis* Forest (CEGL002086).
- *Fraxinus pennsylvanica - (Ulmus americana) / Symphoricarpos occidentalis* Forest (CEGL002088).
- *Fraxinus pennsylvanica - Ulmus americana - (Acer negundo, Tilia americana)* Northern Forest (CEGL002089).
- *Fraxinus pennsylvanica - Ulmus* spp. - *Celtis occidentalis* Forest (CEGL002014).

Related Concepts:

- *Acer negundo* riparian woodland (Vanderhorst 2001b) =

SOURCES

Description Authors: mod. E. Largay and S. C. Gawler.

References: Blair 1938, Campbell pers. comm., Fleming et al. 2001, Foti pers. comm., Harrison 2004, Hoagland 2000, INAI unpubl. data, Leahy pers. comm., Patterson and DeSelm 1989, Schotz pers. comm., Southeastern Ecology Working Group n.d., TDNH unpubl. data, Vanderhorst 2001b, Vanderhorst 2007, Zollner pers. comm.

Figure B1. An example of Successional Box-elder Forest from the New River Gorge National River.

COMMON NAME (PARK-SPECIFIC): SILVER MAPLE FLOODPLAIN FOREST

SYNONYMS
NVC English Name: **Silver Maple - American Elm Forest**
NVC Scientific Name: ***Acer saccharinum* - *Ulmus americana* Forest**
NVC Identifier: **CEGL002586**

LOCAL INFORMATION

Environmental Description: This association occurs in very small linear patches on floodplains along the New River. Observed patches occur on sandy levees imbedded within other more common floodplain forest and woodland associations (i.e., *Platanus occidentalis - Fraxinus pennsylvanica / Carpinus caroliniana / Verbesina alternifolia* Forest (CEGL006458) and *Platanus occidentalis - (Betula nigra, Salix* spp.) Temporarily Flooded Woodland (CEGL003725)). It appears to be favored by deposition of deep sandy sediments by low-energy flood waters. Soil chemistry analyzed from one plot indicates slightly acidic soil (pH = 6.1) with relatively high levels of Mg, Mn, and Zn, low to average levels of other nutrients, and low organic matter. There may be heavy accumulations of flotsam including driftwood and garbage. Lines of *Acer saccharinum* along low-gradient reaches of the river in developed areas (e.g., Cunard, Dun Glen) provide evidence that this association may have been somewhat more abundant in the past and that its habitat was favored for human use. Slopes range from gentle to moderate (mapping unit values range from 2 to 11 degrees, mean = 10 degrees). Elevations of mapped stands range from 319 to 343 m.

Vegetation Description: This association is a floodplain forest dominated by *Acer saccharinum*. The canopy in the one sampled plot is about 30 m tall with 80% cover. Additional trees in the plot include *Fraxinus pennsylvanica*, *Platanus occidentalis*, and *Halesia tetraptera*. The subcanopy of some stands may include *Acer negundo*. In the plot there is about 35% cover in the tall-shrub layer dominated by *Lindera benzoin* and 15% cover in the short-shrub layer dominated by *Toxicodendron radicans*. Understory vegetation can be lush, dominated by tall herbs, or may be sparse, with high exposure of bare sand. In the plot there is 60% cover in the herb layer, with high cover by *Boehmeria cylindrica, Chasmanthium latifolium, Cryptotaenia canadensis, Elymus virginicus, Glechoma hederacea, Helianthus* sp., *Impatiens capensis, Menispermum canadense, Microstegium vimineum, Monarda clinopodia, Polygonum virginianum, Rudbeckia laciniata,* and *Verbesina alternifolia*. Vascular plant species richness in the 1 sampled plot is 48.

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Acer saccharinum* (silver maple)
Tall shrub/sapling	Broad-leaved deciduous shrub	*Lindera benzoin* (northern spicebush)
Short shrub/sapling	Vine/Liana	*Toxicodendron radicans* (eastern poison-ivy)
Herb (field)	Forb	*Verbesina alternifolia* (wingstem)

Characteristic Species: *Acer negundo, Boehmeria cylindrica, Chasmanthium latifolium, Cryptotaenia canadensis, Elymus virginicus, Fraxinus pennsylvanica, Glechoma hederacea, Halesia tetraptera, Impatiens capensis, Menispermum canadense, Microstegium vimineum, Monarda clinopodia, Platanus occidentalis, Polygonum virginianum, Rudbeckia laciniata.*

Other Noteworthy Species: Information not available.

Subnational Distribution with Crosswalk Data:

State	State Rank	Confidence	State Name	Reference
WV	SNR	1		WVNHP unpubl. data b

Local Range: Four mapped stands occur in the middle section of the park downstream from Terry and upstream from Thurmond. Additional small patches are most likely to occur along slow reaches of river in the southern two-thirds of the park.

Classification Comments: This association is not well-developed in the park, and its classification here is based on extrapolation of the type which occurs as the predominant floodplain forest type farther downstream along the Ohio River (Walton et al. 1996). It is favored by larger, lower gradient rivers which deposit finer sediments than is common along the New River within the park.

Other Comments: Information not available.

Local Description Authors: J.P. Vanderhorst

Plots: NERI.305.

New River Gorge National River Inventory Notes: Information not available.

GLOBAL INFORMATION

NVC CLASSIFICATION

Physiognomic Class	Forest (I)
Physiognomic Subclass	Deciduous forest (I.B.)
Physiognomic Group	Cold-deciduous forest (I.B.2.)
Physiognomic Subgroup	Natural/Semi-natural cold-deciduous forest (I.B.2.N.)
Formation	Temporarily flooded cold-deciduous forest (I.B.2.N.d.)
Alliance	*Acer saccharinum* Temporarily Flooded Forest Alliance (A.279)
Alliance (English name)	Silver Maple Temporarily Flooded Forest Alliance
Association	*Acer saccharinum* - *Ulmus americana* Forest
Association (English name)	Silver Maple - American Elm Forest
Ecological System(s):	Laurentian-Acadian Floodplain Forest (CES201.587). Central Appalachian Floodplain (CES202.608). Mississippi River Riparian Forest (CES203.190). North-Central Interior Floodplain (CES202.694). South-Central Interior Large Floodplain (CES202.705).

GLOBAL DESCRIPTION

Concept Summary: This silver maple - elm - cottonwood forest community is found throughout the midwestern United States and parts of the eastern United States. Stands occur on large, regularly flooded floodplains. The canopy cover is more-or-less closed and dominated by *Acer saccharinum*. Codominants may include *Platanus occidentalis, Betula nigra,* and rarely *Acer saccharum*. Associated species may include *Ulmus americana, Ulmus rubra, Acer negundo, Salix nigra, Celtis occidentalis, Carya cordiformis, Juglans nigra,* and *Fraxinus pennsylvanica*. The shrub and sapling layer is often open (<25% cover). Species that may be present include *Sambucus canadensis, Rubus occidentalis,* or *Lindera benzoin*. Woody and herbaceous vines can be prominent, including among the woody vines *Parthenocissus quinquefolia, Toxicodendron radicans,* and *Vitis riparia*. Herbaceous vine species include *Apios americana, Amphicarpaea bracteata,* and *Echinocystis lobata*. Herbaceous grasses, forbs, and ferns dominate the ground layer, including *Symphyotrichum lateriflorum (= Aster lateriflorus), Boehmeria cylindrica, Erythronium americanum, Solidago gigantea, Cinna arundinacea,*

Leersia virginica, Elymus virginicus, Impatiens pallida, Laportea canadensis, Matteuccia struthiopteris, Onoclea sensibilis, Pilea pumila, Urtica dioica, and others. A variety of exotics may be present, including *Lysimachia* spp., *Microstegium vimineum, Polygonum cuspidatum, Rosa multiflora*, and *Lonicera japonica*.

Environmental Description: This community occurs on temporarily flooded soils along major rivers and smaller perennial streams. Soils may be well-drained and sandy, more loamy on infrequently flooded bottomlands and levees, or deep silts on stabilized sites along larger rivers. It appears to be favored by deposition of deep sandy sediments by low-energy floodwaters. The community may form small linear patches among other floodplain associations or be locally extensive. The structure and composition of the type is influenced by the flooding regime. Floods leave river-deposited debris on the forest floor, ice scars on trees, and abandoned channels that retain water at or above the level of the main river channel.

Vegetation Description: The canopy cover is more-or-less closed and dominated by *Acer saccharinum*. Codominants may include *Platanus occidentalis, Betula nigra*, and rarely *Acer saccharum*. Associated species may include *Ulmus americana, Ulmus rubra, Acer negundo, Salix nigra, Celtis occidentalis, Carya cordiformis, Juglans nigra, Fraxinus pennsylvanica*, and occasionally *Halesia tetraptera*. The shrub and sapling layer is often open (<25% cover). Species that may be present include *Sambucus canadensis, Rubus occidentalis*, or *Lindera benzoin*. Woody and herbaceous vines can be prominent, including among the woody vines *Parthenocissus quinquefolia, Toxicodendron radicans*, and *Vitis riparia*. Herbaceous vine species include *Apios americana, Amphicarpaea bracteata*, and *Echinocystis lobata*. Grasses, forbs, and ferns dominate the ground layer, including various combinations of *Symphyotrichum lateriflorum (= Aster lateriflorus), Boehmeria cylindrica, Chasmanthium latifolium, Cryptotaenia canadensis, Erythronium americanum, Solidago gigantea, Cinna arundinacea, Leersia virginica, Elymus virginicus, Helianthus* sp., *Impatiens capensis, Impatiens pallida, Laportea canadensis, Matteuccia struthiopteris, Menispermum canadense, Onoclea sensibilis, Pilea pumila, Polygonum virginianum, Rudbeckia laciniata, Verbesina alternifolia, Urtica dioica*, and others. A variety of exotics may be present, including *Lysimachia* spp., *Microstegium vimineum, Glechoma hederacea, Polygonum cuspidatum, Rosa multiflora*, and *Lonicera japonica*.

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Acer saccharinum* (silver maple)
Herb (field)	Vine/Liana	*Parthenocissus quinquefolia* (Virginia creeper)
		Toxicodendron radicans (eastern poison-ivy)
Herb (field)	Graminoid	*Leersia virginica* (whitegrass)

Characteristic Species: *Acer negundo, Acer saccharinum, Alliaria petiolata, Conium maculatum, Elymus virginicus, Glechoma hederacea, Humulus japonicus, Populus deltoides, Urtica dioica* ssp. *gracilis.*

Other Noteworthy Species: Information not available.

USFWS Wetland System: Palustrine.

DISTRIBUTION

Range: This association is found throughout the midwestern United States and in the mid-Atlantic region of the eastern United States, ranging from Delaware, New Jersey, and Pennsylvania west to Minnesota, and south to Arkansas.

States/Provinces: AR, DE, IA:SU, IL, IN, KY, MI, MN, MO, NJ, OH, ON, PA, TN, WI:S3, WV.

Federal Lands: NPS (Delaware Water Gap, Effigy Mounds, New River Gorge); USFS (Ozark?).

CONSERVATION STATUS
Rank: G4? (3-Oct-1996).
Reasons: There has been significant conversion of stands to agriculture, hydrologic modifications due to river dams, etc., and siltation caused by modified flooding regimes.

CLASSIFICATION INFORMATION
Status: Standard.
Confidence: 2 - Moderate,
Comments: This type includes stands where *Acer saccharinum* represents the majority of trees (>50% cover or basal area?). This type is most clearly expressed on larger rivers. To some degree this type is more northern, separable from the more southern type *Acer saccharinum - Celtis laevigata - Carya illinoinensis* Forest (CEGL002431), but this distinction is not yet well resolved. In the southern parts of its range, this type may overlap with *Platanus occidentalis - Acer saccharinum - Juglans nigra - Ulmus rubra* Forest (CEGL007334), but that type is generally a higher terrace, small stream type. Compare this type with SAF cover type 62 (Eyre 1980). In Minnesota stands with less than either 50% cottonwood or silver maple and not in northwestern Minnesota tend to occur here (i.e., a mixed floodplain forest), as do silver maple stands with a supercanopy of cottonwoods. In southwestern Minnesota, stands with only some swamp white oak go here. If swamp white oak is dominant the stands probably belong with either an association in the *Quercus palustris - (Quercus bicolor)* Seasonally Flooded Forest Alliance (A.329), or *Quercus macrocarpa - Quercus bicolor - Carya laciniosa / Leersia* spp. - *Cinna* spp. Forest (CEGL002098), at least in the Midwest. *Fraxinus pennsylvanica* is a typical codominant in this type. In Wisconsin, this type may better be named *Acer saccharinum - Fraxinus pennsylvanica - Betula nigra* Forest (E. Epstein pers. comm. 1999).
Similar Associations:
- *Acer (rubrum, saccharinum) - Fraxinus* spp. - *Ulmus americana* Forest (CEGL005038)—grades into this community in backwater swamps.
- *Acer saccharinum - (Populus deltoides) / Matteuccia struthiopteris - Laportea canadensis* Forest (CEGL006147)--is somewhat more northern, lacking *Platanus* and *Betula nigra.*
- *Acer saccharinum - Acer negundo / Ageratina altissima - Laportea canadensis - (Elymus virginicus)* Forest (CEGL006217).
- *Acer saccharinum - Betula nigra / Cephalanthus occidentalis* Forest (CEGL007810).
- *Acer saccharinum - Celtis laevigata - Carya illinoinensis* Forest (CEGL002431)--is more southern.
- *Acer saccharinum* Temporarily Flooded Forest [Placeholder] (CEGL007304).
- *Fagus grandifolia - Quercus* spp. - *Acer rubrum - Juglans nigra* Forest (CEGL005014)—in the eastern part of its range on the mesic side.
- *Fraxinus pennsylvanica - Ulmus americana - (Acer negundo, Tilia americana)* Northern Forest (CEGL002089)--in the western part of its range on the mesic side.
- *Fraxinus pennsylvanica - Ulmus* spp. - *Celtis occidentalis* Forest (CEGL002014).
- *Platanus occidentalis - Acer saccharinum - Juglans nigra - Ulmus rubra* Forest (CEGL007334)--may overlap in southern parts of the range of CEGL002586.
- *Populus deltoides - Salix nigra* Forest (CEGL002018)--grades into this community on the wetter side.

- *Quercus macrocarpa* - *Quercus bicolor* - *Carya laciniosa / Leersia* spp. - *Cinna* spp. Forest (CEGL002098).

Related Concepts:

- Silver Maple - American Elm: 62 (Eyre 1980) B
- Silver maple - American elm - cottonwood floodplain forest (CAP pers. comm. 1998) ?

SOURCES

Description Authors: D. Faber-Langendoen, mod. L. A. Sneddon, E. Largay, S. C. Gawler.

References: Anderson 1996, CAP pers. comm. 1998, Eyre 1980, Fike 1999, INAI unpubl. data, MNNHP 1993, Midwestern Ecology Working Group n.d., TDNH unpubl. data, Vanderhorst 2007, WNHIP unpubl. data, WPC and TNC 2002, Walton et al. 1996.

Figure B2. An example of Silver Maple Floodplain Forest from the New River Gorge National River.

COMMON NAME (PARK-SPECIFIC): SYCAMORE - ASH FLOODPLAIN FOREST

SYNONYMS
NVC English Name: **Sycamore - Green Ash / American Hornbeam / Wingstem Forest**
NVC Scientific Name: ***Platanus occidentalis - Fraxinus pennsylvanica / Carpinus caroliniana / Verbesina alternifolia* Forest**
NVC Identifier: **CEGL006458**

LOCAL INFORMATION

Environmental Description: This association occurs in small to medium-sized patches (<0.1–13 ha) on floodplains of the New River. The best developed stands occur on the wider floodplains which are associated with point bars along the inside bends of large river meanders. It also occurs on alluvial fans at the mouths of tributaries, and at knickpoints created by rapids and waterfalls. These positions are temporarily inundated by low- to medium-energy floods which may occur at any time of year but are more frequent in the winter and spring. Flooding frequency varies by relative elevation but is likely to occur at least annually throughout most of this community. Evidence of flooding includes fluvial microtopography, flotsam piles, and lack of thick litter layers and organic soil horizons. Substrates are alluvium, including boulders, cobbles, gravel, and sand. Soils in plots are described as well-drained, slightly acidic to neutral sand and sandy loam. Soil chemistry analyzed from 5 plots indicates slightly acidic soils (mean pH = 5.92) with relatively low levels of organic matter, S, Al, K, and P, and relatively high levels of Ca, Cu, Mg, and Zn. Slopes range from level to steep (mapping unit values range from 0 to 35 degrees, mean = 8 degrees). Elevations of mapped stands range from 259 to 418 m. Adjacent communities include *Platanus occidentalis - (Betula nigra, Salix* spp.) Temporarily Flooded Woodland (CEGL003725), which occurs closer to the rivershore in positions subject to higher energy flooding, and *Quercus (alba, rubra, velutina) / Halesia tetraptera* Forest (CEGL006462), which occurs on higher floodplain terraces which are infrequently flooded.
Vegetation Description: This association represents closed-canopy deciduous floodplain forests along the New River. The tree canopy is usually tall (20–35 m) with cover in plots ranging from 40 to 80% dominated by *Platanus occidentalis, Fraxinus pennsylvanica*, and *Liriodendron tulipifera*. Additional important trees in the canopy include *Betula nigra, Fraxinus americana, Juglans nigra, Nyssa sylvatica, Quercus rubra, Robinia pseudoacacia, Ulmus americana*, and *Ulmus rubra*. Subcanopy cover ranges from 10 to 80% and may include canopy species and *Acer saccharum, Carpinus caroliniana ssp. virginiana, Cercis canadensis, Chionanthus virginicus, Cornus florida, Halesia tetraptera, Sassafras albidum*, and *Zanthoxylum americanum*. Cover in the tall-shrub layer of plots ranges from 10 to 80%; cover in the short-shrub layer ranges from 10 to 50%. Additional species in the shrub layers not included in the canopy include *Asimina triloba, Campsis radicans, Dirca palustris, Hamamelis virginiana, Lindera benzoin, Toxicodendron radicans*, and *Viburnum recognitum*. Cover in the diverse herb layer of plots ranges from 20 to 90%. Herbs with highest constancy and/or cover in plots include *Ageratina altissima, Allium cernuum, Amphicarpaea bracteata, Arabis laevigata, Aristolochia macrophylla, Asarum canadense, Boehmeria cylindrica, Brachyelytrum erectum, Cardamine impatiens, Chasmanthium latifolium, Cinna arundinacea, Cryptotaenia canadensis, Dichanthelium clandestinum, Dioscorea villosa, Elymus hystrix, Elymus virginicus, Eurybia divaricata, Festuca subverticillata, Galium aparine, Iris cristata, Laportea canadensis, Lysimachia ciliata, Maianthemum racemosum, Packera aurea, Parthenocissus quinquefolia,*

Phlox paniculata, Pilea pumila, Polygonatum biflorum, Polygonum virginianum, Polystichum acrostichoides, Rudbeckia laciniata, Sanicula odorata, Sedum ternatum, Silene stellata, Solidago flexicaulis, Symphyotrichum cordifolium, Tradescantia virginiana, Verbesina alternifolia, Verbesina occidentalis, Viola striata, Zizia aptera, Zizia aurea, and *Zizia trifoliata*. State-rare plants tracked by West Virginia Natural Heritage Program which occur in this community include the herbs *Silphium perfoliatum var. connatum* and *Cardamine flagellifera*. Exotic plant species which invade this community include *Alliaria petiolata, Glechoma hederacea, Lonicera japonica, Microstegium vimineum, Polygonum cuspidatum, Prunella vulgaris*, and *Rosa multiflora*. Vascular plant species richness in the 16 sampled plots ranges from 26 to 70 (mean = 53.2).

Most Abundant Species:

Stratum	Lifeform	Species
Tree (canopy & subcanopy)	Broad-leaved deciduous tree	*Fraxinus pennsylvanica* (green ash)
		Liriodendron tulipifera (tuliptree)
		Platanus occidentalis (American sycamore)
Tree subcanopy	Broad-leaved deciduous tree	*Carpinus caroliniana* ssp. *virginiana* (American hornbeam)

Characteristic Species: *Acer saccharum, Ageratina altissima, Allium cernuum, Amphicarpaea bracteata, Arabis laevigata, Aristolochia macrophylla, Asarum canadense, Asimina triloba, Betula nigra, Boehmeria cylindrica, Brachyelytrum erectum, Campsis radicans, Cardamine impatiens, Cercis canadensis, Chasmanthium latifolium, Chionanthus virginicus, Cinna arundinacea, Cornus florida, Cryptotaenia canadensis, Dichanthelium clandestinum, Dioscorea villosa, Dirca palustris, Elymus hystrix, Elymus virginicus, Eurybia divaricata, Festuca subverticillata, Fraxinus americana, Galium aparine, Halesia tetraptera, Hamamelis virginiana, Iris cristata, Juglans nigra, Laportea canadensis, Lindera benzoin, Lysimachia ciliata, Maianthemum racemosum, Nyssa sylvatica, Packera aurea, Parthenocissus quinquefolia, Phlox paniculata, Pilea pumila, Polygonatum biflorum, Polygonum virginianum, Polystichum acrostichoides, Quercus rubra, Robinia pseudoacacia, Rudbeckia laciniata, Sanicula odorata, Sassafras albidum, Sedum ternatum, Silene stellata, Solidago flexicaulis, Symphyotrichum cordifolium, Toxicodendron radicans, Tradescantia virginiana, Ulmus americana, Ulmus rubra, Verbesina alternifolia, Verbesina occidentalis, Viburnum recognitum, Viola striata, Zanthoxylum americanum, Zizia aptera, Zizia aurea, Zizia trifoliata.*

Other Noteworthy Species: *Cardamine flagellifera, Silphium perfoliatum* var. *connatum*

Subnational Distribution with Crosswalk Data:

State	State Rank	Confidence	State Name	Reference
WV	SNR	1		WVNHP unpubl. data b

Local Range: This association occurs in patches along the New River throughout its length in the park.

Classification Comments: Spatially and compositionally, this association is intermediate to *Platanus occidentalis - (Betula nigra, Salix* spp.) Temporarily Flooded Woodland (CEGL003725), which is usually a woodland and occurs in lower positions subject to more frequent, higher energy flooding, and *Quercus (alba, rubra, velutina) / Halesia tetraptera* Forest (CEGL006462), which occurs in higher positions subject to less frequent, lower energy floods. Suiter (1995) considered the floodplain forests along the New River to be part of the mesic upland forest.

Other Comments: Information not available.

Local Description Authors: J. P. Vanderhorst.

Plots: NERI.3, NERI.5, NERI.54, NERI.79, NERI.127, NERI.129, NERI.130, NERI.140, NERI.141, NERI.141, NERI.269, NERI.270, NERI.307, NERI.324, NERI.327, NERI.355, NERI.361.
New River Gorge National River Inventory Notes: Information not available.

GLOBAL INFORMATION

NVC CLASSIFICATION

Physiognomic Class	Forest (I)
Physiognomic Subclass	Deciduous forest (I.B.)
Physiognomic Group	Cold-deciduous forest (I.B.2.)
Physiognomic Subgroup	Natural/Semi-natural cold-deciduous forest (I.B.2.N.)
Formation	Temporarily flooded cold-deciduous forest (I.B.2.N.d.)
Alliance	*Platanus occidentalis - (Liquidambar styraciflua, Liriodendron tulipifera)* Temporarily Flooded Forest Alliance (A.289)
Alliance (English name)	Sycamore - (Sweetgum, Tuliptree) Temporarily Flooded Forest Alliance
Association	*Platanus occidentalis - Fraxinus pennsylvanica / Carpinus caroliniana / Verbesina alternifolia* Forest
Association (English name)	Sycamore - Green Ash / American Hornbeam / Wingstem Forest
Ecological System(s):	Information not available.

GLOBAL DESCRIPTION

Concept Summary: This association is currently only known and described from New River Gorge, West Virginia. It occurs in small to medium-sized patches (<0.1–13 ha) on floodplains of the New River. The best developed stands occur on the wider floodplains which are associated with point bars along the inside bends of large river meanders. It also occurs on alluvial fans at the mouths of tributaries, and at knickpoints created by rapids and waterfalls. These positions are temporarily inundated by low- to medium-energy floods which may occur at any time of year but are more frequent in the winter and spring. Substrates are alluvium, including boulders, cobbles, gravel, and sand. Soils are well-drained, slightly acidic to neutral sand and sandy loam. Elevations of mapped stands range from 259 to 418 m. This association represents closed-canopy deciduous floodplain forests along the New River. The tree canopy is dominated by *Platanus occidentalis, Fraxinus pennsylvanica,* and *Liriodendron tulipifera*. Additional important trees in the canopy include *Betula nigra, Fraxinus americana, Juglans nigra, Nyssa sylvatica, Quercus rubra, Robinia pseudoacacia, Ulmus americana,* and *Ulmus rubra*. The subcanopy includes canopy species and *Acer saccharum, Carpinus caroliniana ssp. virginiana, Cercis canadensis, Chionanthus virginicus, Cornus florida, Halesia tetraptera, Sassafras albidum* and *Zanthoxylum americanum*. Species in the shrub layers not included in the canopy include *Asimina triloba, Campsis radicans, Dirca palustris, Hamamelis virginiana, Lindera benzoin, Toxicodendron radicans,* and *Viburnum recognitum*. Cover in the diverse herb layer ranges from 20 to 90%.
Environmental Description: This association occurs in small to medium-sized patches (<0.1–13 ha) on floodplains of the New River. The best developed stands occur on the wider floodplains which are associated with point bars along the inside bends of large river meanders. It also occurs on alluvial fans at the mouths of tributaries, and at knickpoints created by rapids and waterfalls. These positions are temporarily inundated by low- to medium-energy floods which may occur at any time of year but are more frequent in the winter and spring. Substrates

are alluvium, including boulders, cobbles, gravel, and sand. Soils in plots are described as well-drained, slightly acidic to neutral sand and sandy loam. Soil chemistry analyzed from 5 plots at New River Gorge indicates slightly acidic soils (mean pH = 5.92) with relatively low levels of organic matter, S, Al, K, and P, and relatively high levels of Ca, Cu, Mg, and Zn. Slopes range from level to steep (mapping unit values range from 0 to 35 degrees, mean = 8 degrees). Elevations of mapped stands range from 259 to 418 m.

Vegetation Description: This association represents closed-canopy deciduous floodplain forests along the New River. The tree canopy is usually tall (20–35 m) with cover in plots ranging from 40 to 80% dominated by *Platanus occidentalis, Fraxinus pennsylvanica*, and *Liriodendron tulipifera*. Additional important trees in the canopy include *Betula nigra, Fraxinus americana, Juglans nigra, Nyssa sylvatica, Quercus rubra, Robinia pseudoacacia, Ulmus americana*, and *Ulmus rubra*. Subcanopy cover ranges from 10 to 80% and may include canopy species and *Acer saccharum, Carpinus caroliniana ssp. virginiana, Cercis canadensis, Chionanthus virginicus, Cornus florida, Halesia tetraptera, Sassafras albidum* and *Zanthoxylum americanum*. Cover in the tall-shrub layer of plots ranges from 10 to 80%, and cover in the short-shrub layers ranges from 10 to 50%. Additional species in the shrub layers not included in the canopy include *Asimina triloba, Campsis radicans, Dirca palustris, Hamamelis virginiana, Lindera benzoin, Toxicodendron radicans*, and *Viburnum recognitum*. Cover in the diverse herb layer of plots ranges from 20 to 90%. Herbs with highest constancy and/or cover in plots include *Ageratina altissima, Allium cernuum, Amphicarpaea bracteata, Arabis laevigata, Aristolochia macrophylla, Asarum canadense, Boehmeria cylindrica, Brachyelytrum erectum, Cardamine impatiens, Chasmanthium latifolium, Cinna arundinacea, Cryptotaenia canadensis, Dichanthelium clandestinum, Dioscorea villosa, Elymus hystrix, Elymus virginicus, Eurybia divaricata, Festuca subverticillata, Galium aparine, Iris cristata, Laportea canadensis, Lysimachia ciliata, Maianthemum racemosum, Packera aurea, Parthenocissus quinquefolia, Phlox paniculata, Pilea pumila, Polygonatum biflorum, Polygonum virginianum, Polystichum acrostichoides, Rudbeckia laciniata, Sanicula odorata, Sedum ternatum, Silene stellata, Silphium perfoliatum var. connatum, Solidago flexicaulis, Symphyotrichum cordifolium, Tradescantia virginiana, Verbesina alternifolia, Verbesina occidentalis, Viola striata, Zizia aptera, Zizia aurea*, and *Zizia trifoliata*. Exotic plant species which invade this community include *Alliaria petiolata, Glechoma hederacea, Lonicera japonica, Microstegium vimineum, Polygonum cuspidatum, Prunella vulgaris*, and *Rosa multiflora*. Vascular plant species richness in the 16 sampled plots ranges from 26 to 70 (mean = 53.2).

Most Abundant Species:

Stratum	Lifeform	Species
Tree (canopy & subcanopy)	Broad-leaved deciduous tree	*Fraxinus pennsylvanica* (green ash)
		Liriodendron tulipifera (tuliptree)
		Platanus occidentalis (American sycamore)
Tree subcanopy	Broad-leaved deciduous tree	*Carpinus caroliniana* ssp. *virginiana* (American hornbeam)

Characteristic Species: *Ageratina altissima, Allium cernuum, Amphicarpaea bracteata, Arabis laevigata, Aristolochia macrophylla, Asarum canadense, Asimina triloba, Betula nigra, Boehmeria cylindrica, Brachyelytrum erectum, Campsis radicans, Cardamine impatiens, Cercis canadensis, Chasmanthium latifolium, Chionanthus virginicus, Cinna arundinacea, Cornus florida, Cryptotaenia canadensis, Dichanthelium clandestinum, Dioscorea villosa, Dirca palustris, Elymus hystrix, Elymus virginicus, Eurybia divaricata, Festuca subverticillata,*

Fraxinus americana, Galium aparine, Halesia tetraptera, Hamamelis virginiana, Iris cristata, Juglans nigra, Laportea canadensis, Lindera benzoin, Lysimachia ciliata, Maianthemum racemosum, Nyssa sylvatica, Packera aurea, Parthenocissus quinquefolia, Phlox paniculata, Pilea pumila, Polygonatum biflorum, Polygonum virginianum, Polystichum acrostichoides, Quercus rubra, Robinia pseudoacacia, Rudbeckia laciniata, Sanicula odorata, Sassafras albidum, Sedum ternatum, Silene stellata, Solidago flexicaulis, Symphyotrichum cordifolium, Toxicodendron radicans, Tradescantia virginiana, Ulmus americana, Ulmus rubra, Verbesina alternifolia, Verbesina occidentalis, Viburnum recognitum, Viola striata, Zanthoxylum americanum, Zizia aptera, Zizia aurea, Zizia trifoliata.
Other Noteworthy Species: Information not available.
USFWS Wetland System: Not applicable.

DISTRIBUTION
Range: This association is currently documented from the New River in West Virginia but is presumably wider ranging.
States/Provinces: WV.
Federal Lands: NPS (New River Gorge).

CONSERVATION STATUS
Rank: GNR (2-Aug-2006).
Reasons: Information not available.

CLASSIFICATION INFORMATION
Status: Standard
Confidence: 3 - Weak.
Comments: Information not available.
Similar Associations:
- *Platanus occidentalis - Acer negundo - Juglans nigra / Asimina triloba / Mertensia virginica* Forest (CEGL004073)--occurs on richer floodplains in the central Appalachians, usually on calcareous substrates.
- *Platanus occidentalis - Acer saccharinum - Juglans nigra - Ulmus rubra* Forest (CEGL007334)--occurs on richer floodplains in the southern Appalachians, Cumberlands, and adjacent regions, usually on calcareous substrates.
- *Platanus occidentalis - Liquidambar styraciflua / Carpinus caroliniana - Asimina triloba* Forest (CEGL007340)--has Coastal Plain affinity.

Related Concepts:
- *Platanus occidentalis - Fraxinus pennsylvanica / Carpinus caroliniana* riparian forest (Vanderhorst 2001b) =
- Mesic upland forest (Suiter 1995) B

SOURCES
Description Authors: J. P. Vanderhorst.
References: Eastern Ecology Working Group n.d., Suiter 1995, Vanderhorst 2001b, Vanderhorst 2007.

Figure B3. An example of Sycamore - Ash Floodplain Forest from the Bluestone National Scenic River.

COMMON NAME (PARK-SPECIFIC): EASTERN RED-CEDAR - VIRGINIA PINE FLATROCK WOODLAND

SYNONYMS

NVC English Name:	**Eastern Red-cedar - Virginia Pine - Post Oak / Running Serviceberry / Poverty Oatgrass - Two-flower Melicgrass Woodland**
NVC Scientific Name:	***Juniperus virginiana* var. *virginiana* - *Pinus virginiana* - *Quercus stellata* / *Amelanchier stolonifera* / *Danthonia spicata* - *Melica mutica* Woodland**
NVC Identifier:	**CEGL008449**

LOCAL INFORMATION

Environmental Description: This association occurs in small patches along the New River on flat bedrock of Stony Gap sandstone of the Hinton Formation (Mauch Chunk Group). These exposures, which occur beside the river at two major waterfalls, are rarely flooded but are hypothesized to have been subjected to catastrophic floods in the past. The natural flooding regime of the New River was altered by construction of Bluestone Dam in 1949. Some areas of this association are still subject to flooding, but maximum flows and energy have been reduced since the dam was built. Soils are shallow, rapidly drained sands and sandy loams over bedrock. Soils are extremely acidic (pH = 3.9) with high organic matter content and low levels of major nutrients (Mitchem 2004). Soil moisture regime is relatively xeric. Slopes range from level to moderate (mapping unit values range from 0 to 13 degrees, mean = 4 degrees). Elevations of mapped stands range from 379 to 402 m. Although it is similar to other types which have fire ecologies, fire was probably not an important part of the natural disturbance regime of this association. Despite this, in 2002 a controlled burn was conducted in this community at Camp Brookside with the objective of maintaining conifer dominance (Gellerstedt and Johnson 2005). Fires have also occurred at Sandstone Falls where they were related to unregulated camping and other forms of recreation. This community continues to be subject to trampling by recreational visitors.

Vegetation Description: Although this association is currently known only within the boundaries of New River Gorge National River, and thus the park vegetation is the same as the global vegetation, additional information is presented here which is not covered in the global description. The exotic *Rubus phoenicolasius* was found in the shrub layer of one plot at Sandstone Falls in 1999 and has since become abundant in this community at Camp Brookside, apparently in positive response to the controlled burn conducted in 2002. Vascular plant species richness in the 5 sampled plots ranges from 19 to 53 (mean = 36.4). Rare plants tracked by West Virginia Natural Heritage Program which have been documented in this community by past surveys include *Aristida purpurascens, Carex woodii, Commelina erecta, Coreopsis pubescens* (in ecotone with mowed field), *Galactia volubilis, Hypericum virgatum, Melica mutica,* and *Piptochaetium avenaceum* Additional details on the composition, structure, and dynamics of the vegetation at Camp Brookside are provided in Mitchem and Johnson (2001) and Mitchem (2004).

Most Abundant Species:

Stratum	Lifeform	Species
Tree (canopy & subcanopy)	Needle-leaved tree	*Juniperus virginiana* (eastern redcedar)
		Pinus virginiana (Virginia pine)

Characteristic Species: *Amelanchier stolonifera, Andropogon virginicus, Celtis occidentalis, Cercis canadensis, Chionanthus virginicus, Cladina subtenuis, Cladonia furcata, Cladonia grayi, Cladonia robbinsii, Cladonia strepsilis, Danthonia spicata, Dicranum condensatum, Dicranum scoparium, Fraxinus americana, Grimmia pilifera, Hedwigia ciliata, Hypericum gentianoides, Hypnum imponens, Isopterygium tenerum, Krigia virginica, Leersia virginica, Leucobryum glaucum, Melica mutica, Parmotrema hypotropum, Piptochaetium avenaceum, Plagiomnium ciliare, Polytrichum juniperinum, Punctelia rudecta, Quercus stellata, Rhus copallinum, Rosa carolina, Thuidium delicatulum, Ulmus americana, Viburnum prunifolium.*

Other Noteworthy Species: *Aristida purpurascens* var. *purpurascens, Carex woodii, Commelina erecta* var. *angustifolia, Coreopsis pubescens* var. *robusta, Galactia volubilis, Hypericum virgatum.*

Subnational Distribution with Crosswalk Data:

State	State Rank	Confidence	State Name	Reference
WV	SNR	1		Vanderhorst 2001b

Local Range: This association is confined to two sites, Sandstone Falls and Camp Brookside (Brooks Falls) in the southern section of the park.

Classification Comments: This community was described by Rouse and McDonald (1986) as a part of the "Appalachian river flatrock" community, by McDonald and Trianosky (1995) as sub-mesic Virginia pine woodland, and by Suiter (1995) and Suiter and Evans (1999) as *Pinus virginiana - Juniperus virginiana - Quercus stellata* woodland. It is similar to associations in the *Juniperus virginiana - Quercus (stellata, velutina, marilandica)* Forest Alliance (A.383), but differs by its history of flooding as opposed to fire disturbance and by its floristic composition. McDonald and Trianosky (1995) identified communities described from other eastern states which are superficially similar to the community described here, but their ecology is related to fire and/or edaphic regimes rather than flooding. They suggested this community may be most similar to xeric *Pinus virginiana* woodlands in the vicinity of Great Falls on the Potomac River in Maryland. The community at Great Falls has been described as *Pinus virginiana - Carya glabra - Quercus (rubra, stellata) / Chasmanthium latifolium* (Thomson et al.1999) and *Pinus virginiana - Quercus stellata / Vaccinium pallidum / Helianthus divaricatus* Forest (Lea 2000). In a previous report (Vanderhorst 2001b), this association was divided into a woodland type and a sparsely vegetated type, however, floristic similarities, small size of openings, and constant co-occurrence of these physiognomic expressions support recognition of just one woodland association in the IVC. Two separate community types within this association at Camp Brookside were also recognized and described by Mitchem (2004).

Other Comments: Information not available.

Local Description Authors: J.P. Vanderhorst

Plots: NERI.17, NERI.20, NERI.24, NERI.25, NERI.77.

New River Gorge National River Inventory Notes: Information not available.

GLOBAL INFORMATION

NVC CLASSIFICATION

Physiognomic Class	Woodland (II)
Physiognomic Subclass	Evergreen woodland (II.A.)
Physiognomic Group	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
Physiognomic Subgroup	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.)
Formation	Conical-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.b.)
Alliance	*Juniperus virginiana* Woodland Alliance (A.545)
Alliance (English name)	Eastern Red-cedar Woodland Alliance
Association	*Juniperus virginiana* var. *virginiana - Pinus virginiana - Quercus stellata / Amelanchier stolonifera / Danthonia spicata - Melica mutica* Woodland
Association (English name)	Eastern Red-cedar - Virginia Pine - Post Oak / Running Serviceberry / Poverty Oatgrass - Two-flower Melicgrass Woodland
Ecological System(s):	Information not available.

GLOBAL DESCRIPTION

Concept Summary: This woodland occupies areas of flat sandstone bedrock along the New River in West Virginia. It has an open to nearly closed canopy dominated by a mixture of evergreen conifer and deciduous tree species over a diverse understory of shrubs and herbs often with heavy ground cover by mosses and lichens. The open canopy is dominated by about equal amounts of *Juniperus virginiana var. virginiana* and *Pinus virginiana*. Associated deciduous tree species include *Quercus stellata, Fraxinus americana, Celtis occidentalis, Ulmus americana*, and *Cercis canadensis*. The dense shrub layer includes *Amelanchier stolonifera, Rhus copallinum, Rosa carolina*, and *Viburnum prunifolium*. Vines include *Toxicodendron radicans, Parthenocissus quinquefolia*, and *Vitis aestivalis*. The exotics *Ligustrum vulgare, Rubus phoenicolasius, Lonicera japonica*, and *Rosa multiflora* may also be present. The herbaceous layer has high representation of grasses; species include *Andropogon virginicus, Danthonia spicata, Leersia virginica, Melica mutica*, and *Piptochaetium avenaceum*. The fern ally *Selaginella rupestris* may also contribute significant ground cover. Cover by mosses and lichens is variable and may approach 90%.

Environmental Description: This community occupies areas of flat sandstone bedrock along the New River Gorge National River (Camp Brookside and Sandstone Falls), West Virginia. These areas are above the normal river floodplain but are hypothesized to have been impacted by catastrophic floods in the late 1800s resulting in establishment of primary successional species on the scoured bedrock (McDonald and Trianosky 1995). The soils are shallow with considerable areas of exposed rock. Soils are extremely acidic (pH = 3.9) with high organic matter content and low levels of major nutrients (Mitchem 2004). Soil moisture regime is relatively xeric. Slopes range from level to moderate (mapping unit values range from 0 to 13 degrees, mean = 4 degrees). Elevations of mapped stands range from 379 to 402 m.

Vegetation Description: This woodland has an open to nearly closed canopy (40–75% total cover) dominated by a mixture of evergreen conifer and deciduous tree species over a diverse

understory of shrubs and herbs often with heavy ground cover by mosses and lichens. The open canopy is dominated by about equal amounts of *Juniperus virginiana var. virginiana* and *Pinus virginiana*. Associated deciduous tree species occurring in lesser amounts include *Quercus stellata, Fraxinus americana, Celtis occidentalis, Chionanthus virginicus, Ulmus americana, Gleditsia triacanthos, Ostrya virginiana,* and *Cercis canadensis*. In addition to saplings of tree species, the dense shrub layer (60% total cover) layer includes *Amelanchier stolonifera, Rhus copallinum, Rosa carolina,* and *Viburnum prunifolium*. The exotics *Ligustrum vulgare* and *Rosa multiflora* may also be present. Vines (5% total cover) include *Toxicodendron radicans, Parthenocissus quinquefolia,* and *Vitis aestivalis*. The invasive exotics *Lonicera japonica* and *Rubus phoenicolasius* may invade this stratum as well. The herbaceous layer (20–40% cover) has high representation of grasses compared to most woodland communities in this region; species include *Andropogon virginicus, Danthonia spicata, Leersia virginica, Melica mutica,* and *Piptochaetium avenaceum*. Unusually high cover by the small fern *Asplenium platyneuron* has been noted in examples of this community; in addition, the fern ally *Selaginella rupestris* may contribute significant ground cover (Suiter 1995). Additional characteristic species in the herb layer include *Hypericum gentianoides, Krigia virginica, Lespedeza virginica, Potentilla simplex, Salvia lyrata, Symphyotrichum patens,* and *Toxicodendron radicans*. Vascular plant species richness in the 5 sampled plots at New River Gorge ranges from 19 to 53 (mean = 36.4). Cover by mosses and lichens is variable, though typically high, approaching 90%. Mosses identified in plots include *Dicranum condensatum, Dicranum scoparium, Grimmia pilifera, Hedwigia ciliata, Hypnum imponens, Isopterygium tenerum, Leucobryum glaucum, Plagiomnium ciliare, Polytrichum juniperinum,* and *Thuidium delicatulum*. Lichens in the plots include *Cladonia furcata, Cladonia grayi, Cladonia robbinsii, Cladonia strepsilis, Cladina subtenuis (= Cladonia subtenuis), Parmotrema hypotropum,* and *Punctelia rudecta*.

Most Abundant Species:

Stratum	Lifeform	Species
Tree (canopy & subcanopy)	Needle-leaved tree	*Juniperus virginiana* (eastern redcedar)
		Pinus virginiana (Virginia pine)

Characteristic Species: *Amelanchier stolonifera, Andropogon virginicus, Celtis occidentalis, Chionanthus virginicus, Danthonia spicata, Dicranum condensatum, Dicranum scoparium, Fraxinus americana, Grimmia pilifera, Hypericum gentianoides, Krigia virginica, Leersia virginica, Leucobryum glaucum, Melica mutica, Piptochaetium avenaceum, Polytrichum juniperinum, Quercus stellata, Rhus copallinum, Rosa carolina, Ulmus americana, Viburnum prunifolium.*

Other Noteworthy Species: Information not available.

USFWS Wetland System: Not applicable.

DISTRIBUTION

Range: This community is currently restricted to the New River Gorge of West Virginia; more information is needed.

States/Provinces: MD?, WV.

Federal Lands: NPS (New River Gorge).

CONSERVATION STATUS

Rank: G2? (25-Aug-2000).

Reasons: This community hosts several rare plant species and is itself a rare element of biodiversity. Unfortunately, its long-term persistence is uncertain due to altered flooding regime since building of Bluestone Dam in 1949. Succession of this community towards deciduous

woodland has been very slow, probably due to shallow, droughty soils. Occurrences of this community are in extremely rocky areas which are protected and not vulnerable to resource extraction, conversion, or development. Currently stands of this association are probably most threatened by encroachment of exotic weeds such as Lonicera japonica and Rosa multiflora.

CLASSIFICATION INFORMATION

Status: Standard.

Confidence: 3 - Weak.

Comments: This community was described by Rouse and McDonald (1986) as a part of the "Appalachian river flatrock" community, by McDonald and Trianosky (1995) as sub-mesic Virginia pine woodland, and by Suiter (1995) and Suiter and Evans (1999) as *Pinus virginiana - Juniperus virginiana - Quercus stellata* woodland. It is similar to associations in the *Juniperus virginiana - Quercus (stellata, velutina, marilandica)* Forest Alliance (A.383), but differs by its history of flooding, as opposed to fire disturbance, and by its floristic composition. McDonald and Trianosky (1995) identified communities described from other eastern states which are superficially similar to the community described here, but their ecology is related to fire and/or edaphic regimes rather than flooding. They suggested this community may be most similar to xeric *Pinus virginiana* woodlands in the vicinity of Great Falls on the Potomac River in Maryland. The community at Great Falls has been described as *Pinus virginiana - Carya glabra - Quercus (rubra, stellata) / Chasmanthium latifolium* (Thomson et al. 1999) and *Pinus virginiana - Quercus stellata / Vaccinium pallidum / Helianthus divaricatus* Forest (Lea 2000). In a previous report (Vanderhorst 2001b), this association was divided into a woodland type and a sparsely vegetated type, however, floristic similarities, small size of openings, and constant co-occurrence of these physiognomic expressions support recognition of just one woodland association. Two separate community types within this association at Camp Brookside were also recognized and described by Mitchem (2004).

Similar Associations: Information not available.

Related Concepts:

- *Juniperus virginiana - Pinus virginiana - Quercus stellata / Asplenium platyneuron* woodland (Vanderhorst 2001b) =
- *Pinus virginiana - Juniperus virginiana - Quercus stellata* woodland (Suiter and Evans 1999) =
- *Pinus virginiana - Juniperus virginiana - Quercus stellata* woodland (Suiter 1995) =
- Appalachian river flatrock (Rouse and McDonald 1986) B
- sub-mesic Virginia pine woodland (McDonald and Trianosky 1995) =

SOURCES

Description Authors: M. Pyne after Vanderhorst (2000), mod. S. C. Gawler.

References: Eastern Ecology Working Group n.d., Gellerstedt and Johnson 2005, Lea 2000, McDonald and Trianosky 1995, Mitchem 2004, Mitchem and Johnson 2001, Rouse and McDonald 1986, Suiter 1995, Suiter and Evans 1999, Thomson et al. 1999, Vanderhorst 2000a, Vanderhorst 2001b, Vanderhorst 2007, Vanderhorst pers. comm.

Photo not available

COMMON NAME (PARK-SPECIFIC): SYCAMORE - RIVER BIRCH RIVERSCOUR WOODLAND

SYNONYMS

NVC English Name: **Sycamore - (River Birch, Willow species) Temporarily Flooded Woodland**

NVC Scientific Name: ***Platanus occidentalis* - (*Betula nigra, Salix* spp.) Temporarily Flooded Woodland**

NVC Identifier: **CEGL003725**

LOCAL INFORMATION

Environmental Description: This association occurs in small patches and more often in relatively continuous linear zones along the shores of the New River in positions that are subject to frequent high-energy flooding. These floods damage and remove trees, maintaining an open canopy. The alluvial substrate is composed of boulders and cobbles with gravel and sand accumulations but no soil development. These coarse-textured substrates are potentially well-drained, but fluvial topography and proximity to the water table often results in a mixture of well-drained and poorly drained microsites, including areas of standing water, within the community. Soil (sandy alluvium) chemistry analyzed from four plots indicates relatively high pH (mean = 6.73), low levels of macronutrients (N, P, K) and organic matter, and high levels of several micronutrients (Ca, Cu, Fe, Mg, Mn, Zn). Slopes range from level to steep (mapping unit values range from 0 to 35 degrees, mean = 9 degrees). Elevations of mapped stands range from 252 to 408 m. Ecologically and spatially this association is intermediate between *Andropogon gerardii - Panicum virgatum - Baptisia australis* Herbaceous Vegetation (CEGL006283), which occurs on sites which are more severely impacted by flooding, and *Platanus occidentalis - Fraxinus pennsylvanica / Carpinus caroliniana / Verbesina alternifolia* Forest (CEGL006458), which occurs on sites less severely impacted by floods. *Salix nigra - Betula nigra / Schoenoplectus (pungens, tabernaemontani)* Wooded Herbaceous Vegetation (CEGL006463) occurs in similar riverside positions along lower energy reaches, often just downstream from rapids.

Vegetation Description: This association is a deciduous woodland or open forest typically codominated by *Platanus occidentalis* and *Betula nigra*. One atypical stand has a canopy codominated by *Pinus virginiana*. Additional important trees include *Acer saccharinum, Catalpa speciosa, Diospyros virginiana, Fraxinus americana, Fraxinus pennsylvanica, Robinia pseudoacacia, Salix nigra, Ulmus americana*, and *Ulmus rubra*. The usually short, open canopy is composed mostly of flood-battered trees. The tallest trees are often the younger ones which have not yet been subjected to damage by severe floods. Common shrubs include *Alnus serrulata, Cephalanthus occidentalis, Chionanthus virginicus, Cornus amomum, Hypericum prolificum*, and *Salix caroliniana*. There is often a large component of woody vines in the short-shrub layer, including *Campsis radicans, Toxicodendron radicans*, and *Vitis rupestris*. The herb layer is composed of a mixture of warm-season grasses and forbs adapted to frequent flooding and high light exposure. Characteristic herbs include *Andropogon gerardii, Apocynum cannabinum, Baptisia australis, Chasmanthium latifolium, Conoclinium coelestinum, Dichanthelium clandestinum, Eupatorium fistulosum, Justicia americana, Lobelia cardinalis, Lysimachia ciliata, Panicum virgatum, Solidago juncea, Tripsacum dactyloides*, and *Viola cucullata*. Rare plants tracked by West Virginia Natural Heritage Program which occur in this

community include *Baptisia australis, Carex emoryi, Coreopsis pubescens var. robusta, Solidago simplex var. racemosa*, and *Vitis rupestris*. Vascular plant species richness in the 14 sampled plots ranges from 20 to 59 (mean = 38.7). The bryophyte layer is usually poorly developed. Crustose lichens may occur on large rocks.

Most Abundant Species:

Stratum	Lifeform	Species
Tree (canopy & subcanopy)	Broad-leaved deciduous tree	*Betula nigra* (river birch)
		Platanus occidentalis (American sycamore)

Characteristic Species: *Acer saccharinum, Alnus serrulata, Andropogon gerardii, Apocynum cannabinum, Baptisia australis, Campsis radicans, Catalpa speciosa, Cephalanthus occidentalis, Chasmanthium latifolium, Chionanthus virginicus, Cornus amomum, Dichanthelium clandestinum, Diospyros virginiana, Eupatorium coelestinum, Eupatorium fistulosum, Fraxinus americana, Fraxinus pennsylvanica, Hypericum prolificum, Justicia americana, Lobelia cardinalis, Lysimachia ciliata, Panicum virgatum, Robinia pseudoacacia, Salix caroliniana, Salix nigra, Solidago juncea, Toxicodendron radicans, Tripsacum dactyloides, Ulmus americana, Ulmus rubra, Viola cucullata, Vitis rupestris.*

Other Noteworthy Species: *Baptisia australis, Carex emoryi, Coreopsis pubescens* var. *robusta, Solidago simplex* var. *racemosa, Vitis rupestris.*

Subnational Distribution with Crosswalk Data:

State	State Rank	Confidence	State Name	Reference
WV	SNR	1	*Platanus occidentalis* (*Betula nigra, Salix* spp.) Temporarily Flooded Woodland [Provisional]	Vanderhorst 2001b

Local Range: This association occurs in patches scattered along the New River throughout its length in the park.

Classification Comments: Within the park this association is ecologically and floristically intermediate between *Andropogon gerardii - Panicum virgatum - Baptisia australis* Herbaceous Vegetation (CEGL006283), which is more open and occurs on sites which are more severely impacted by flooding, and *Platanus occidentalis - Fraxinus pennsylvanica / Carpinus caroliniana / Verbesina alternifolia* Forest (CEGL006458), which has a more closed canopy, usually lacking *Betula nigra*, and occurs on sites less severely impacted by flooding. It is also similar to *Salix nigra - Betula nigra / Schoenoplectus (pungens, tabernaemontani)* Wooded Herbaceous Vegetation (CEGL006463), which occurs on finer textured alluvium in riverside positions along lower energy reaches. Similar vegetation was described from the New River Gorge by Suiter (1995) as the *Platanus occidentalis - Betula nigra* forest. Recent classification studies in the National Park Service National Capitol Region have shown this association to be distinct from similar vegetation in the Potomac drainage. Its relationship to riverscour woodlands along the Bluestone and Gauley rivers has not yet been analyzed.

Other Comments: Information not available.

Local Description Authors: J. P. Vanderhorst.

Plots: NERI.56, NERI.80, NERI.92, NERI.105, NERI.126, NERI.128, NERI.207, NERI.208, NERI.209, NERI.318, NERI.352, NERI.357, NERI.358, NERI.359.

New River Gorge National River Inventory Notes: Information not available.

GLOBAL INFORMATION

NVC CLASSIFICATION

Physiognomic Class	Woodland (II)
Physiognomic Subclass	Deciduous woodland (II.B.)
Physiognomic Group	Cold-deciduous woodland (II.B.2.)
Physiognomic Subgroup	Natural/Semi-natural cold-deciduous woodland (II.B.2.N.)
Formation	Temporarily flooded cold-deciduous woodland (II.B.2.N.b.)
Alliance	*Platanus occidentalis* - *(Betula nigra, Salix* spp.*)* Temporarily Flooded Woodland Alliance (A.633)
Alliance (English name)	Sycamore - (River Birch, Willow species) Temporarily Flooded Woodland Alliance
Association	*Platanus occidentalis* - *(Betula nigra, Salix* spp.) Temporarily Flooded Woodland
Association (English name)	Sycamore - (River Birch, Willow species) Temporarily Flooded Woodland
Ecological System(s):	Cumberland Riverscour (CES202.036).

GLOBAL DESCRIPTION

Concept Summary: These woodlands occur along high-energy Appalachian rivershores, such as the New River in West Virginia. They maintain an open canopy due to mechanical disturbance (flooding and scouring). The coarse-textured substrates are potentially well-drained, but fluvial topography and proximity to the water table often result in a mixture of well-drained and poorly drained microsites. The usually short, open canopy is composed mostly of flood-battered trees, typically codominated by *Platanus occidentalis* and *Betula nigra*. The tallest trees are often the younger ones which have not yet been subjected to damage by severe floods. Additional important trees include *Acer saccharinum, Catalpa speciosa, Diospyros virginiana, Fraxinus americana, Fraxinus pennsylvanica, Robinia pseudoacacia, Salix nigra, Ulmus americana*, and *Ulmus rubra*. Common shrubs include *Alnus serrulata, Cephalanthus occidentalis, Chionanthus virginicus, Cornus amomum, Hypericum prolificum*, and *Salix caroliniana*. There is often a large component of woody vines, including *Campsis radicans, Toxicodendron radicans*, and *Vitis rupestris*. The herb layer is composed of a mixture of warm-season grasses and forbs adapted to frequent flooding and high light exposure. Characteristic herbs include *Andropogon gerardii, Apocynum cannabinum, Baptisia australis, Chasmanthium latifolium, Conoclinium coelestinum, Dichanthelium clandestinum, Eupatorium fistulosum, Justicia americana, Lobelia cardinalis, Lysimachia ciliata, Panicum virgatum, Solidago juncea, Tripsacum dactyloides*, and *Viola cucullata*.

Environmental Description: These woodlands occur along high-energy Appalachian rivershores, such as the New River in West Virginia. They maintain an open canopy due to mechanical disturbance (flooding and scouring). This association occurs as relatively continuous linear zones (sometimes in small patches) along the shores of the New River in positions that are subject to frequent high-energy flooding. These floods damage and remove trees, maintaining an open canopy. The sandy alluvium substrate is composed of boulders and cobbles with gravel and sand accumulations but no soil development. These coarse-textured substrates are potentially well-drained, but fluvial topography and proximity to the water table often result in a mixture of well-drained and poorly drained microsites, including areas of standing water, within the community. Soil chemistry analyzed from four plots indicates relatively high pH (mean = 6.73),

low levels of macronutrients (N, P, K) and organic matter, and high levels of several micronutrients (Ca, Cu, Fe, Mg, Mn, Zn). Slopes range from level to steep but are generally gentle. Known elevations range from 250 to 400 m (810–1350 feet).

Vegetation Description: This association is a deciduous woodland or open forest typically codominated by *Platanus occidentalis* and *Betula nigra*. One atypical stand has a canopy codominated by *Pinus virginiana*. Additional important trees include *Acer saccharinum, Catalpa speciosa, Diospyros virginiana, Fraxinus americana, Fraxinus pennsylvanica, Robinia pseudoacacia, Salix nigra, Ulmus americana*, and *Ulmus rubra*. The usually short, open canopy is composed mostly of flood-battered trees. The tallest trees are often the younger ones which have not yet been subjected to damage by severe floods. Common shrubs include *Alnus serrulata, Cephalanthus occidentalis, Chionanthus virginicus, Cornus amomum, Hypericum prolificum*, and *Salix caroliniana*. There is often a large component of woody vines in the short-shrub layer, including *Campsis radicans, Toxicodendron radicans*, and *Vitis rupestris*. The herb layer is composed of a mixture of warm-season grasses and forbs adapted to frequent flooding and high light exposure. Characteristic herbs include *Andropogon gerardii, Apocynum cannabinum, Baptisia australis, Chasmanthium latifolium, Conoclinium coelestinum, Dichanthelium clandestinum, Eupatorium fistulosum, Justicia americana, Lobelia cardinalis, Lysimachia ciliata, Panicum virgatum, Solidago juncea, Tripsacum dactyloides*, and *Viola cucullata*. Rare plants tracked by West Virginia Natural Heritage Program which occur in this community include *Baptisia australis, Carex emoryi, Coreopsis pubescens var. robusta, Solidago simplex ssp. randii var. racemosa*, and *Vitis rupestris*. Vascular plant species richness in the 14 sampled plots ranged from 20 to 59 (mean = 38.7). The bryophyte layer is usually poorly developed; crustose lichens may occur on large rocks.

Most Abundant Species:

Stratum	Lifeform	Species
Tree (canopy & subcanopy)	Broad-leaved deciduous tree	*Betula nigra* (river birch)
		Platanus occidentalis (American sycamore)

Characteristic Species: *Acer saccharinum, Alnus serrulata, Andropogon gerardii, Apocynum cannabinum, Baptisia australis, Campsis radicans, Catalpa speciosa, Cephalanthus occidentalis, Chasmanthium latifolium, Chionanthus virginicus, Cornus amomum, Dichanthelium clandestinum, Diospyros virginiana, Eupatorium coelestinum, Eupatorium fistulosum, Hypericum prolificum, Justicia americana, Lobelia cardinalis, Lysimachia ciliata, Panicum virgatum, Robinia pseudoacacia, Salix caroliniana, Salix nigra, Solidago juncea, Toxicodendron radicans, Tripsacum dactyloides, Ulmus americana, Ulmus rubra, Viola cucullata, Vitis rupestris.*

Other Noteworthy Species: *Baptisia australis, Carex emoryi, Coreopsis pubescens* var. *robusta, Solidago simplex* var. *racemosa, Vitis rupestris.*

USFWS Wetland System: Riverine.

DISTRIBUTION

Range: This type is being reserved for vegetation of high-energy Appalachian rivers, such as the New River in West Virginia. Its range may include Virginia as well.

States/Provinces: VA, WV.

Federal Lands: NPS (New River Gorge).

CONSERVATION STATUS

Rank: GNR (1-Dec-1997).

Reasons: Information not available.

CLASSIFICATION INFORMATION

Status: Standard.

Confidence: 2 - Moderate.

Comments: Along the New River, this association is ecologically and floristically intermediate between *Andropogon gerardii - Panicum virgatum - Baptisia australis* Herbaceous Vegetation (CEGL006283), which is more open and occurs on sites which are more severely impacted by flooding, and *Platanus occidentalis - Fraxinus pennsylvanica / Carpinus caroliniana / Verbesina alternifolia* Forest (CEGL006458), which has a more closed canopy, usually lacking *Betula nigra*, and occurs on sites less severely impacted by flooding. It is also similar to *Salix nigra - Betula nigra / Schoenoplectus (pungens, tabernaemontani)* Wooded Herbaceous Vegetation (CEGL006463) ,which occurs on finer textured alluvium in riverside positions along lower energy reaches. Similar vegetation was described from the New River Gorge by Suiter (1995) as *Platanus occidentalis - Betula nigra* forest. Recent classification studies in the National Park Service National Capitol Region have shown this association to be distinct from similar vegetation in the Potomac drainage, which is being placed in *Platanus occidentalis - Betula nigra - Salix (caroliniana, nigra)* Woodland (CEGL003896). Its relationship to riverscour woodlands along the Bluestone and Gauley rivers has not yet been analyzed.

Similar Associations:

- *Betula nigra - Platanus occidentalis* Forest (CEGL002086)--with a more-or-less closed canopy.
- *Platanus occidentalis - Betula nigra - Salix (caroliniana, nigra)* Woodland (CEGL003896).
- *Quercus bicolor - Fraxinus pennsylvanica - (Platanus occidentalis) / Chasmanthium latifolium - Dichanthelium clandestinum - Zizia aurea* Woodland (CEGL006218).
- *Salix nigra - Betula nigra / Schoenoplectus pungens* Wooded Herbaceous Vegetation [Provisional] (CEGL006463)--occurs in similar riverside positions along lower energy reaches, often just downstream from rapids.

Related Concepts:

- *Platanus occidentalis - Betula nigra / Cornus amomum* riparian woodland (Vanderhorst 2001b) =
- *Platanus occidentalis - Betula nigra* forest (Suiter 1995) ?

SOURCES

Description Authors: M. Pyne, mod. S. C. Gawler.

References: Fleming et al. 2001, Mitchem 2004, Southeastern Ecology Working Group n.d., Suiter 1995, Vanderhorst 2000b, Vanderhorst 2001b, Vanderhorst 2007, Vanderhorst pers. comm.

Figure B4. An example of Sycamore - River Birch Riverscour Woodland (river birch / Indian woodoats phase) from the Bluestone National Scenic River.

COMMON NAME (PARK-SPECIFIC): RIVERSCOUR PRAIRIE

SYNONYMS

NVC English Name:	**Big Bluestem - Switchgrass - Tall Blue Wild Indigo Herbaceous Vegetation**
NVC Scientific Name:	***Andropogon gerardii - Panicum virgatum - Baptisia australis* Herbaceous Vegetation**
NVC Identifier:	**CEGL006283**

LOCAL INFORMATION

Environmental Description: This association occurs along the shores of the New River in positions that are subject to frequent high-energy flooding, usually within the active channel shelf along rapids. These positions are prone to dramatic restructuring by large floods, and patches of this association may be ephemeral. Floods maintain herbaceous physiognomy by damaging and removing woody vegetation. Substrates can include bedrock, boulders, and cobble, with gravel and sand accumulations but no soil development. These coarse-textured substrates are potentially well-drained, but fluvial topography and a high water table often result in a mixture of well-drained and poorly drained microsites. Occurrences on flat bedrock often develop scoured-out potholes which hold flood and rain water; vegetation is confined to cracks and sediment accumulations. Soil (sand) chemistry analyzed from one plot indicates very slight acidity (pH = 6.4) with relatively low levels of organic matter and relatively high levels of Ca, Mg, Mn, and Zn. Slopes range from nearly level to somewhat steep but are typically gentle (mapping unit values range from 0.3 to 24 degrees, mean = 7 degrees). Elevations of mapped stands range from 288 to 397 m. Adjacent positions with somewhat less severe flooding regime are usually occupied by *Platanus occidentalis - (Betula nigra, Salix* spp.) Temporarily Flooded Woodland (CEGL003725).

Vegetation Description: This association represents herbaceous or herb-shrub vegetation dominated by tall, warm-season grasses. There may be low cover (10% or less in plots) by trees, which are usually short and flood-battered, including *Betula nigra, Chionanthus virginicus, Diospyros virginiana, Fraxinus americana, Fraxinus pennsylvanica, Platanus occidentalis, Ulmus americana*, and *Ulmus rubra*. Cover in the shrub layers of plots ranges from 15 to 20%, which includes short individuals of the tree species and shrub species, including *Alnus serrulata, Cephalanthus occidentalis, Cornus amomum, Hypericum prolificum*, and *Salix caroliniana*. Low-growing vines with high cover and/or constancy include *Campsis radicans, Toxicodendron radicans*, and *Vitis rupestris*. Cover in the herb layer of plots ranges from 20 to 80%. Dominant grasses include *Andropogon gerardii, Panicum virgatum*, and *Sorghastrum nutans*. Additional herbs with high cover and/or constancy include *Apocynum cannabinum, Baptisia australis, Chasmanthium latifolium, Coreopsis tripteris, Cyperus strigosus, Eupatorium fistulosum, Justicia americana, Lobelia cardinalis, Ludwigia alternifolia, Potentilla simplex, Rhynchospora capitellata, Solidago juncea, Symphyotrichum laeve, Viola cucullata*, and *Zizia trifoliata*. State-rare plants tracked by West Virginia Natural Heritage Program which occur in this community include *Aristida purpurascens, Baptisia australis, Carex suberecta, Eleocharis compressa, Helianthus occidentalis ssp. occidentalis, Pycnanthemum torrei, Rhynchospora recognita*, and *Vitis rupestris*. Vascular plant species richness in the 7 sampled plots ranges from 23 to 66 (mean = 43.1). There may be low cover of mosses and lichens on rocks.

Most Abundant Species:

Stratum	Lifeform	Species
Herb (field)	Forb	*Baptisia australis* (wild blue indigo)
Herb (field)	Graminoid	*Andropogon gerardii* (big bluestem)
		Panicum virgatum (switchgrass)
		Sorghastrum nutans (Indiangrass)

Characteristic Species: *Alnus serrulata, Apocynum cannabinum, Baptisia australis, Betula nigra, Campsis radicans, Cephalanthus occidentalis, Chasmanthium latifolium, Chionanthus virginicus, Coreopsis tripteris, Cornus amomum, Cyperus strigosus, Diospyros virginiana, Eupatorium fistulosum, Fraxinus americana, Fraxinus pennsylvanica, Hypericum prolificum, Justicia americana, Lobelia cardinalis, Ludwigia alternifolia, Panicum virgatum, Platanus occidentalis, Potentilla simplex, Rhynchospora capitellata, Salix caroliniana, Solidago juncea, Sorghastrum nutans, Symphyotrichum laeve, Toxicodendron radicans, Ulmus americana, Ulmus rubra, Viola cucullata, Vitis rupestris, Zizia trifoliata.*

Other Noteworthy Species: *Aristida purpurascens, Baptisia australis, Carex suberecta, Eleocharis compressa, Helianthus occidentalis* ssp. *occidentalis, Pycnanthemum torrei, Rhynchospora recognita, Vitis rupestris.*

Subnational Distribution with Crosswalk Data:

State	State Rank	Confidence	State Name	Reference
WV	SNR	1		Vanderhorst 2001b

Local Range: In the park, this association occurs in a few small patches along the New River from Camp Brookside downstream to Keeney's Creek Rapids. Nearby, outside the park, it is found downstream along the New River at Cotton Hill and upstream along the Greenbrier River.

Classification Comments: Riverside prairies within the park are characterized by high cover and constancy of the nominal species *Andropogon gerardii* and *Baptisia australis*. Similar communities have been observed along the Greenbrier River which empties into the New River upstream from the park and which may be one source of the high levels of Ca found in substrates of this and other riparian communities in the park. Riverscour prairies along other West Virginia rivers, including the Cheat (Vanderhorst 2001a, Vanderhorst and Streets 2006), Tygart Valley, Gauley, Bluestone, Shenandoah (Vanderhorst 2000b), and Potomac, usually lack *Baptisia australis*. Prairies along the Tygart Valley and Gauley rivers share a number of species which distinguish them from this association (e.g., *Osmunda regalis, Packera paupercula, Solidago simplex, Ilex verticillata*), but this vegetation has not yet been described in the IVC.

Other Comments: Information not available.

Local Description Authors: J. P. Vanderhorst.

Plots: NERI.84, NERI.102, NERI.124, NERI.202, NERI.203, NERI.317, NERI.360.

New River Gorge National River Inventory Notes: Information not available.

GLOBAL INFORMATION

NVC CLASSIFICATION

Physiognomic Class	Herbaceous Vegetation (V)
Physiognomic Subclass	Perennial graminoid vegetation (V.A.)
Physiognomic Group	Temperate or subpolar grassland (V.A.5.)
Physiognomic Subgroup	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N.)
Formation	Temporarily flooded temperate or subpolar grassland (V.A.5.N.j.)
Alliance	*Andropogon gerardii - (Sorghastrum nutans)* Temporarily Flooded Herbaceous Alliance (A.1337)
Alliance (English name)	Big Bluestem - (Yellow Indiangrass) Temporarily Flooded Herbaceous Alliance
Association	*Andropogon gerardii - Panicum virgatum - Baptisia australis* Herbaceous Vegetation
Association (English name)	Big Bluestem - Switchgrass - Tall Blue Wild Indigo Herbaceous Vegetation
Ecological System(s):	Central Appalachian Riparian (CES202.609).

GLOBAL DESCRIPTION

Concept Summary: This community is found in the east-central United States along high-gradient sections of major rivers, such as in gorges and along the fall-line. It usually occupies rocky areas within the active channel shelf at an intermediate level above the low-water level and the bank-full level. Flood scouring and ice floods are powerful and ecologically important abrasive forces that shape the physiognomy and composition of this association. Soils are rapidly drained Psamments. Often, soil material is restricted to the narrow interstices of tightly packed boulders, or to small crevices in bedrock exposures. This community is characterized by a luxuriant growth of the robust grasses *Andropogon gerardii, Sorghastrum nutans, Panicum virgatum*, and *Spartina pectinata* which resembles prairie vegetation. *Tripsacum dactyloides* may also occur. Many of the forbs are also typical of prairies. Characteristic species include *Baptisia australis, Allium cernuum, Aristida purpurascens, Bidens frondosa, Chasmanthium latifolium, Clematis viorna, Eleocharis compressa, Conoclinium coelestinum (= Eupatorium coelestinum), Eupatorium serotinum, Lespedeza violacea, Packera aurea, Physostegia virginiana, Pycnanthemum virginianum, Solidago rupestris, Teucrium canadense, Veronicastrum virginicum, Zizia trifoliata*, and *Zizia aurea*. Scattered and flood-battered shrubs and tree saplings often occur.

Environmental Description: Stands occur along high-gradient sections of major rivers, such as in gorges and along the fall-line. They occupy rocky areas within the active channel shelf subject to frequent high-energy flooding, at an intermediate level above the low-water level and the bank-full level. These positions are prone to dramatic restructuring by large floods and patches of this association may be ephemeral. Flood scouring and ice floods are powerful and ecologically important abrasive forces that shape the physiognomy and composition of this association. Soils are rapidly drained Psamments, usually with neutral to high pH. These coarse-textured substrates are potentially well-drained, but fluvial topography and a high water table often result in a mixture of well-drained and poorly drained microsites. Occurrences on flat bedrock often develop scoured out potholes which hold flood and rain water, and vegetation is confined to cracks and sediment accumulations. Soil material is restricted to the narrow

interstices of tightly packed boulders, or to small crevices in bedrock exposures. However, along the Greenbrier and New rivers in West Virginia, stands of this type occupy cobble bars rather than stabilized outcrops and boulder deposits.

Vegetation Description: This community is characterized by a luxuriant growth of the robust grasses *Andropogon gerardii, Sorghastrum nutans, Panicum virgatum*, and *Spartina pectinata*, which resembles prairie vegetation. *Tripsacum dactyloides* may also occur. Many of the forbs are also typical of prairies. Characteristic species include *Baptisia australis, Allium cernuum, Aristida purpurascens, Bidens frondosa, Chasmanthium latifolium, Clematis viorna, Eleocharis compressa, Conoclinium coelestinum (= Eupatorium coelestinum), Eupatorium serotinum, Lespedeza violacea, Packera aurea, Physostegia virginiana, Pycnanthemum virginianum, Solidago rupestris, Teucrium canadense, Veronicastrum virginicum, Zizia trifoliata*, and *Zizia aurea*. Additional herbs with high cover and/or constancy in some areas include *Apocynum cannabinum, Coreopsis tripteris, Cyperus strigosus, Eupatorium fistulosum, Helianthus occidentalis ssp. occidentalis, Justicia americana, Lobelia cardinalis, Ludwigia alternifolia, Potentilla simplex, Pycnanthemum torrei, Rhynchospora capitellata, Rhynchospora recognita, Solidago juncea, Symphyotrichum laeve*, and *Viola cucullata*. There may be low cover (≤ by trees, which are usually short and flood-battered, including *Betula nigra, Chionanthus virginicus, Diospyros virginiana, Fraxinus americana, Fraxinus pennsylvanica, Platanus occidentalis, Ulmus americana*, and *Ulmus rubra*. Cover in the shrub layer is likewise low and includes short individuals of the tree and shrub species, including *Alnus serrulata, Cephalanthus occidentalis, Cornus amomum, Hypericum prolificum*, and *Salix caroliniana*. Low-growing vines include *Campsis radicans, Toxicodendron radicans*, and *Vitis rupestris*. In the Potomac River drainage, *Solidago simplex var. racemosa, Helianthus occidentalis, Cerastium arvense var. velutinum*, and *Ceanothus herbaceus* are noteworthy components (Lea 2000). In the James River drainage, *Orbexilum pedunculatum var. psoralioides, Silphium trifoliatum, Solidago speciosa*, and *Vicia americana* are associated. Vascular plant species richness of sampled plots (Virginia and West Virginia sample sets) averages 43–56 taxa per 100 square meters.

Most Abundant Species:

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Andropogon gerardii* (big bluestem)
		Sorghastrum nutans (Indiangrass)

Characteristic Species: *Andropogon gerardii, Apocynum cannabinum, Baptisia australis, Betula nigra, Cornus amomum, Desmodium glabellum, Lespedeza violacea, Packera aurea, Panicum virgatum, Physostegia virginiana, Sorghastrum nutans, Spartina pectinata.*

Other Noteworthy Species: *Vicia americana.*

USFWS Wetland System: Palustrine.

DISTRIBUTION

Range: This community is found in the east-central United States, from Pennsylvania, Maryland, West Virginia, and Virginia, and possibly Ohio.

States/Provinces: MD, OH, PA, VA:S1, WV.

Federal Lands: NPS (C&O Canal, New River Gorge); USFS (Jefferson).

CONSERVATION STATUS

Rank: G2G3 (14-Dec-1998).

Reasons: There are probably fewer than 100 occurrences of this community rangewide, depending on how an occurrence is defined. It is known from Maryland, the District of Columbia, and Virginia along the Potomac River, from the James River, Shenandoah River, and

various tributaries in Virginia, and from scattered patches along about 50 miles along the Greenbrier River in West Virginia. It is also reported from the Delaware River in Pennsylvania and may also occur in Ohio. This community is threatened by invasion of exotic weeds, especially *Sorghum halepense*, *Centaurea biebersteinii*, and *Lythrum salicaria*.

CLASSIFICATION INFORMATION

Status: Standard.

Confidence: 2 - Moderate.

Comments: The distinctions between this community type and *Salix* spp. / *Andropogon gerardii - Sorghastrum nutans* Gravel Wash Herbaceous Vegetation (CEGL005175) and *(Salix caroliniana, Rhododendron arborescens) - Andropogon gerardii - Baptisia australis - (Solidago simplex var. randii)* Herbaceous Vegetation (CEGL008471) seem quite artificial and further study should be undertaken to determine whether these merely represent geographic subtypes of a single association. In the Central Appalachian region, the type is found predominantly on Western Allegheny Mountains (M221Be + M221Bd, Gauley M221Ca dammed).

Similar Associations:

- *(Salix caroliniana, Rhododendron arborescens) - Andropogon gerardii - Baptisia australis - (Solidago simplex* var. *randii)* Herbaceous Vegetation (CEGL008471).
- *Andropogon gerardii - Phlox subulata - Solidago simplex* var. *racemosa - Packera paupercula* Herbaceous Vegetation (CEGL004284)--sparse vegetation of less frequently flooded, xeric rock outcrops.
- *Panicum virgatum - Andropogon gerardii* Gravel Wash Herbaceous Vegetation (CEGL006477)--on gravel and cobble depositional bars along lower-gradient rivershores.
- *Salix* spp. / *Andropogon gerardii - Sorghastrum nutans* Gravel Wash Herbaceous Vegetation (CEGL005175).

Related Concepts:

- *Andropogon gerardii - Baptisia australis* riparian herbaceous vegetation (Vanderhorst 2001b) =
- *Andropogon gerardii - Panicum virgatum - Rhus radicans - Baptisia australis* Association (Rawinski et al. 1996) =
- *Cornus amomum / Andropogon gerardii - Panicum virgatum - Baptisia australis* Shrub Herbaceous Vegetation (Fleming and Coulling 2001) =
- *Fraxinus pennsylvanica / Andropogon gerardii - Panicum virgatum - Baptisia australis* Wooded Herbaceous Vegetation (Lea 2000) =
- Riverwash Grasslands (*Baptisia australis - Lespedeza violacea - Chasmanthium latifolium* Herbaceous Vegetation) (Grossman et al. 1994) ?
- Willow - Indian grass riverine shrubland (Perles et al. 2004) B

SOURCES

Description Authors: L. A. Sneddon, mod. G. Fleming and P. Coulling, mod. S. C. Gawler.

References: Eastern Ecology Working Group n.d., Fike 1999, Fleming and Coulling 2001, Fleming et al. 2001, Grossman et al. 1994, Harrison 2004, Lea 2000, Perles et al. 2004, Rawinski 1988, Rawinski et al. 1996, TDNH unpubl. data, VDNH 2003, Vanderhorst 2000b, Vanderhorst 2001a, Vanderhorst 2001b, Vanderhorst 2007, Vanderhorst and Streets 2006.

Figure B5. An example of Riverscour Prairie from the New River Gorge National River.

COMMON NAME (PARK-SPECIFIC): TWISTED SEDGE ROCKY CREEKBED

SYNONYMS
NVC English Name: **Twisted Sedge Herbaceous Vegetation**
NVC Scientific Name: ***Carex torta* Herbaceous Vegetation**
NVC Identifier: **CEGL004103**

LOCAL INFORMATION

Environmental Description: This association occurs in small patches within the channel shelves of large, high-gradient tributaries of the New River. These positions are subject to frequent high-energy floods which can occur at any time of year. The rooting zone of the nominal species *Carex torta* is typically semipermanently saturated and temporarily flooded. Substrates consist of boulders, cobbles, gravel, and sand. The community is usually partially shaded by overhanging trees. Elevations of sampled plots range from 398 to 541 m. This community is most abundant on tributaries which support stands of *Betula alleghaniensis - (Tsuga canadensis) / Rhododendron maximum / Leucothoe fontanesiana* Forest (CEGL007861) along their banks.

Vegetation Description: This association represents herbaceous vegetation strongly dominated by *Carex torta*. It is usually partially shaded by overhanging trees. The three plots in the park were placed to sample a broader community than the more strictly herbaceous type concept of the global description and thus include a mixture of woody and herbaceous species, including both upland and wetland indicators. However, wetland and flood-adapted species are emphasized in this description. The most abundant canopy tree species in plots are *Betula alleghaniensis* and *Platanus occidentalis*. Shrubs which occur on the edges of the community include *Alnus serrulata, Cornus amomum, Rhododendron arborescens*, and *Rhododendron maximum*. Cover by *Carex torta* in the plots ranges from 5 to 10% consisting of dense monospecific patches. Additional characteristic herbs which occur in lesser amounts include *Eupatorium fistulosum, Helenium autumnale, Houstonia caerulea, Hypericum mutilum, Lobelia cardinalis, Prunella vulgaris, Solidago canadensis, Symphyotrichum prenanthoides, Trautvetteria caroliniensis*, and *Viola cucullata*. Vascular plant species richness in the 3 sampled plots ranges from 32 to 48 (mean = 38.3). The moss *Climacium americanum* has 10% cover in one plot.

Most Abundant Species:

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Carex torta* (twisted sedge)

Characteristic Species: *Alnus serrulata, Betula alleghaniensis, Climacium americanum, Cornus amomum, Eupatorium fistulosum, Helenium autumnale, Houstonia caerulea, Hypericum mutilum, Lobelia cardinalis, Platanus occidentalis, Prunella vulgaris, Rhododendron arborescens, Rhododendron maximum, Solidago canadensis, Symphyotrichum prenanthoides, Trautvetteria caroliniensis, Viola cucullata.*

Other Noteworthy Species: Information not available.

Subnational Distribution with Crosswalk Data:

State	State Rank	Confidence	State Name	Reference
WV	SNR	1		Byers et al. 2007

Local Range: This association was sampled along Glade Creek and Mann's Creek but may also occur in small patches along other large tributaries in the park.

Classification Comments: The three plots in the park were placed to sample a broader community than the strictly herbaceous type concept of the global description and thus include a mixture of woody and herbaceous species, including both upland and wetland indicators.
Other Comments: Information not available.
Local Description Authors: J. P. Vanderhorst.
Plots: NERI.38, NERI.311, NERI.313.
New River Gorge National River Inventory Notes: Information not available.

GLOBAL INFORMATION

NVC CLASSIFICATION

Physiognomic Class	Herbaceous Vegetation (V)
Physiognomic Subclass	Perennial graminoid vegetation (V.A.)
Physiognomic Group	Temperate or subpolar grassland (V.A.5.)
Physiognomic Subgroup	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N.)
Formation	Temporarily flooded temperate or subpolar grassland (V.A.5.N.j.)
Alliance	*Carex torta* Temporarily Flooded Herbaceous Alliance (A.1340)
Alliance (English name)	Twisted Sedge Temporarily Flooded Herbaceous Alliance
Association	*Carex torta* Herbaceous Vegetation
Association (English name)	Twisted Sedge Herbaceous Vegetation
Ecological System(s):	Central Appalachian Riparian (CES202.609). Cumberland Riverscour (CES202.036). Central Appalachian Floodplain (CES202.608). South-Central Interior Large Floodplain (CES202.705). South-Central Interior Small Stream and Riparian (CES202.706).

GLOBAL DESCRIPTION

Concept Summary: This association accommodates herbaceous alluvial wetlands in which *Carex torta* is a dominant or characteristic species. It occupies sand, gravel, and rock bars along small rivers and streams in valleys and gorges in the Southern Appalachians, ranging west into the Cumberland Plateau and the Interior Low Plateau, and north into the Central Appalachians, Allegheny Mountains, and Piedmont. This association is characterized by light-requiring, tough-rooted herbaceous perennials tolerant of frequent inundation and flood-scouring. *Carex torta* often forms dense, extensive colonies. Associated species vary with geography but can include *Polygonum sagittatum, Dichanthelium clandestinum, Solidago rugosa ssp. aspera, Juncus effusus, Equisetum arvense, Onoclea sensibilis, Vernonia noveboracensis, Lycopus virginicus, Lobelia cardinalis, Symphyotrichum dumosum (= Aster dumosus), Lycopus virginicus, Osmunda regalis, Hypericum mutilum, Eupatorium fistulosum, Solidago patula, Boehmeria cylindrica, Amphicarpaea bracteata, Acalypha rhomboidea, Hypericum mutilum, Impatiens capensis, Leersia oryzoides*, and *Symphyotrichum lateriflorum (= Aster lateriflorus)*. Physiognomy of this type varies from strictly herbaceous to wooded herbaceous to shrubby. Scattered shrubs and small, battered specimens of *Platanus occidentalis, Betula nigra, Cornus amomum, Alnus serrulata*, and *Carpinus caroliniana* are present in some stands. An overhanging canopy may include *Platanus occidentalis, Betula alleghaniensis var. alleghaniensis*, or *Acer rubrum*. Overhanging shrubs often include *Rhododendron maximum*. Stands in disturbed landscapes may

be heavily invaded by *Microstegium vimineum, Polygonum caespitosum var. longisetum*, and other weedy exotics.

Environmental Description: This association occupies boulder and gravel bars on the frequently flooded, active channel shelves of high-gradient streams and small rivers, often forming small, discontinuous, linear patches. It is subject to frequent, high-energy inundation and flood-scouring, which can occur at any time of year. Flooding duration is probably similar to that documented along Passage Creek in Shenandoah County, Virginia, by Hupp (1982). In that drainage, the channel shelf was inundated approximately 15% of the time. Elevations in West Virginia range from 390–1200 m. Soils are moderately to poorly drained sand with pH averaging 6.5 (n=5). Organic soils are not present. Soil chemistry is characterized by high Cu, Mn; moderate B, Ca, Mg; and low Al, ENR, Fe, H, K, Na, P, S, TEC, Zn, and organic matter (n=3).

Vegetation Description: Vegetation is characterized by light-demanding, tough-rooted herbaceous perennials tolerant of frequent inundation and flood-scouring. *Carex torta* is usually the dominant species and typically forms dense, extensive colonies. Associated species vary with geography. *Polygonum sagittatum, Solidago rugosa*, and *Dichanthelium clandestinum* are typical; others include *Acalypha rhomboidea, Amphicarpaea bracteata, Boehmeria cylindrica, Equisetum arvense, Eupatorium fistulosum, Euthamia graminifolia var. graminifolia, Juncus effusus, Hypericum mutilum, Hypericum perforatum, Impatiens capensis, Leersia oryzoides, Lobelia cardinalis, Lycopus virginicus, Onoclea sensibilis, Osmunda regalis, Prunella vulgaris, Solidago patula, Symphyotrichum dumosum (= Aster dumosus), Symphyotrichum lateriflorum (= Aster lateriflorus), Symphyotrichum prenanthoides, Thalictrum* spp., *Trautvetteria caroliniensis var. caroliniensis, Verbesina alternifolia*, and *Vernonia noveboracensis*. Cover by nonvascular plants is insignificant. Physiognomy of this type varies from strictly herbaceous to wooded herbaceous to shrubby. Scattered shrubs and small, battered specimens of *Platanus occidentalis, Betula nigra, Cornus amomum, Alnus serrulata*, and *Carpinus caroliniana* are present in some stands. An overhanging canopy with an average cover of 20% may include *Platanus occidentalis, Betula alleghaniensis var. alleghaniensis*, or *Acer rubrum*. Sparse overhanging shrubs often include *Rhododendron maximum*. Stands in disturbed landscapes may be heavily invaded by *Microstegium vimineum, Polygonum caespitosum var. longisetum*, and other weedy exotics. Mean species richness of vascular plants in six West Virginia plots was 36 taxa per 400 square meters, with most of the diversity in the herbaceous stratum.

Most Abundant Species:

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Carex torta* (twisted sedge)

Characteristic Species: *Carex torta, Polygonum sagittatum, Solidago rugosa.*

Other Noteworthy Species: Information not available.

USFWS Wetland System: Palustrine.

DISTRIBUTION

Range: This community is found as small-patch linear occurrences along waterways in the Southern Appalachians, west into the Cumberland Plateau and the Interior Low Plateau, and north into the Central Appalachians, Allegheny Mountains, and Piedmont.

States/Provinces: AL, DE:S1?, GA, KY, MD, NC, PA, SC, TN, VA:S2?, WV.

Federal Lands: NPS (Blue Ridge Parkway?, C&O Canal, Catoctin Mountain, Great Smoky Mountains, New River Gorge, Prince William); USFS (Bankhead, Chattahoochee, Chattahoochee (Piedmont), Chattahoochee (Southern Blue Ridge), Cherokee, Daniel Boone,

George Washington, Jefferson, Monongahela, Nantahala, Pisgah, Sumter, Sumter (Mountains), Sumter (Piedmont)).

CONSERVATION STATUS

Rank: G3G4 (21-Jan-2000).
Reasons: This community is found as small-patch linear occurrences along waterways in the Southern Appalachians, west into the Cumberland Plateau and the Interior Low Plateau, and north into the Central Appalachians, Allegheny Mountains, and Piedmont. Although this community has a moderately large geographic range, it is uncommon within its range and occurrences are small. This community is more common than the number of documented occurrences would suggest, since it is often overlooked in inventories.

CLASSIFICATION INFORMATION

Status: Standard.
Confidence: 2 - Moderate.
Comments: Information not available.
Similar Associations:

- *Carex torta* - *Apocynum cannabinum* - *Cyperus* spp. Herbaceous Vegetation (CEGL006536).

Related Concepts:

- *Carex torta* Association (Fleming and Moorhead 1996) ?
- *Carex torta* Herbaceous Vegetation (Fleming and Coulling 2001) ?
- *Carex torta* riparian herbaceous vegetation (Vanderhorst 2001b) =
- *Carex torta* riverscour prairie (Byers et al. 2007) =
- IIE3a. Riverside Shoal and Stream Bar Complex (Allard 1990) B
- Riverine Upper and Lower Perennial Beach/Bar, Cobble/Gravel, Seasonally Flooded (R2and3BB1C) (Cowardin et al. 1979) ?
- Riverine Upper and Lower Perennial Beach/Bar, Sand, Seasonally Flooded (R2and3BB2C) (Cowardin et al. 1979) ?
- Rocky Bar and Shore (Twisted Sedge Subtype) (Schafale 1998b) ?
- Sedge - spotted joe pye weed riverine herbaceous vegetation (Perles et al. 2004) =
- Torturous sedge gravel rivershore (CAP pers. comm. 1998) ?

SOURCES

Description Authors: G. Fleming and P. Coulling, mod. G. Fleming and S. C. Gawler.
References: Allard 1990, Bowman 2000, Byers et al. 2007, CAP pers. comm. 1998, Cowardin et al. 1979, Eyre 1980, Fleming and Coulling 2001, Fleming and Moorhead 1996, Fleming et al. 2001, Fleming et al. 2004, Hupp 1982, NatureServe Ecology - Southeastern U.S. unpubl. data, Palmer-Ball et al. 1988, Peet et al. unpubl. data 2002, Perles et al. 2004, Schafale 1998b, Schafale 2002, Schafale and Weakley 1990, Schafale pers. comm., Schotz pers. comm., Southeastern Ecology Working Group n.d., TDNH unpubl. data, Vanderhorst 2001b, Vanderhorst 2007.

No photo available.

COMMON NAME (PARK-SPECIFIC): BLACK WILLOW SLACKWATER WOODLAND

SYNONYMS

NVC English Name:	**Black Willow - River Birch / Common Threesquare Wooded Herbaceous Vegetation**
NVC Scientific Name:	***Salix nigra - Betula nigra / Schoenoplectus pungens* Wooded Herbaceous Vegetation [Provisional]**
NVC Identifier:	**CEGL006463**

LOCAL INFORMATION

Environmental Description: This association occurs along the shores of the New River, usually in positions with slack water (the "eddy zone") just downstream from rapids. These are frequently flooded positions within the active channel shelf which receive sediments of relatively fine-textured alluvium. Substrates often exhibit definite layering of sand and silt laid down by successive flood events. Ground cover by rocks is usually low and by flotsam is often high. Substrates are usually saturated, with water inputs from flooding and from upslope seepage, and most occurrences would qualify as jurisdictional wetlands. Additional hydric soil indicators observed in plots include low chroma horizons, diffuse mottle, and odor of hydrogen sulfide. Soil pH measured in the field from plots ranges from 6.5 to 7. Soil chemistry analyzed from one plot indicates pH of 6.2, relatively low levels of Al and K, and relatively high levels of Ca, Fe, Mg, Mn, P, Su, and Zn. Slopes range from gentle to moderate (mapping unit values range from 3 to 21 degrees, mean = 10 degrees). Elevations of mapped stands range from 305 to 346 m. Adjacent associations commonly include *Platanus occidentalis - (Betula nigra, Salix* spp.) Temporarily Flooded Woodland (CEGL003725), which occurs along higher energy reaches of river, and *Platanus occidentalis - Fraxinus pennsylvanica / Carpinus caroliniana / Verbesina alternifolia* Forest (CEGL006458), which occurs on floodplains above the channel bank.
Vegetation Description: This association represents woodland or wooded herbaceous vegetation which occurs on wet beaches along the New River downstream from rapids. The three plots were placed to sample herbaceous physiognomy, but further observations made during river floats suggest that the tree species *Salix nigra* has high indicator value for this community and that it is better recognized as a woodland. Additional tree species in plots include *Betula nigra* and *Platanus occidentalis*. Trees are often rooted on the uphill side of stands, are flood-battered or toppled, and overhang or extend horizontally into the community. Cover in the shrub layers is also dominated by *Salix nigra*. The shrub *Cephalanthus occidentalis*, a wetland indicator, may also occur in this community. Herb cover in plots ranges from 10 to 40%, with a large component of wetland indicator species. *Schoenoplectus pungens* is the dominant herb (5–40% cover) and constant in plots; this species, along with *Betula nigra*, has high indicator value for this association, but it may be absent in some stands. Additional herbs with highest constancy in plots include *Chasmanthium latifolium, Conoclinium coelestinum, Dichanthelium clandestinum, Eleocharis* spp., *Equisetum arvense, Eragrostis hypnoides, Justicia americana, Leersia virginica, Panicum rigidulum, Polygonum caespitosum var. longisetum*, and *Saururus cernuus*. Additional characteristic herbs include *Bidens frondosa, Cyperus odoratus, Eleocharis obtusa, Eragrostis pilosa, Hibiscus laevis, Lindernia dubia, Ludwigia palustris, Panicum dichotomiflorum*, and *Vernonia noveboracensis*. Vascular plant species richness in the 3 sampled plots ranges from 14 to 28 (mean = 23).

Most Abundant Species:

Stratum	Lifeform	Species
Tree (canopy & subcanopy)	Broad-leaved deciduous tree	*Salix nigra* (black willow)
Shrub/sapling (tall & short)	Broad-leaved deciduous tree	*Salix nigra* (black willow)
Herb (field)	Graminoid	*Schoenoplectus pungens* (common threesquare)

Characteristic Species: *Bidens frondosa, Cephalanthus occidentalis, Chasmanthium latifolium, Cyperus odoratus, Dichanthelium clandestinum, Eleocharis obtusa, Equisetum arvense, Eragrostis hypnoides, Eragrostis pilosa, Eupatorium coelestinum, Justicia americana, Leersia virginica, Lindernia dubia, Ludwigia palustris, Panicum dichotomiflorum, Panicum rigidulum, Polygonum caespitosum* var. *longisetum, Salix nigra, Saururus cernuus, Vernonia noveboracensis.*

Other Noteworthy Species: Information not available.

Subnational Distribution with Crosswalk Data:

State	State Rank	Confidence	State Name	Reference
WV	SNR	1		WVNHP unpubl. data b

Local Range: This association occurs in small patches along the New River. Mapped stands are located in the middle section of the park from the vicinity of the town of Meadow Creek downstream to Sewell, but small patches may occur upstream and downstream beyond this range.

Classification Comments: The nominal species *Schoenoplectus pungens* was previously included in the genus *Scirpus*, and, due to taxonomic confusion, plants of this species in West Virginia were misidentified as *Scirpus americanus* (now *Schoenoplectus americanus*), a species which is now known to be restricted to the Coastal Plain. In a previous report (Vanderhorst 2001b), this association was described as an herbaceous type, the *Scirpus americanus (Scirpus tabernaemontani)* riparian herbaceous wetland. Although *Scirpus tabernaemontani* was included in the name for this community, its occurrence in this type has not been documented. The three plots were placed to sample herbaceous physiognomy, but further observations made during river floats suggest that the tree species *Salix nigra* has high indicator value for this community and that it is better recognized as a woodland. These observations also support the recognition of this association because its occurrences are easily distinguished on the ground and are repeated on the landscape in a pattern which reflects environmental gradients.

Other Comments: Information not available.

Local Description Authors: J. P. Vanderhorst.

Plots: NERI.226, NERI.227, NERI.306.

New River Gorge National River Inventory Notes: Additional plots are needed to improve the classification confidence of this association. Plot sampling should emphasize the whole woodland community, rather than focusing on stands of *Schoenoplectus pungens*.

GLOBAL INFORMATION

NVC CLASSIFICATION

Physiognomic Class	Herbaceous Vegetation (V)
Physiognomic Subclass	Perennial graminoid vegetation (V.A.)
Physiognomic Group	Temperate or subpolar grassland with a sparse tree layer (V.A.6.)
Physiognomic Subgroup	Natural/Semi-natural temperate or subpolar grassland with a sparse tree layer (V.A.6.N.)
Formation	Semipermanently flooded temperate or subpolar grassland with a sparse cold-deciduous tree layer (V.A.6.N.n.)
Alliance	*Schoenoplectus pungens* Semipermanently Flooded Wooded Herbaceous Alliance (A.3034)
Alliance (English name)	Common Threesquare Semipermanently Flooded Wooded Herbaceous Alliance
Association	*Salix nigra - Betula nigra / Schoenoplectus pungens* Wooded Herbaceous Vegetation [Provisional]
Association (English name)	Black Willow - River Birch / Common Threesquare Wooded Herbaceous Vegetation
Ecological System(s):	Central Appalachian Floodplain (CES202.608).

GLOBAL DESCRIPTION

Concept Summary: This association represents woodland or wooded herbaceous vegetation which occurs on wet beaches along the New River downstream from rapids (the "eddy zone"). These are frequently flooded positions within the active channel shelf which receive sediments of relatively fine-textured alluvium. Substrates often exhibit definite layering of sand and silt laid down by successive flood events. Ground cover by flotsam is often high. Substrates are usually saturated, with water inputs from flooding and from upslope seepage. The dominant tree is *Salix nigra*, often rooted on the uphill side of stands; individuals are flood-battered or toppled, and overhang or extend horizontally into the community. *Betula nigra* is common as a small tree or shrub. The shrub layer is also dominated by *Salix nigra*, sometimes with *Cephalanthus occidentalis*. Herb cover in plots ranges from 10 to 40%, with a large component of wetland indicator species. *Schoenoplectus pungens* is the dominant herb (5–40% cover and high constancy). Additional herbs with high constancy in plots include *Chasmanthium latifolium, Conoclinium coelestinum, Dichanthelium clandestinum, Eleocharis* spp., *Equisetum arvense, Eragrostis hypnoides, Justicia americana, Leersia virginica, Panicum rigidulum, Polygonum caespitosum var. longisetum*, and *Saururus cernuus*. Additional characteristic herbs include *Bidens frondosa, Cyperus odoratus, Eleocharis obtusa, Eragrostis pilosa, Hibiscus laevis, Lindernia dubia, Ludwigia palustris, Panicum dichotomiflorum*, and *Vernonia noveboracensis*.

Environmental Description: This association is documented from the shores of the New River, usually in positions with slack water (the "eddy zone") just downstream from rapids. These are frequently flooded positions within the active channel shelf which receive sediments of relatively fine-textured alluvium. Substrates often exhibit definite layering of sand and silt laid down by successive flood events. Ground cover by rocks is usually low and ground cover by flotsam is often high. Substrates are usually saturated, with water inputs from flooding and from upslope seepage, and most occurrences would qualify as jurisdictional wetlands. Additional hydric soil indicators observed in plots include low chroma horizons, diffuse mottle, and odor of hydrogen sulfide. Soil pH measured in the field from plots ranges from 6.5 to 7. Soil chemistry analyzed

from one plot indicates pH of 6.2, relatively low levels of Al and K, and relatively high levels of Ca, Fe, Mg, Mn, P, Su, and Zn. Slopes range from gentle to moderate. Elevations of mapped stands range from 305 to 346 m.

Vegetation Description: This association represents woodland or wooded herbaceous vegetation which occurs on wet beaches along the New River downstream from rapids. The three plots were placed to sample herbaceous physiognomy, but further observations suggest that the tree species *Salix nigra* has high indicator value for this community and that it is better recognized as a woodland. Additional tree species in plots include *Betula nigra* and *Platanus occidentalis*. Trees are often rooted on the uphill side of stands, are flood-battered or toppled, and overhang or extend horizontally into the community. Cover in the shrub layers is also dominated by *Salix nigra*. The shrub *Cephalanthus occidentalis*, a wetland indicator, may also occur in this community. Herb cover in plots ranges from 10 to 40%, with a large component of wetland indicator species. *Schoenoplectus pungens* is the dominant herb (5–40% cover) and constant in plots, and this species, along with *Betula nigra*, has high indicator value for this association, but it may be absent in some stands. Additional herbs with highest constancy in plots include *Chasmanthium latifolium, Conoclinium coelestinum, Dichanthelium clandestinum, Eleocharis* spp., *Equisetum arvense, Eragrostis hypnoides, Justicia americana, Leersia virginica, Panicum rigidulum, Polygonum caespitosum var. longisetum*, and *Saururus cernuus*. Additional characteristic herbs include *Bidens frondosa, Cyperus odoratus, Eleocharis obtusa, Eragrostis pilosa, Hibiscus laevis, Lindernia dubia, Ludwigia palustris, Panicum dichotomiflorum*, and *Vernonia noveboracensis*. Vascular plant species richness in the 3 sampled plots ranges from 14 to 28 (mean = 23).

Most Abundant Species:

Stratum	Lifeform	Species
Tree (canopy & subcanopy)	Broad-leaved deciduous tree	*Salix nigra* (black willow)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Salix nigra* (black willow)
Herb (field)	Graminoid	*Schoenoplectus pungens* (common threesquare)

Characteristic Species: *Bidens frondosa, Cephalanthus occidentalis, Chasmanthium latifolium, Cyperus odoratus, Dichanthelium clandestinum, Eleocharis obtusa, Equisetum arvense, Eragrostis hypnoides, Eragrostis pilosa, Eupatorium coelestinum, Justicia americana, Leersia virginica, Lindernia dubia, Ludwigia palustris, Panicum dichotomiflorum, Panicum rigidulum, Polygonum caespitosum* var. *longisetum, Salix nigra, Saururus cernuus, Vernonia noveboracensis.*

Other Noteworthy Species: Information not available.

USFWS Wetland System: Not applicable.

DISTRIBUTION

Range: This association is currently known from the New River in West Virginia, with wider distribution in the Central Appalachians, Cumberland, and Western Allegheny Plateau ecoregions possible.

States/Provinces: WV.

Federal Lands: NPS (New River Gorge).

CONSERVATION STATUS

Rank: GNR (5-Jun-2006).

Reasons: Information not available.

CLASSIFICATION INFORMATION
Status: Provisional.
Confidence: 3 - Weak.
Comments: The nominal species *Schoenoplectus pungens* was previously included in the genus *Scirpus*. This association was described by Vanderhorst (2001b) as an herbaceous type, *Scirpus americanus (Scirpus tabernaemontani)* riparian herbaceous wetland. Although *Scirpus tabernaemontani* was originally included in the name for this community, its occurrence in this type has not been documented. The three plots on which this description is based were placed to sample herbaceous physiognomy, but further observations suggest that the tree species *Salix nigra* has high indicator value for this community and that it is better recognized as a woodland. These observations also support the recognition of this association because its occurrences are easily distinguished on the ground and are repeated on the landscape in a pattern which reflects environmental gradients.
Similar Associations:
- *Platanus occidentalis* - (*Betula nigra*, *Salix* spp.) Temporarily Flooded Woodland (CEGL003725)

Related Concepts: Information not available.

SOURCES
Description Authors: S. C. Gawler and J. Vanderhorst.
References: Eastern Ecology Working Group n.d., Vanderhorst 2001b, Vanderhorst 2007.

Figure B6. An example of Black Willow Slackwater Woodland from the New River Gorge National River.

COMMON NAME (PARK-SPECIFIC): RIVERBANK TALL HERBS

SYNONYMS

NVC English Name: **Wingstem - American Germander - Riverbank Wild Rye - (Giant Goldenrod) Herbaceous Vegetation**

NVC Scientific Name: ***Verbesina alternifolia - Teucrium canadense - Elymus riparius - (Solidago gigantea)*** **Herbaceous Vegetation**

NVC Identifier: **CEGL006480**

LOCAL INFORMATION

Environmental Description: This association occurs in small patches on sandy floodplains and banks along the shores of the New River. Patches typically occur along slow, straight reaches of river with high banks, often on eroded alluvial fans at the mouths of small drainages. Soils are deep alluvial sands with little horizon development. In one plot, pH measured in the field was 6.5. Elevations of mapped stands range from 292 to 318 m. Slopes are flat to gentle. Occurrences may be partially shaded but generally have high solar exposure. Trees along the river edge of this community often lean out over the river due to undercutting of the bank which creates a sunny corridor back from the river's edge. Adjacent forested communities include *Platanus occidentalis - Fraxinus pennsylvanica / Carpinus caroliniana / Verbesina alternifolia* Forest (CEGL006458) and *Acer saccharinum - Ulmus americana* Forest (CEGL002586).

Vegetation Description: This association represents herbaceous vegetation or wooded herbaceous vegetation dominated by tall herbs which occurs on sandy banks of the New River. Tree cover in the two plots range from 10 to 30%. Tree species in the plots include *Acer saccharinum, Betula nigra, Fraxinus pennsylvanica, Platanus occidentalis,* and *Robinia pseudoacacia*. Cover in the tall-shrub layer of plots averages about 20% dominated by *Lindera benzoin*. There is a lush tall-herb layer with average cover of 90% in plots. Herbs with high constancy and/or cover include *Chasmanthium latifolium, Conoclinium coelestinum, Dichanthelium clandestinum, Elymus canadensis, Elymus virginicus, Eupatorium fistulosum, Eupatorium serotinum, Glechoma hederacea, Helianthus strumosus, Heliopsis helianthoides, Leersia virginica, Microstegium vimineum, Packera aurea, Phlox paniculata, Polygonum scandens, Polygonum virginianum, Senna hebecarpa, Solanum carolinense, Solidago canadensis, Solidago gigantea, Symphyotrichum lanceolatum, Symphyotrichum lateriflorum, Tripsacum dactyloides, Verbena urticifolia, Verbesina alternifolia,* and *Vernonia noveboracensis*. Vascular plant species richness in the 2 sampled plots ranges from 40 to 43 (mean = 41.5).

Most Abundant Species: Information not available.

Characteristic Species: *Chasmanthium latifolium, Dichanthelium clandestinum, Elymus canadensis, Elymus virginicus, Eupatorium coelestinum, Eupatorium fistulosum, Eupatorium serotinum, Glechoma hederacea, Helianthus strumosus, Heliopsis helianthoides, Leersia virginica, Lindera benzoin, Microstegium vimineum, Packera aurea, Phlox paniculata, Polygonum scandens, Polygonum virginianum, Senna hebecarpa, Solanum carolinense, Solidago canadensis, Solidago gigantea, Symphyotrichum lanceolatum, Symphyotrichum lateriflorum, Tripsacum dactyloides, Verbena urticifolia, Verbesina alternifolia, Vernonia noveboracensis.*

Other Noteworthy Species: Information not available.

Subnational Distribution with Crosswalk Data:

State	State Rank	Confidence	State Name	Reference
WV	SNR	1		Vanderhorst 2007

Local Range: This association was sampled and observed along the New River in the northern section of the park between Thurmond and Mann's Creek, but additional small patches are likely to occur throughout the length of the river in the park.
Classification Comments: This association shares many herbaceous species with the adjacent floodplain forest types *Platanus occidentalis - Fraxinus pennsylvanica / Carpinus caroliniana / Verbesina alternifolia* Forest (CEGL006458) and *Acer saccharinum - Ulmus americana* Forest (CEGL002586), but it is distinguished by an open canopy which promotes rank growth of herbs adapted to full sunlight. Recognition of individual occurrences may depend on the size of the sampled patch.
Other Comments: Information not available.
Local Description Authors: J. P. Vanderhorst.
Plots: NERI.230, NERI.325.
New River Gorge National River Inventory Notes: Information not available.

GLOBAL INFORMATION

NVC CLASSIFICATION

Physiognomic Class	Herbaceous Vegetation (V)
Physiognomic Subclass	Perennial forb vegetation (V.B.)
Physiognomic Group	Temperate or subpolar perennial forb vegetation (V.B.2.)
Physiognomic Subgroup	Natural/Semi-natural temperate or subpolar perennial forb vegetation (V.B.2.N.)
Formation	Temporarily flooded temperate perennial forb vegetation (V.B.2.N.d.)
Alliance	*Eupatorium serotinum - Diodia virginiana* Temporarily Flooded Herbaceous Alliance (A.2017)
Alliance (English name)	Late Thoroughwort - Virginia Buttonweed Temporarily Flooded Herbaceous Alliance
Association	*Verbesina alternifolia - Teucrium canadense - Elymus riparius - (Solidago gigantea)* Herbaceous Vegetation
Association (English name)	Wingstem - American Germander - Riverbank Wild Rye - (Giant Goldenrod) Herbaceous Vegetation
Ecological System(s):	Central Appalachian Riparian (CES202.609). Central Appalachian Floodplain (CES202.608).

GLOBAL DESCRIPTION

Concept Summary: This tall herb-dominated association is known from the shores of rivers and large streams in the Piedmont and mountain regions of Maryland, Virginia, and West Virginia. It occupies well-drained riverbanks and, less commonly, depositional bars or alluvial fans of medium-sized to large rivers that experience low rates of sediment erosion and turnover during small to moderate floods. The type typically occurs as a narrow, linear strip along the outer edge of a floodplain forest. Occurrences may be partially shaded but generally have high solar exposure. Vegetation is characterized by a dense growth of tall (1–3 m), light-demanding, native perennial herbs. The most characteristic species across the range are *Chasmanthium latifolium, Dichanthelium clandestinum, Verbesina alternifolia, Elymus* spp. (*Elymus riparius,*

Elymus villosus, Elymus virginicus), *Conoclinium coelestinum (= Eupatorium coelestinum)*, several species of *Eupatorium* (*Eupatorium fistulosum, Eupatorium perfoliatum, Eupatorium serotinum*), *Solidago gigantea*, and *Verbena urticifolia*. Along the Potomac in the Great Valley of Virginia downstream to the fall line, *Teucrium canadense* and *Scrophularia marilandica* are also abundant; less abundant species include *Ageratina altissima, Helianthus decapetalus, Oenothera biennis, Phytolacca americana, Monarda fistulosa*, and *Rudbeckia laciniata*. Along the New River in West Virginia, additional characteristic species include *Conoclinium coelestinum, Helianthus strumosus, Heliopsis helianthoides, Leersia virginica, Packera aurea, Phlox paniculata, Polygonum scandens, Polygonum virginianum, Senna hebecarpa, Solanum carolinense, Solidago canadensis, Symphyotrichum lanceolatum, Symphyotrichum lateriflorum, Tripsacum dactyloides*, and *Vernonia noveboracensis*. Tall annual species characteristically dominant on less stabilized bars may be present but generally do not dominate. Vines are often common and include *Toxicodendron radicans, Vitis riparia*, and *Calystegia sepium*. Scattered shrubby or occasionally full-sized trees of flood-tolerant species may occur, with *Acer saccharinum, Platanus occidentalis, Fraxinus pennsylvanica, Betula nigra*, and *Acer negundo* the most frequent. *Lindera benzoin* may be present as a shrub. This type often has a number of invasive exotic weeds, including *Polygonum cuspidatum, Polygonum perfoliatum, Lolium arundinaceum (= Festuca arundinacea), Phalaris arundinacea, Humulus japonicus, Glechoma hederacea, Microstegium vimineum*, and *Stellaria media*.

Environmental Description: This community occupies well-drained riverbanks and, less commonly, depositional bars of medium-sized to large rivers that experience low rates of sediment erosion and turnover during small to moderate floods. The type typically occurs as a narrow, linear strip along the outer edge of a floodplain forest. Along the Potomac River in the Potomac River Gorge west of Washington, DC, habitats are inundated for 1–4% of the full year and are generally exposed for nearly all of the growing season in most years (Lea 2000). Hydrologic regime is best described as temporarily flooded. Substrates in Potomac River Gorge are sandy loams or loamy sands (Lea 2000). Samples collected from 10 plots in the Potomac drainage had 100% total base saturation, high pH, and very high calcium levels. Along the New River, West Virginia, patches typically occur along slow, straight reaches of river with high banks, often on eroded alluvial fans at the mouths of small drainages. Soils are deep alluvial sands with little horizon development. In one plot, pH measured in the field was 6.5. Elevations range from near sea level on the Potomac River to 320 m on the New River.

Vegetation Description: This association represents vegetation consisting of a dense growth (90% cover) of tall (1–3 m), light-demanding, native perennial herbs. Along the Potomac River in the Great Valley of Virginia downstream to the fall line, the most abundant species are *Verbesina alternifolia, Teucrium canadense, Elymus riparius, Verbena urticifolia, Conoclinium coelestinum (= Eupatorium coelestinum)*, several species of *Eupatorium (Eupatorium fistulosum, Eupatorium perfoliatum, Eupatorium serotinum*), *Dichanthelium clandestinum, Scrophularia marilandica*, and *Chasmanthium latifolium*. Less abundant species include *Ageratina altissima, Elymus villosus, Elymus virginicus, Helianthus decapetalus, Oenothera biennis, Phytolacca americana, Monarda fistulosa, Rudbeckia laciniata*, and *Solidago gigantea*. *Hasteola suaveolens, Sida hermaphrodita, Iresine rhizomatosa, Rumex altissimus*, and *Ruellia strepens* are Maryland rare species known from this type. Tall annual species characteristically dominant on less stabilized bars may be present but generally do not dominate. Vines are often common and include *Toxicodendron radicans, Vitis riparia*, and *Calystegia sepium*. Scattered shrubby or occasionally full-sized trees of flood-tolerant species may occur, with *Acer saccharinum*,

Platanus occidentalis, Betula nigra, Fraxinus pennsylvanica, and *Acer negundo* the most frequent. On the Potomac River above the Great Valley, on the Monocacy River, and on smaller streams outside the Great Valley, several of the more characteristic species for the Shenandoah River, Antietam Creek, and the rest of the Potomac are apparently rare or absent, particularly *Rudbeckia laciniata* and *Solidago gigantea*. These differences may reflect the influence of more calcareous substrates and/or stream order on the communities. Along the New River, herbs with high constancy and/or cover include *Chasmanthium latifolium, Conoclinium coelestinum, Dichanthelium clandestinum, Elymus canadensis, Elymus virginicus, Eupatorium fistulosum, Eupatorium serotinum, Helianthus strumosus, Heliopsis helianthoides, Leersia virginica, Packera aurea, Phlox paniculata, Polygonum scandens, Polygonum virginianum, Senna hebecarpa, Solanum carolinense, Solidago canadensis, Solidago gigantea, Symphyotrichum lanceolatum, Symphyotrichum lateriflorum, Tripsacum dactyloides, Verbena urticifolia, Verbesina alternifolia*, and *Vernonia noveboracensis*. This type often has a number of invasive exotic weeds, including *Polygonum cuspidatum, Polygonum perfoliatum, Lolium arundinaceum (= Festuca arundinacea), Phalaris arundinacea, Humulus japonicus, Glechoma hederacea, Microstegium vimineum*, and *Stellaria media*. During years of more continuous high water during the growing season, vegetation may be sparse.

Most Abundant Species:

Stratum	Lifeform	Species
Herb (field)	Forb	*Verbesina alternifolia* (wingstem)
Herb (field)	Graminoid	*Chasmanthium latifolium* (Indian woodoats)
		Dichanthelium clandestinum (deertongue)

Characteristic Species: *Chasmanthium latifolium, Dichanthelium clandestinum, Elymus canadensis, Elymus riparius, Elymus virginicus, Eupatorium fistulosum, Eupatorium serotinum, Helianthus strumosus, Heliopsis helianthoides, Leersia virginica, Packera aurea, Polygonum virginianum, Rudbeckia laciniata, Scrophularia marilandica, Solanum carolinense, Solidago canadensis, Solidago gigantea, Verbena urticifolia, Verbesina alternifolia, Vernonia noveboracensis.*

Other Noteworthy Species: *Hasteola suaveolens, Iresine rhizomatosa, Ruellia strepens, Rumex altissimus, Sida hermaphrodita.*

USFWS Wetland System: Not applicable.

DISTRIBUTION

Range: This community type is known from the shores of rivers and large streams in the Piedmont and mountain regions of Maryland, Virginia, and West Virginia. It has been documented by plots or observed on the Potomac, Shenandoah, New, and Monocacy rivers and Antietam Creek (Maryland). Small-stream analogues or variants have been observed on Fifteen Mile Creek (Maryland) and on the South Fork of Quantico Creek (Virginia). Potential habitat for this association is widespread, and the type is likely to have a much wider geographic range than current documentation indicates.

States/Provinces: DC, MD, VA, WV.

Federal Lands: NPS (Antietam, C&O Canal, Harpers Ferry, New River Gorge, Prince William).

CONSERVATION STATUS

Rank: GNR (2-Aug-2006).

Reasons: More data on the global distribution are needed to determine a conservation rank for this community.

CLASSIFICATION INFORMATION

Status: Standard.
Confidence: 3 - Weak.
Comments: The classification of this type was based, in part, on analysis of data from 10 plots collected during the National Capital Region Parks project, with additional data from the New River Gorge in West Virginia. Although some plots of this type performed convincingly as a discrete group in the National Capital Region analysis, others could not be separated from a group representing the Central Appalachian silver maple floodplain forest, with which this type frequently co-occurs. These results suggest that this type is weakly distinct floristically, sharing many species with the silver maple forest and varying from it along a gradual cline of (presumed) light exposure and increased stress from flooding near the channel. Because the type also tends to occur in small patches, it might, therefore, be considered as an ecotonal expression of the silver maple forest. However, the distinctiveness of its physiognomy and habitat (open canopy which promotes rank growth of herbs adapted to full sunlight), as well as certain conservation issues, supports its recognition.
Similar Associations: Information not available.
Related Concepts:

- *Rudbeckia laciniata - Solidago gigantea - Teucrium canadense* Wooded Herbaceous Vegetation (Lea 2000) =
- *Verbesina alternifolia - Teucrium canadense - Verbena urticifolia - (Rudbeckia laciniata - Solidago gigantea)* Wooded Herbaceous Vegetation (Lea 2003) =

SOURCES

Description Authors: C. Lea and G. P. Fleming, mod. S. C. Gawler.
References: Eastern Ecology Working Group n.d., Lea 2000, Lea 2003, Vanderhorst 2007.

Figure B7. An example of Riverbank Tall Herbs from the Bluestone National Scenic River.

COMMON NAME (PARK-SPECIFIC): AMERICAN WATER-WILLOW COBBLE BAR

SYNONYMS
NVC English Name: **American Water-willow Herbaceous Vegetation**
NVC Scientific Name: ***Justicia americana* Herbaceous Vegetation**
NVC Identifier: **CEGL004286**

LOCAL INFORMATION

Environmental Description: This association occurs in shallow water within the main channel and back channels of the New River. Stands commonly occur on the edge of the river and at the heads and tails of islands and may sometimes occur on deposition bars in the middle of the river. They are subject to frequent high-energy floods. Substrates, including bedrock, boulders, cobble, gravel, and sand, are saturated and semipermanently flooded, but stands may be exposed during dry periods. Substrate pH measured in the field from two plots ranges from 6.0 to 6.5. Slopes range from level to moderate but are typically gentle (mapping unit values range from 0 to 12 degrees, mean = 3 degrees). Elevations of mapped stands range from 292 to 409 m. Stands typically occur in full sunlight, but there may be scattered trees or an overhanging canopy in some areas. Adjacent community types include aquatic *Potamogeton* spp. - *Ceratophyllum* spp. - *Elodea* spp. Permanently Flooded Herbaceous Vegetation (CEGL004725)% in deeper water, *Peltandra virginica - Saururus cernuus - Boehmeria cylindrica / Climacium americanum* Herbaceous Vegetation (CEGL007696) in backwater positions, and *Platanus occidentalis - (Betula nigra, Salix* spp.) Temporarily Flooded Woodland (CEGL003725) in less flooded riverside positions.
Vegetation Description: This association represents herbaceous vegetation dominated by *Justicia americana*. Some stands have low cover by scattered flood-suppressed trees or an overhanging canopy. Trees in plots include *Acer saccharinum, Betula nigra, Fraxinus pennsylvanica*, and *Platanus occidentalis*. Many occurrences are near monocultures of the dominant herb which forms picturesque lawn-like stands in shallow reaches of the river. Cover by *Justicia americana* in plots ranges from 40 to 85%. Herbs which may codominate in some stands, typically in positions subjected to somewhat lower energy flooding, include *Saururus cernuus* and *Schoenoplectus pungens*. Additional characteristic herbs which may occur in small amounts include *Bidens* spp., *Leersia virginica*, and *Polygonum caespitosum var. longisetum*. The exotic invasive *Lythrum salicaria* was found in trace amount in one plot but has not been observed in abundance in this community, possibly due to intolerance of high-energy flooding. Vascular plant species richness in the 5 sampled plots ranges from 6 to 14 (mean = 9.4).
Most Abundant Species:

Stratum	Lifeform	Species
Herb (field)	Forb	*Justicia americana* (American waterwillow)

Characteristic Species: *Leersia virginica, Polygonum caespitosum* var. *longisetum, Saururus cernuus, Schoenoplectus pungens.*
Other Noteworthy Species: Information not available.
Subnational Distribution with Crosswalk Data:

State	State Rank	Confidence	State Name	Reference
WV	SNR	1		Vanderhorst 2001b

Local Range: This association occurs in small patches within the river channel scattered throughout the length of the park. It is most abundant in the southern section near Hinton.

Classification Comments: This association may grade towards *Peltandra virginica - Saururus cernuus - Boehmeria cylindrica / Climacium americanum* Herbaceous Vegetation (CEGL007696) which occurs in positions, typically backwater sloughs, which are subject to less high-energy flooding. The latter association is characterized by extremely high diversity, whereas *Justicia americana* Herbaceous Vegetation (CEGL004286) usually has very low diversity.
Other Comments: Information not available.
Local Description Authors: J.P. Vanderhorst
Plots: NERI.57, NERI.61, NERI.228, NERI.229, NERI.319.
New River Gorge National River Inventory Notes: Information not available.

GLOBAL INFORMATION

NVC CLASSIFICATION

Physiognomic Class	Herbaceous Vegetation (V)
Physiognomic Subclass	Perennial forb vegetation (V.B.)
Physiognomic Group	Temperate or subpolar perennial forb vegetation (V.B.2.)
Physiognomic Subgroup	Natural/Semi-natural temperate or subpolar perennial forb vegetation (V.B.2.N.)
Formation	Temporarily flooded temperate perennial forb vegetation (V.B.2.N.d.)
Alliance	*Justicia americana* Temporarily Flooded Herbaceous Alliance (A.1657)
Alliance (English name)	American Water-willow Temporarily Flooded Herbaceous Alliance
Association	*Justicia americana* Herbaceous Vegetation
Association (English name)	American Water-willow Herbaceous Vegetation
Ecological System(s):	Central Appalachian Floodplain (CES202.608). Central Appalachian Riparian (CES202.609). South-Central Interior Small Stream and Riparian (CES202.706). Southern Piedmont Small Floodplain and Riparian Forest (CES202.323). Cumberland Riverscour (CES202.036). South-Central Interior Large Floodplain (CES202.705). Ozark-Ouachita Riparian (CES202.703).

GLOBAL DESCRIPTION

Concept Summary: This association is found primarily in the Piedmont, Central Appalachians, Cumberland Plateau, Interior Low Plateau, Ozarks, Ouachita Mountains, and adjacent provinces. Stands occur on the shoals or bars of rocky streams and riverbeds, where they are subject to frequent high-energy floods. It provides habitat in some portions of its range for globally rare dragonflies and herbs. *Justicia americana* is the characteristic dominant. *Saururus cernuus* is often present and may be codominant. Other herbaceous species that may be present include *Leersia oryzoides, Leersia virginica, Lemna minor, Orontium aquaticum, Podostemum ceratophyllum, Scirpus* sp., *Schoenoplectus pungens, Schoenoplectus tabernaemontani, Cyperus* spp., *Eleocharis* spp., *Diodia teres, Gratiola brevifolia, Bidens* spp., *Polygonum caespitosum var. longisetum*, and *Xyris difformis var. difformis*. Exotics include *Lythrum salicaria* and

Lysimachia vulgaris. A sparse canopy layer, which can include *Carpinus caroliniana ssp. caroliniana, Salix interior, Acer saccharinum, Platanus occidentalis, Betula nigra, Fagus grandifolia*, and *Fraxinus pennsylvanica*, among other species, may be present. Scattered shrub seedlings of *Salix nigra, Betula nigra, Acer saccharinum*, or *Platanus occidentalis* may also be present.

Environmental Description: This association occurs on the shoals or bars of rocky streams and riverbeds, on bedrock, boulders, cobble, gravel, and sands. They are subject to frequent high energy floods, and are entirely submerged by most flood events. During extreme low water periods, the soil below the beds can be exposed, showing a varied mixture of sand, gravel and cobbles, often with deposits of silt and muck. Stands commonly occur on the edge of the river and at the heads and tails of islands and may sometimes occur on deposition bars in the middle of the river. Substrate pH was circumneutral (6.0–6.5) in two samples. Slopes range from level to moderate but are typically gentle. Elevations of West Virginia stands range from 73 to at least 654 m; the type occurs at lower elevations in the Piedmont and Coastal Plain.

Vegetation Description: *Justicia americana* is the dominant(and sometimes the only) species,, forming lawn-like stands in shallow reaches of rivers. Cover by *Justicia americana* ranges from 40 to 85%. *Saururus cernuus* is often present and may be codominant. Other herbaceous species may be present but rarely achieve more than 1% cover; they include *Leersia oryzoides, Leersia virginica, Lemna minor, Orontium aquaticum, Podostemum ceratophyllum, Scirpus* sp., *Schoenoplectus pungens, Schoenoplectus tabernaemontani, Cyperus* spp., *Elodea* sp., *Eleocharis* spp., *Equisetum arvense, Bidens* spp., *Polygonum caespitosum var. longisetum, Diodia teres, Gratiola brevifolia*, and *Xyris difformis var. difformis*. Exotics include *Lythrum salicaria* and *Lysimachia vulgaris*. In some areas, *Justicia* usually grows in nearly pure patches, so that few other species are associated with it. *Bidens* spp., *Cuscuta gronovii, Mimulus ringens, Polygonum* spp., *Rumex* spp., and *Salix interior* can occur (Anderson 1982). Some stands have low cover by scattered flood-suppressed trees or an overhanging canopy. Trees in plots include *Acer saccharinum, Betula nigra, Fraxinus pennsylvanica*, and *Platanus occidentalis*. A sparse canopy layer may be present, which can include *Carpinus caroliniana, Fagus grandifolia*, and *Fraxinus pennsylvanica*, among others. Scattered shrub seedlings of *Salix nigra, Betula nigra, Acer saccharinum*, or *Platanus occidentalis* may also be present. In the Cumberland Plateau of Alabama, *Justicia americana* is present in dense patches with some interspersion of other species, including *Pilea pumila, Boehmeria cylindrica, Eclipta prostrata (= Eclipta alba), Juncus coriaceus, Mikania scandens, Ludwigia palustris, Leersia* sp., and *Bidens* sp. Schmalzer and DeSelm (1982) discuss *Orontium aquaticum* growing along streambanks or in shallow riffles "along or with" *Justicia americana* in the Obed River in the Cumberland Plateau of Tennessee. In 29 plots sampled in the Potomac River watershed (Piedmont, Blue Ridge and Ridge and Valley provinces), *Justicia* was overwhelmingly dominant (50–75% mean cover), and no associated species occurred in more than 48% of the plots. Vascular plant species richness in sampled plots is low (typically 6–14 taxa). The exotic invasive *Lythrum salicaria* was found in one West Virginia plot but has not been observed in abundance in this community, possibly due to intolerance of high-energy flooding.

Most Abundant Species:

Stratum	Lifeform	Species
Herb (field)	Forb	*Justicia americana* (American waterwillow)

Characteristic Species: *Justicia americana, Leersia oryzoides, Leersia virginica, Polygonum amphibium, Polygonum caespitosum* var. *longisetum, Saururus cernuus, Schoenoplectus pungens.*

Other Noteworthy Species: Information not available.
USFWS Wetland System: Palustrine.

DISTRIBUTION

Range: This type is found primarily in the Piedmont, Interior Low Plateau, Cumberland Plateau, Ozarks, Ouachita Mountains, and adjacent provinces. It ranges from Alabama, Georgia and the Carolinas west to Arkansas and Oklahoma and north to Ohio, Pennsylvania, and Delaware.
States/Provinces: AL, AR, GA, KY, MD, NC, NJ, OH:S4, OK, PA, SC?, TN, VA, WV
Federal Lands: NPS (Big South Fork, C&O Canal, Delaware Water Gap, George Washington Parkway, Harpers Ferry, Little River Canyon?, Mammoth Cave, Manassas, Natchez Trace, New River Gorge, Obed, Stones River, Upper Delaware); USFS (Bankhead, Cherokee, Daniel Boone, Oconee?, Ouachita, Ouachita (Mountains), Ozark, Pisgah, Sumter (Mountains)?, Sumter (Piedmont)?, Sumter?, Uwharrie).

CONSERVATION STATUS

Rank: G4G5 (12-Sep-1997).
Reasons: Information not available.

CLASSIFICATION INFORMATION

Status: Standard.
Confidence: 2 - Moderate.
Comments: This type, in Ohio, often forms pure patches, but consistent identification may require a simple cutoff rule, such as at least 50% cover of *Justicia* (Anderson 1982). However, Anderson (1996) no longer recognizes this type.
Similar Associations:

- *Hymenocallis coronaria* - *Justicia americana* Herbaceous Vegetation (CEGL004285).
- *Peltandra virginica* - *Saururus cernuus* - *Boehmeria cylindrica / Climacium americanum* Herbaceous Vegetation (CEGL007696).

Related Concepts:

- *Justicia americana* riparian herbaceous vegetation (Vanderhorst 2001b) =
- Aquatic Types (Schmalzer and DeSelm 1982) B
- IIE3a. Riverside Shoal and Stream Bar Complex (Allard 1990) B
- Lizard's tail emergent bed (Perles et al. 2004) ?
- Rocky Bar and Shore (Water Willow Subtype) (Schafale 1998b) ?
- Water willow emergent bed (Perles et al. 2004) ?

SOURCES

Description Authors: A. S. Weakley, mod. D. Faber-Langendoen and S. C. Gawler.
References: Allard 1990, Anderson 1982, Anderson 1996, Fike 1999, Fleming et al. 2001, Harrison 2004, Hoagland 1997, Hoagland 2000, Major et al. 1999, McCoy 1958, Nelson 1986, OHNHD unpubl. data, Palmer-Ball et al. 1988, Peet et al. unpubl. data 2002, Penfound 1953, Perles et al. 2004, Schafale 1998b, Schafale 2002, Schafale and Weakley 1990, Schmalzer and DeSelm 1982, Schotz pers. comm., Southeastern Ecology Working Group n.d., TDNH unpubl. data, TNC and WPC 2004, Vanderhorst 2001b, Vanderhorst 2007.

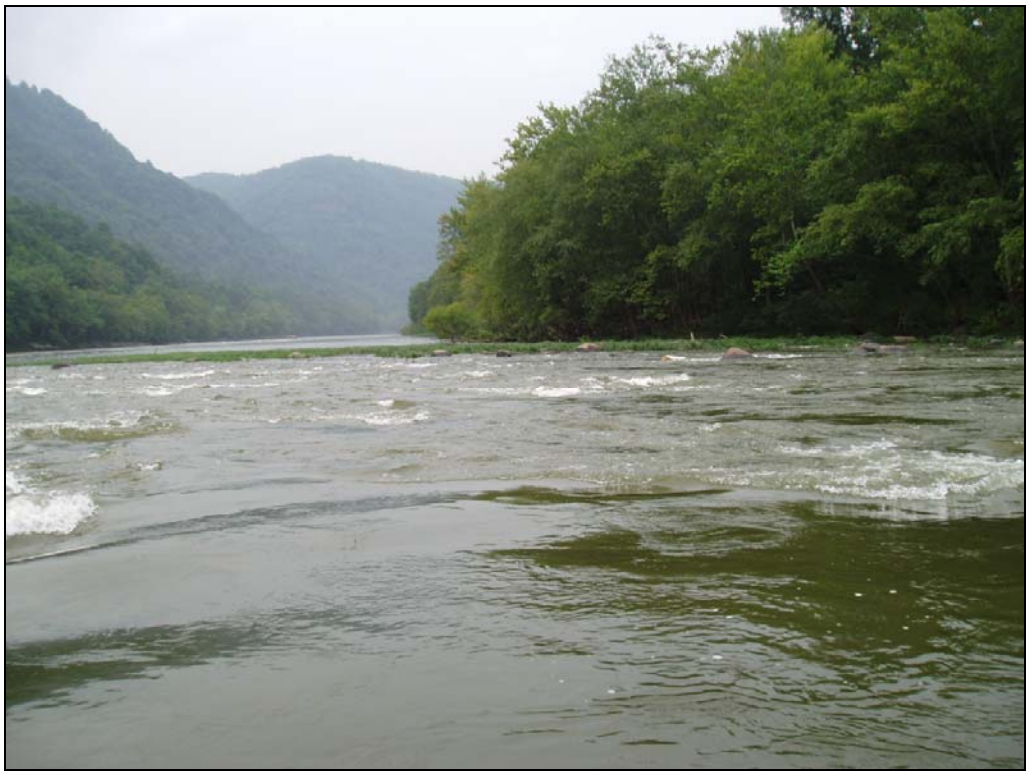

Figure B8. An example of American Water-willow Cobble Bar from the New River Gorge National River.

COMMON NAME (PARK-SPECIFIC): LIZARD'S-TAIL BACKWATER SLOUGH

SYNONYMS

NVC English Name:	**Green Arrow-arum - Lizard's-tail - Small-spike False Nettle / Tree Moss Herbaceous Vegetation**
NVC Scientific Name:	***Peltandra virginica - Saururus cernuus - Boehmeria cylindrica / Climacium americanum* Herbaceous Vegetation**
NVC Identifier:	**CEGL007696**

LOCAL INFORMATION

Environmental Description: This association occurs in backwater sloughs associated with floodplains of the New River. These alluvial landforms are located at the bottom of upland gorge slopes behind larger floodplains, typically on point bars on the inside bends of river meanders. These positions may be flooded by forward-flowing water during larger floods and by back-flowing water during smaller floods. They also receive water inputs from seepage and rain. Patches of this vegetation type can be highly ephemeral but are likely to develop again on the same site following their destruction by large floods. As these habitats dry out, bare substrate is exposed which is colonized in a zonal pattern by a high diversity of weedy and flood-adapted species. There are usually some more-or-less permanent pools which provide important habitat for aquatic animals, including fish and amphibians. Most sites would qualify as jurisdictional wetlands. Soils in plots are described as moderately well- to very poorly drained sand, clay loam, and muck. Slopes range from level to moderate but are typically gentle (mapping unit values range from 0 to 17 degrees, mean = 6 degrees). Elevations of mapped stands (backwater slough mapping unit) range from 300 to 413 m. Stands are usually partially shaded by overhanging trees from adjacent forest types. Occurrences of this association are typically imbedded within or located behind patches of *Platanus occidentalis - Fraxinus pennsylvanica / Carpinus caroliniana / Verbesina alternifolia* Forest (CEGL006458) and downslope from upland *Liriodendron tulipifera - Tilia americana var. heterophylla - Aesculus flava - Acer saccharum / Magnolia tripetala* Forest (CEGL005222).

Vegetation Description: This association represents herbaceous wetland vegetation which is usually partially shaded by overhanging trees rooted outside of the community. Dominant tree species in plots include *Aesculus flava, Juglans nigra,* and *Platanus occidentalis*. Shrubs which may occur on the edges of the community include *Asimina triloba, Cornus amomum, Ilex verticillata, Lindera benzoin, Rosa multiflora, Salix nigra,* and *Sambucus nigra ssp. canadensis*. Herbaceous cover in plots ranges from 80 to 100%, but cover may be less early in the season or in years following large floods. Herbs are usually sorted out in zones along a hydrologic gradient and include a high diversity of wetland emergent and "weedy" native and exotic taxa. Characteristic herbs with highest constancy and/or cover in plots include *Amphicarpaea bracteata, Apios americana, Arthraxon hispidus, Bidens* spp., *Boehmeria cylindrica, Calystegia sepium, Cardamine impatiens, Cuscuta gronovii, Dichanthelium clandestinum, Elymus virginicus, Equisetum arvense, Eragrostis hypnoides, Galium tinctorium, Glechoma hederacea, Glyceria striata, Hypericum mutilum, Impatiens capensis, Iris pseudacorus, Juncus effusus, Justicia americana, Lindernia dubia, Lobelia cardinalis, Lonicera japonica, Ludwigia palustris, Lysimachia ciliata, Lysimachia nummularia, Mentha arvensis, Microstegium vimineum, Mimulus alatus, Mimulus ringens, Onoclea sensibilis, Panicum anceps, Panicum rigidulum var. elongatum, Penthorum sedoides, Pilea pumila, Polygonum sagittatum, Sagittaria latifolia,*

Saururus cernuus, Scutellaria lateriflora, Silphium perfoliatum var. connatum, Toxicodendron radicans, Verbesina alternifolia, Veronica anagallis-aquatica, and *Viola striata*. Vascular plant species richness in the 5 sampled plots ranges from 38 to 108 (mean = 58.6).

Most Abundant Species:

Stratum	Lifeform	Species
Herb (field)	Forb	*Saururus cernuus* (lizard's tail)

Characteristic Species: *Amphicarpaea bracteata, Apios americana, Arthraxon hispidus, Boehmeria cylindrica, Calystegia sepium, Cardamine impatiens, Cuscuta gronovii, Dichanthelium clandestinum, Elymus virginicus, Equisetum arvense, Eragrostis hypnoides, Galium tinctorium, Glechoma hederacea, Glyceria striata, Hypericum mutilum, Impatiens capensis, Iris pseudacorus, Juncus effusus, Justicia americana, Lindernia dubia, Lobelia cardinalis, Lonicera japonica, Ludwigia palustris, Lysimachia ciliata, Lysimachia nummularia, Mentha arvensis, Microstegium vimineum, Mimulus alatus, Mimulus ringens, Onoclea sensibilis, Panicum anceps, Panicum rigidulum* var. *elongatum, Penthorum sedoides, Pilea pumila, Polygonum sagittatum, Sagittaria latifolia, Scutellaria lateriflora, Toxicodendron radicans, Verbesina alternifolia, Veronica anagallis-aquatica, Viola striata.*

Other Noteworthy Species: Information not available.

Subnational Distribution with Crosswalk Data:

State	State Rank	Confidence	State Name	Reference
WV	SNR	1		Vanderhorst 2001b

Local Range: This association occurs in small patches along the New River from Hinton downstream to Mann's Creek.

Classification Comments: Suiter (1995) described the occurrence of this association at Sandstone Falls as *Saururus cernuus* silt accumulations. This association may grade towards *Justicia americana* Herbaceous Vegetation (CEGL004286) which occurs in positions, typically in the main channel of the river, that are subject to higher energy flooding. The latter association is characterized by extremely low diversity, whereas *Peltandra virginica - Saururus cernuus - Boehmeria cylindrica / Climacium americanum* Herbaceous Vegetation (CEGL007696) usually has very high diversity.

Other Comments: Information not available.

Local Description Authors: J. P. Vanderhorst.

Plots: NERI.68, NERI.75, NERI.76, NERI.78, NERI.137.

New River Gorge National River Inventory Notes: Information not available.\

GLOBAL INFORMATION

NVC CLASSIFICATION

Physiognomic Class	Herbaceous Vegetation (V)
Physiognomic Subclass	Perennial forb vegetation (V.B.)
Physiognomic Group	Temperate or subpolar perennial forb vegetation (V.B.2.)
Physiognomic Subgroup	Natural/Semi-natural temperate or subpolar perennial forb vegetation (V.B.2.N.)
Formation	Semipermanently flooded temperate perennial forb vegetation (V.B.2.N.e.)
Alliance	*Pontederia cordata* - *Peltandra virginica* Semipermanently Flooded Herbaceous Alliance (A.1669)
Alliance (English name)	Pickerelweed - Green Arrow-arum Semipermanently Flooded Herbaceous Alliance
Association	*Peltandra virginica* - *Saururus cernuus* - *Boehmeria cylindrica* / *Climacium americanum* Herbaceous Vegetation
Association (English name)	Green Arrow-arum - Lizard's-tail - Small-spike False Nettle / Tree Moss Herbaceous Vegetation
Ecological System(s):	Central Appalachian Floodplain (CES202.608).

GLOBAL DESCRIPTION

Concept Summary: This vegetation occupies depressions of Piedmont and mountain floodplains, as well as broad flat floodplains of the Coastal Plain of Delaware and New Jersey. These depressions are usually abandoned channel segments or swales behind natural levees in which water is ponded for all or much of the year. Water may be supplied primarily by stream flooding or by rainfall. Vegetative cover is variable and may be confined to edges or shallower portions that dry out during the growing season. The vascular plant species vary widely among examples. Emergent vegetation may include *Peltandra virginica*, *Dulichium arundinaceum*, and *Polygonum* spp. *Carex crinita* or some other wetland *Carex* species are almost always present. *Saururus cernuus* and *Boehmeria cylindrica* are other typical herbs. Larger examples may have pad-leaved aquatic species such as *Brasenia schreberi* or *Nymphaea odorata*. Some examples have wetland shrubs on edges or in shallow portions, including *Cornus amomum* and *Cephalanthus occidentalis*. The moss *Climacium americanum* is often abundant on the landward side.

Environmental Description: This vegetation occurs in Piedmont and mountain floodplains, as well as broad flat floodplains of the Coastal Plain of Delaware and New Jersey. These depressions are usually abandoned channel segments or swales behind natural levees in which water is ponded for all or much of the year. These alluvial landforms are located at the bottom of upland gorge slopes behind larger floodplains, typically on point bars on the inside bends of river meanders. These positions may be flooded by forward-flowing water during larger floods and by back-flowing water during smaller floods. They also receive water inputs from seepage and rain. Patches of this vegetation type can be highly ephemeral but are likely to develop again on the same site following their destruction by large floods. As these habitats dry out, bare substrate is exposed which is colonized in a zonal pattern by a high diversity of weedy and flood-adapted species. There are usually some more-or-less permanent pools which provide important habitat for aquatic animals, including fish and amphibians. Soils are moderately well- to very poorly drained sand, clay loam, and muck. Slopes range from level to moderate but are typically gentle

Water may be supplied primarily by stream flooding or by rainfall. Stands are usually partially shaded by overhanging trees from adjacent forests.

Vegetation Description: This association represents herbaceous wetland vegetation that is usually partially shaded by overhanging trees rooted outside of the community. Herbs are usually sorted out in zones along a hydrologic gradient and include a high diversity of wetland emergent and "weedy" native and exotic taxa. Emergent vegetation may include *Peltandra virginica, Dulichium arundinaceum*, and *Polygonum* spp. Other vascular plant species vary widely among examples. *Carex crinita* or some other wetland *Carex* species are almost always present. Other herbs with relatively high cover or constancy include *Amphicarpaea bracteata, Apios americana, Arthraxon hispidus, Bidens* spp., *Boehmeria cylindrica, Calystegia sepium, Cardamine impatiens, Cuscuta gronovii, Dichanthelium clandestinum, Elymus virginicus, Equisetum arvense, Eragrostis hypnoides, Galium tinctorium, Glechoma hederacea, Glyceria striata, Hypericum mutilum, Impatiens capensis, Iris pseudacorus, Juncus effusus, Justicia americana, Lindernia dubia, Lobelia cardinalis, Lonicera japonica, Ludwigia palustris, Lysimachia ciliata, Lysimachia nummularia, Mentha arvensis, Microstegium vimineum, Mimulus alatus, Mimulus ringens, Onoclea sensibilis, Panicum anceps, Panicum rigidulum var. elongatum, Penthorum sedoides, Pilea pumila, Polygonum sagittatum, Sagittaria latifolia, Saururus cernuus, Scutellaria lateriflora, Silphium perfoliatum var. connatum, Toxicodendron radicans, Verbesina alternifolia, Veronica anagallis-aquatica* and *Viola striata*. Larger examples may have pad-leaved aquatic species such as *Brasenia schreberi* or *Nymphaea odorata*. Some examples have wetland shrubs on edges or in shallow portions, including *Cornus amomum, Asimina triloba, Ilex verticillata, Lindera benzoin, Rosa multiflora, Salix nigra, Sambucus nigra ssp. canadensis*, and *Cephalanthus occidentalis*. Vascular plant species richness is typically high. The moss *Climacium americanum* is often abundant on the landward side.

Most Abundant Species:

Stratum	Lifeform	Species
Herb (field)	Forb	*Boehmeria cylindrica* (smallspike false nettle)
		Peltandra virginica (green arrow arum)
		Saururus cernuus (lizard's tail)
Herb (field)	Graminoid	*Dulichium arundinaceum* (threeway sedge)

Characteristic Species: *Cardamine impatiens, Carex crinita, Dichanthelium clandestinum, Elymus virginicus, Equisetum arvense, Glyceria striata, Hypericum mutilum, Impatiens capensis, Iris pseudacorus, Juncus effusus, Justicia americana, Lindernia dubia, Lobelia cardinalis, Ludwigia palustris, Lysimachia ciliata, Mentha arvensis, Mimulus alatus, Mimulus ringens, Onoclea sensibilis, Panicum anceps, Panicum rigidulum* var. *elongatum, Peltandra virginica, Pilea pumila, Polygonum sagittatum, Sagittaria latifolia, Scutellaria lateriflora, Veronica anagallis-aquatica.*

Other Noteworthy Species: Information not available.

USFWS Wetland System: Palustrine.

DISTRIBUTION

Range: This association is found in the Piedmont, Southern Blue Ridge and related ecoregions, north to the Coastal Plain in Connecticut. It may range south to Tennessee and North Carolina.

States/Provinces: CT, DE, MD, NC, NJ, PA, TN?, VA, WV.

Federal Lands: NPS (New River Gorge); USFWS (Great Swamp).

CONSERVATION STATUS

Rank: G2G3? (20-Dec-2006).

Reasons: This community is apparently rare but extends over a moderate geographic range. Individual occurrences are small, generally less than an acre. Many sites for this community have been lost to clearing for agriculture, ditching and draining, hydrologic alteration, and development. These sites are important for amphibian breeding.

CLASSIFICATION INFORMATION

Status: Standard.

Confidence: 2 - Moderate.

Comments: These floodplain pools are transitional between wetland vegetated communities and aquatic communities. They are more distinctive for their aquatic fauna (and probably microflora) than for their higher plant communities. In fact, vegetation and floristics can be highly variable among sites. Two distinct kinds can be recognized based on the aquatic animal communities. Pools that are flooded by overbank streamflow at least as often as they dry out support fish as the dominant animal component. Those that are flooded more rarely and dry out between floods lack fish most of the time and support significant amphibian communities. These differences are not known to be reflected in vegetation but are important ecologically.

Similar Associations:

- *Justicia americana* Herbaceous Vegetation (CEGL004286).
- *Peltandra virginica* - *Polygonum amphibium* var. *emersum* - *Carex emoryi* - *Impatiens capensis* Herbaceous Vegetation (CEGL006244).

Related Concepts:

- *Saururus cernuus* - *Boehmeria cylindrica* herbaceous wetland (Vanderhorst 2001b) =
- Floodplain Pool (Schafale 1998a) ?

SOURCES

Description Authors: M. P. Schafale and M. Pyne, mod. S. C. Gawler.

References: Breden et al. 2001, Fleming et al. 2001, Harrison 2004, Metzler and Barrett 2001, Schafale 1998a, Schafale and Weakley 1990, Southeastern Ecology Working Group n.d., Suiter 1995, TDNH unpubl. data, Vanderhorst 2001b, Vanderhorst 2007.

Figure B9. An example of Lizard's-tail Backwater Slough from the New River Gorge National River.

COMMON NAME (PARK-SPECIFIC): RIVERBANK ANNUALS

SYNONYMS

NVC English Name: **Creeping Lovegrass - Marsh Seedbox - Yellowseed False Pimpernel - Awned Flatsedge Herbaceous Vegetation**

NVC Scientific Name: ***Eragrostis hypnoides - Ludwigia palustris - Lindernia dubia - Cyperus squarrosus* Herbaceous Vegetation**

NVC Identifier: **CEGL006483**

LOCAL INFORMATION

Environmental Description: This association occurs in small patches and linear zones along the shores of the New River. It occurs in positions within the active channel shelf which are very frequently flooded and submerged for long periods. It occurs on eroded riverbanks and wet beaches and may also occur in back channels and sloughs. The short periods of exposure and heavy disturbance regime result in vegetation dominated by fast-growing annual species. Patches may be highly ephemeral, but this association will likely persist on the landscape under natural or altered flooding regimes. Substrates are sand or silty sand. In the one sampled plot, pH measured in the field was 6.0. Occurrences may be partially shaded by overhanging trees but are best developed in areas with full solar exposure. They are likely to be scattered throughout the length of the New River in the park with elevations ranging from 244 to 402 m.

Vegetation Description: This association represents herbaceous vegetation dominated by weedy native and exotic annuals and short-lived perennials which occur on the shores of the New River. Overhanging trees in the one sampled plot include *Platanus occidentalis* and *Acer saccharinum*. There are seedlings and young saplings of *Betula nigra* in the plot. Herbaceous cover in the plot when sampled was 60%. Characteristic herbs include *Acalypha rhomboidea, Chamaesyce humistrata, Chenopodium ambrosioides, Cyperus strigosus, Digitaria ischaemum, Diodia virginiana, Echinochloa crus-galli, Elsholtzia ciliata, Eragrostis hypnoides, Erechtites hieraciifolia, Fimbristylis autumnalis, Glechoma hederacea, Hypericum mutilum, Leersia virginica, Lindernia dubia var. dubia, Microstegium vimineum, Oxalis stricta, Panicum dichotomiflorum, Panicum gattingeri (= Panicum philadelphicum ssp. gattingeri), Polygonum caespitosum var. longisetum, Solanum ptychanthum, Verbascum thapsus*, and *Verbena urticifolia*. Vascular plant species richness in the 1 sampled plot is 31.

Most Abundant Species: Information not available.

Characteristic Species: *Acalypha rhomboidea, Chamaesyce humistrata, Chenopodium ambrosioides, Cyperus strigosus, Digitaria ischaemum, Diodia virginiana, Echinochloa crus-galli, Elsholtzia ciliata, Eragrostis hypnoides, Erechtites hieraciifolia, Fimbristylis autumnalis, Glechoma hederacea, Hypericum mutilum, Leersia virginica, Lindernia dubia* var. *dubia, Microstegium vimineum, Oxalis stricta, Panicum dichotomiflorum, Panicum gattingeri, Polygonum caespitosum* var. *longisetum, Solanum ptychanthum, Verbascum thapsus, Verbena urticifolia.*

Other Noteworthy Species: Information not available.

Subnational Distribution with Crosswalk Data:

State	State Rank	Confidence	State Name	Reference
WV	SNR	.	[not crosswalked]	.

Local Range: This association is likely to occur in small patches along the shores of the New River throughout its length in the park.

Classification Comments: Many of the annual species which characterize this association are also common in *Salix nigra - Betula nigra / Schoenoplectus (pungens, tabernaemontani)* Wooded Herbaceous Vegetation (CEGL006463) and *Peltandra virginica - Saururus cernuus - Boehmeria cylindrica / Climacium americanum* Herbaceous Vegetation (CEGL007696), and distinction among these types may depend on the size of the sampled patch. Because it occurs in very small, potentially ephemeral patches, it is recognized as an association which occurs in the park, but no attempt was made to map individual patches.
Other Comments: Information not available.
Local Description Authors: J. P. Vanderhorst.
Plots: NERI.326.
New River Gorge National River Inventory Notes: Information not available.

GLOBAL INFORMATION

NVC CLASSIFICATION

Physiognomic Class	Herbaceous Vegetation (V)
Physiognomic Subclass	Annual graminoid or forb vegetation (V.D.)
Physiognomic Group	Temperate or subpolar annual grasslands or forb vegetation (V.D.2.)
Physiognomic Subgroup	Natural/Semi-natural temperate or subpolar annual grasslands or forb vegetation (V.D.2.N.)
Formation	Seasonally flooded temperate annual grassland (V.D.2.N.g.)
Alliance	*Eragrostis hypnoides - Lipocarpha micrantha - Micranthemum umbrosum* Seasonally Flooded Herbaceous Alliance (A.1816)
Alliance (English name)	Creeping Lovegrass - Small-flower Hemicarpha - Shaded Mudflower Seasonally Flooded Herbaceous Alliance
Association	*Eragrostis hypnoides - Ludwigia palustris - Lindernia dubia - Cyperus squarrosus* Herbaceous Vegetation
Association (English name)	Creeping Lovegrass - Marsh Seedbox - Yellowseed False Pimpernel - Awned Flatsedge Herbaceous Vegetation
Ecological System(s):	Central Appalachian Floodplain (CES202.608). Central Appalachian Riparian (CES202.609).

GLOBAL DESCRIPTION

Concept Summary: This association occurs along major rivers in the Piedmont and mountains of Maryland, Virginia, West Virginia, and the District of Columbia. It occupies the lowest parts of riverbanks or very low rivershore depositional bars in areas that receive essentially full sunlight. These habitats are inundated for most of the winter and spring and are generally consistently exposed only from early summer to early autumn (i.e., the "drawdown" zone). During wet years they may be nearly continuously inundated. The type usually occurs as a narrow strip (frequently <2 m wide) along the shoreline. This association may also develop, sometimes as very large (>1 ha) patches, on the drawdown shores and seasonally exposed islands of impounded rivers. Vegetation of stands varies from sparse to dense (10–80% cover) and is characterized by low-growing mats of predominantly annual species, with some low, fast-growing perennials also present. *Eragrostis hypnoides, Ludwigia palustris, Lindernia dubia var. dubia*, and *Cyperus squarrosus* are constant and often abundant. Other characteristic annuals

(and biennials) are *Acalypha rhomboidea, Ammannia coccinea, Artemisia annua, Bidens frondosa, Chamaesyce humistrata, Chamaesyce maculata, Chenopodium ambrosioides, Cyperus bipartitus, Cyperus odoratus, Diodia virginiana, Echinochloa crus-galli, Eclipta prostrata, Elsholtzia ciliata, Eragrostis frankii, Fimbristylis autumnalis, Hypericum mutilum, Lindernia dubia var. anagallidea, Lindernia dubia var. dubia, Lipocarpha micrantha, Mollugo verticillata, Panicum dichotomiflorum var. dichotomiflorum, Panicum gattingeri (= Panicum philadelphicum ssp. gattingeri), Paspalum fluitans, Polygonum caespitosum var. longisetum, Rorippa palustris ssp. fernaldiana, Rotala ramosior, Solanum ptychanthum,* and *Xanthium strumarium*. Frequent perennials include *Boehmeria cylindrica, Cyperus strigosus, Leersia virginica, Justicia americana, Lycopus americanus, Mimulus alatus, Penthorum sedoides, Phyla lanceolata, Rorippa sylvestris*, and *Samolus valerandi ssp. parviflorus*. Stranded mats of *Heteranthera dubia (= Zosterella dubia)* are also frequent. Seedlings of taller annuals and perennials such as *Hibiscus laevis, Eupatorium* spp., and *Polygonum* spp. are also frequent but rarely reach full stature. Overhanging trees of *Platanus occidentalis* and *Acer saccharinum* may be present, as well as saplings of *Betula nigra*.

Environmental Description: Natural occurrences of this community occupy the lowest parts of riverbanks or very low rivershore depositional bars in areas that receive essentially full sunlight. It occurs on eroded riverbanks and wet beaches and may also occur in back channels and sloughs. These habitats are inundated for most of the winter and spring and are generally consistently exposed only from early summer to early autumn (i.e., the "drawdown" zone). During wet years they may be nearly continuously inundated. The type usually occurs as a narrow strip (frequently <2 m wide) along the shoreline. Though more frequently flooded than higher depositional bars that support tall annual or perennial herbaceous vegetation, the habitats of this type probably experience lesser amounts of sediment turnover (erosion and deposition) during a flood of a given magnitude (i.e., are less stochastically disturbed). Soils are usually deep to somewhat shallow sandy loams, loamy sands, or silt loams that are likely saturated to near the surface throughout the growing season. They would likely be classified as Entisols and generally have high pH (7.0), high calcium levels, and are 100% base-saturated. Mean particle size (phi) of samples collected from several Potomac River sites is 2.7 to 1.9. This association may also develop, sometimes as very large (>1 ha) patches, on the drawdown shores and seasonally exposed islands of impounded rivers, e.g., at the upper end of the John H. Kerr Reservoir on the Roanoke River in Halifax, Mecklenburg, and Charlotte counties, Virginia.

Vegetation Description: With the exception of several semi-aquatic perennial species, the short periods of exposure and heavy disturbance regime select for opportunistic, non-competitive annual species and low, short-lived, fast-growing perennials, all of which can grow and reproduce quickly. It would be expected that many species in this community type have relatively long-lived seedbanks and, possibly, specialized germination requirements. Vegetation of stands varies from sparse to dense (10–80% cover) and is characterized by low-growing mats of predominantly annual species. *Eragrostis hypnoides, Ludwigia palustris, Lindernia dubia var. dubia*, and *Cyperus squarrosus* are constant and often abundant. Other characteristic annuals (and biennials) are *Acalypha rhomboidea, Ammannia coccinea, Artemisia annua, Bidens frondosa, Chamaesyce humistrata, Chamaesyce maculata, Chenopodium ambrosioides, Cyperus bipartitus, Cyperus odoratus, Diodia virginiana, Echinochloa crus-galli, Eclipta prostrata, Elsholtzia ciliata, Eragrostis frankii, Fimbristylis autumnalis, Hypericum mutilum, Lindernia dubia var. anagallidea, Lindernia dubia var. dubia, Lipocarpha micrantha, Mollugo verticillata, Panicum dichotomiflorum var. dichotomiflorum, Panicum gattingeri (= Panicum*

philadelphicum ssp. gattingeri), Paspalum fluitans, Polygonum caespitosum var. longisetum, Rorippa palustris ssp. fernaldiana, Rotala ramosior, Solanum ptychanthum, and *Xanthium strumarium*. Frequent perennials include *Boehmeria cylindrica, Cyperus strigosus, Leersia virginica, Justicia americana, Lycopus americanus, Mimulus alatus, Penthorum sedoides, Phyla lanceolata, Rorippa sylvestris,* and *Samolus valerandi ssp. parviflorus*. Stranded mats of *Heteranthera dubia (= Zosterella dubia)* are also frequent. Seedlings of taller annuals and perennials such as *Hibiscus laevis, Eupatorium* spp., and *Polygonum* spp. are also frequent but rarely reach full stature. A variant of this community in the Potomac River drainage is characterized primarily by low, rhizomatous colonies of *Eleocharis tenuis*. Species that are more characteristic of the James River and Roanoke River occurrences in central and southern Virginia include *Cyperus flavicomus, Cyperus erythrorhizos, Ludwigia decurrens, Paspalum dissectum, Rorippa sessiliflora,* and *Sagittaria calycina var. calycina*. Overhanging trees of *Platanus occidentalis* and *Acer saccharinum* may be present, as well as saplings of *Betula nigra*.
Most Abundant Species: Information not available.
Characteristic Species: *Acalypha rhomboidea, Artemisia annua, Chamaesyce humistrata, Chenopodium ambrosioides, Diodia virginiana, Echinochloa crus-galli, Eclipta prostrata, Eragrostis frankii, Eragrostis hypnoides, Fimbristylis autumnalis, Hypericum mutilum, Leersia virginica, Lindernia dubia, Lipocarpha micrantha, Mimulus alatus, Oxalis stricta, Panicum dichotomiflorum, Panicum gattingeri, Polygonum caespitosum* var. *longisetum, Rotala ramosior, Solanum ptychanthum, Verbascum thapsus, Verbena urticifolia.*
Other Noteworthy Species: Information not available.
USFWS Wetland System: Not applicable.

DISTRIBUTION
Range: This community occurs along major rivers in the Piedmont and mountains of Maryland, Virginia, West Virginia, and the District of Columbia. It is definitely known from the Potomac, Shenandoah, Monocacy, New, James, and Roanoke rivers, and likely occurs in other drainages of the region.
States/Provinces: DC, MD, VA, WV.
Federal Lands: NPS (C&O Canal, George Washington Parkway, Harpers Ferry, Monocacy, New River Gorge).

CONSERVATION STATUS
Rank: G3 (29-Sep-2006).
Reasons: Although natural stands occur in very small, somewhat ephemeral patches, this type is widely distributed along major rivers in the greater Mid-Atlantic Piedmont and mountain region and is adaptable to artificial drawdown shores, where it sometimes occurs in extensive patches.

CLASSIFICATION INFORMATION
Status: Standard.
Confidence: 2 - Moderate.
Comments: The classification is supported by analysis of data from 25 plots collected for the National Capital Region Parks project, three plots collected along the Roanoke River in southern Virginia, and one plot from the New River in West Virginia. Many of the annual species which characterize this association are also common in *Salix nigra - Betula nigra / Schoenoplectus (pungens, tabernaemontani)* Wooded Herbaceous Vegetation (CEGL006463) and *Peltandra virginica - Saururus cernuus - Carex crinita / Climacium americanum* Herbaceous Vegetation

(CEGL007696), and distinction between these types may depend on the size of the sampled patch.

Similar Associations:

- *Eragrostis hypnoides - Micranthemum umbrosum - Lipocarpha micrantha - (Juncus repens)* Herbaceous Vegetation (CEGL004341)--on drawdown shores of Coastal Plain rivers.

Related Concepts:

- *Eragrostis hypnoides - Lindernia dubia - Ludwigia palustris - Cyperus squarrosus* Herbaceous Vegetation (Fleming et al. 2004) =
- *Eragrostis hypnoides - Lindernia dubia - Ludwigia palustris* Herbaceous Vegetation (Lea 2000) =
- *Eragrostis hypnoides - Ludwigia palustris - Cyperus squarrosus* Herbaceous Vegetation (Lea 2003) F
- *Panicum rigidulum - Eleocharis tenuis - Phyla lanceolata* Herbaceous Vegetation (Lea 2003) F

SOURCES

Description Authors: C. Lea and G. P. Fleming, mod. S. C. Gawler.

References: Eastern Ecology Working Group n.d., Fleming et al. 2004, Lea 2000, Lea 2003, Vanderhorst 2007.

Figure B10. An example of Riverbank Annuals from the New River Gorge National River.

COMMON NAME (PARK-SPECIFIC): TRIBUTARY FLOODPLAIN FOREST

SYNONYMS

NVC English Name: **(American Beech, Sweetgum, Sycamore, Slippery Elm, Northern Red Oak) Temporarily Flooded Forest**

NVC Scientific Name: **(*Fagus grandifolia, Liriodendron tulipifera, Platanus occidentalis, Ulmus rubra, Quercus rubra*) Temporarily Flooded Forest**

NVC Identifier: **CEGL006487**

LOCAL INFORMATION

Environmental Description: This forest type occurs in small patches and linear zones on floodplains of major tributaries of the New River. These are relatively narrow alluvial landforms which may flood at any time of year. Catastrophic tributary floods occurred during the summer of 2001, which severely impacted many stands of this association by toppling trees, scouring soil and ground cover, and rearranging channel and floodplain topography. Four plots were sampled in less severely flood-impacted sites. Soils in plots are described as well-drained alluvial sands and sandy loams with pH ranging from 5.0 to 7.0. There is a high level of variation in soil chemistry in the plots, but average values indicate slightly acidic soils (mean pH = 5.75) with relatively high levels of Ca, Cu, Mg, P, and Zn. Elevations of mapped stands range from 272 to 633 m. Topography is typically undulating or gently sloping (slope of mapping units ranges from 0.3 to 32 degrees, mean = 9.3 degrees). Adjacent communities are mostly upland forest types. Small patches of *Carex torta* Herbaceous Vegetation (CEGL004103) may occur within the adjacent creek channel.

Vegetation Description: This type represents a variety of deciduous floodplain forests along major tributaries of the New River. There is a high degree of variation in vegetation composition within this type. Canopy cover in the plots ranges from 50 to 70% and cover in the subcanopy ranges from 20 to 50%. Dominant canopy tree species include *Fagus grandifolia, Liriodendron tulipifera, Platanus occidentalis, Quercus rubra*, and *Ulmus rubra*. Additional important trees in the canopy and subcanopy include *Acer negundo, Aesculus flava, Carya cordiformis, Magnolia acuminata, Nyssa sylvatica, Quercus alba*, and *Robinia pseudoacacia*. The shrub layers may include *Carpinus caroliniana ssp. virginiana, Cornus florida, Corylus americana, Halesia tetraptera, Lindera benzoin*, and *Lonicera morrowii*. One distinctive plot (NERI.353) with a canopy dominated by *Quercus rubra* has a dense short-shrub layer dominated by *Xanthorhiza simplicissima*. Common species in the herb layer include *Amphicarpaea bracteata, Elymus hystrix, Glechoma hederacea, Pedicularis canadensis, Pilea pumila, Polygonum cuspidatum, Polystichum acrostichoides, Symphyotrichum prenanthoides*, and *Verbesina occidentalis*. Vascular plant species richness in the 4 sampled plots ranges from 24 to 55 (mean = 39.5).

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Fagus grandifolia* (American beech)
		Liriodendron tulipifera (tuliptree)
		Platanus occidentalis (American sycamore)
		Quercus rubra (northern red oak)
Short shrub/sapling	Broad-leaved deciduous shrub	*Xanthorhiza simplicissima* (yellowroot)

Characteristic Species: *Acer negundo, Aesculus flava, Amphicarpaea bracteata, Carpinus caroliniana* ssp. *virginiana, Carya cordiformis, Cornus florida, Corylus americana, Elymus hystrix, Glechoma hederacea, Halesia tetraptera, Lindera benzoin, Lonicera morrowii,*

Magnolia acuminata, Nyssa sylvatica, Pedicularis canadensis, Pilea pumila, Polygonum cuspidatum, Polystichum acrostichoides, Quercus alba, Symphyotrichum prenanthoides.
Other Noteworthy Species: Information not available.
Subnational Distribution with Crosswalk Data:

State	State Rank	Confidence	State Name	Reference
WV	SNR	.	[not crosswalked]	.

Local Range: Mapped stands occur in the floodplains along Meadow Creek, Laurel Creek, Glade Creek, Piney Creek, Mann's Creek, and Wolf Creek.
Classification Comments: This floodplain forest of tributary streams was created as a park special type because it is poorly sampled and very heterogeneous. It occurs in narrow zones which quickly grade to uplands. Sampling was further complicated by catastrophic flooding in 2001 which impacted or destroyed many stands. Further sampling within the park and/or analysis with plots outside the park may support splitting this unit and lumping parts with broader association concepts.
Other Comments: Information not available.
Local Description Authors: J. P. Vanderhorst.
Plots: NERI. 304, NERI.308, NERI.309, NERI.353.
New River Gorge National River Inventory Notes: Additional plot sampling within and outside the park is needed to resolve classification issues involving tributary floodplain forests.

GLOBAL INFORMATION

NVC CLASSIFICATION

Physiognomic Class	Information not available.
Physiognomic Subclass	Information not available.
Physiognomic Group	Information not available.
Physiognomic Subgroup	Information not available.
Formation	Information not available.
Alliance	Information not available.
Alliance (English name)	Information not available.
Association	(*Fagus grandifolia, Liriodendron tulipifera, Platanus occidentalis, Ulmus rubra, Quercus rubra*) Temporarily Flooded Forest
Association (English name)	(American Beech, Sweetgum, Sycamore, Slippery Elm, Northern Red Oak) Temporarily Flooded Forest
Ecological System(s):	Information not available.

GLOBAL DESCRIPTION

Concept Summary: Information not available.
Environmental Description: Information not available.
Vegetation Description: Information not available.
Most Abundant Species: Information not available.
Characteristic Species: Information not available.
Other Noteworthy Species: Information not available.
USFWS Wetland System: Not applicable.

DISTRIBUTION
Range: Information not available.
States/Provinces: WV.
Federal Lands: NPS (New River Gorge).

CONSERVATION STATUS
Rank: GNR (20-Dec-2006).
Reasons: Information not available.

CLASSIFICATION INFORMATION
Status: Nonstandard.
Confidence: Information not available.
Comments: Information not available.
Similar Associations: Information not available.
Related Concepts: Information not available.

SOURCES
Description Authors: Information not available.
References: Eastern Ecology Working Group n.d., Vanderhorst 2007

No photo available.

COMMON NAME (PARK-SPECIFIC): SUCCESSIONAL EASTERN WHITE PINE - TULIPTREE FOREST

SYNONYMS
NVC English Name: **Eastern White Pine Successional Forest**
NVC Scientific Name: ***Pinus strobus* Successional Forest**
NVC Identifier: **CEGL007944**

LOCAL INFORMATION

Environmental Description: This successional forest occurs in small patches (0–9.5 ha) on gentle topography in areas previously cleared for agriculture. Most sites are mapped as unforested (white) on the 1912 Big Bend and 1929 Flattop USGS 15' topographic maps. It occurs on higher floodplains and alluvial terraces, lower slopes, midslope benches, and plateau and spur ridgetops. Slopes in mapped polygons range from 0 to 37 degrees (mean = 13.8). Elevations in mapped polygons range from 436 to 711 m (mean = 492). Unvegetated ground cover is strongly dominated by litter. Low cover by rocks is an indication of site selection and removal of rocks for agriculture. Rock walls and scattered rock piles are common. Soils in plots are described as dry to moist sand, sandy loam, silt loam, and loam derived from alluvium, sandstone, and shale. Soils from plots tested strongly to extremely acidic (mean pH = 4.5) with relatively high levels of S, Al, Mn, and P, and relatively low levels of organic matter, estimated N release, B, Ca, Cu, Fe, K, Mg, Na, and Zn compared to average values in the park. This association often occupies the highest ground on alluvial terraces adjacent to natural and semi-natural floodplain forest types which occupy lower, more frequently flooded positions. In uplands this association is often adjacent to or imbedded within polygons of the natural matrix upland forest types, including Sugar Maple - Yellow Buckeye - American Basswood Forest (CEGL005222) and Oak - Hickory - Sugar Maple Forest (CEGL007268).
Vegetation Description: Stands of this association are typically closed-canopy evergreen and mixed evergreen-deciduous forests with even-aged canopies strongly dominated by *Pinus strobus* (eastern white pine) or codominated by *Pinus strobus* (eastern white pine) with *Liriodendron tulipifera* (tuliptree). Additional canopy trees with lower constancy and cover in plots include *Quercus alba* (white oak), *Fagus grandifolia* (American beech), *Pinus virginiana* (Virginia pine), *Robinia pseudoacacia* (black locust), *Fraxinus pennsylvanica* (green ash), *Magnolia acuminata* (cucumber-tree), and other deciduous species. Abundant subcanopy trees include *Tsuga canadensis* (eastern hemlock), *Oxydendrum arboreum* (sourwood), *Acer rubrum* var. (red maple), and *Acer saccharum* var. *saccharum* (sugar maple). Regeneration of the shade-tolerant conifer *Tsuga canadensis* (eastern hemlock) is also abundant in the shrub layers of several plots and may reflect succession of some stands on high floodplains towards Eastern Hemlock Floodplain Forest (CEGL006620). Total cover in the shrub layers of plots (including shrubs, vines, and tree saplings) ranges from 10–50%. Common shrubs include *Lindera benzoin* (northern spicebush), *Asimina triloba* (pawpaw), and *Acer pensylvanicum* (striped maple). Common vines include *Smilax rotundifolia* (roundleaf greenbrier), *Toxicodendron radicans* (eastern poison ivy), and *Parthenocissus quinquefolia* (Virginia creeper). Common tree saplings include *Carya cordiformis* (bitternut hickory), *Aesculus flava* (yellow buckeye), *Fraxinus americana* (white ash), and *Fagus grandifolia* (American beech). Total cover in the herb layer of plots ranges from 3–30%. Common herbs, in decreasing order of constancy, include *Polystichum acrostichoides* (Christmas fern), *Galium triflorum* (fragrant bedstraw), *Mitchella repens*

(partridgeberry), *Packera aurea* (golden ragwort), *Verbesina alternifolia* (wingstem), *Sanicula canadensis* (Canadian blacksnakeroot), *Ageratina altissima* var. *altissima* (white snakeroot), *Potentilla simplex* (common cinquefoil), *Carex amphibola* (eastern narrowleaf sedge), *Asplenium platyneuron* (ebony spleenwort), and *Arisaema triphyllum* ssp. *triphyllum* (Jack in the pulpit). Vascular plant species richness in 11 plots ranges from 32 to 66 (mean = 45.6) species per 400-square-meter plot. Total bryophyte cover in plots ranges from 0–3%. Characteristic mosses include *Thuidium delicatulum* (delicate thuidium moss) and *Hypnum imponens* (hypnum moss).

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Pinus strobus* (eastern white pine)
Tree canopy	Broad-leaved deciduous tree	*Liriodendron tulipifera* (tuliptree)
Tree subcanopy	Broad-leaved deciduous tree	*Oxydendrum arboreum* (sourwood)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Lindera benzoin* (northern spicebush)

Characteristic Species: *Galium triflorum* (fragrant bedstraw), *Mitchella repens* (partridgeberry), *Polystichum acrostichoides* (Christmas fern).

Other Noteworthy Species:

Species	GRank	Type	Note
Carex cumberlandensis (Cumberland sedge)	-	plant	WV state-critically imperiled

Subnational Distribution with Crosswalk Data:

State	SRank	Conf	SName	Reference
WV	SNA	1		Vanderhorst 2001b

Local Range: A total of 94 polygons covering 72 hectares are mapped in the park. The majority of stands are scattered on terraces and lower slopes along the length of the Bluestone River and larger tributaries in the park. A few stands occur on midslopes and plateau tops.

Classification Comments: Plots of this association in the Bluestone National Scenic River have greater cover by *Liriodendron tulipifera* (tuliptree) and greater cover and diversity in the shrub and herb layers compared to plots sampled at New River Gorge National River (Vanderhorst et al. 2007). This may reflect more fertile soils derived from shale and alluvium at Bluestone compared to sterile soils derived from sandstone at New River.

Other Comments: Information not available.

Local Description Authors: J. P. Vanderhorst.

Plots: Eleven plots were sampled: BLUE.4, BLUE.11, BLUE.34, BLUE.40, BLUE.46, BLUE.64, BLUE.65, BLUE.68, BLUE.81, BLUE.82, and BLUE.135.

Bluestone National Scenic River Inventory Notes: Information not available.

GLOBAL INFORMATION

NVC CLASSIFICATION

Physiognomic Class	Forest (I)
Physiognomic Subclass	Evergreen forest (I.A.)
Physiognomic Group	Temperate or subpolar needle-leaved evergreen forest (I.A.8.)
Physiognomic Subgroup	Natural/Semi-natural temperate or subpolar needle-leaved evergreen forest (I.A.8.N.)
Formation	Rounded-crowned temperate or subpolar needle-leaved evergreen forest (I.A.8.N.b.)
Alliance	*Pinus strobus* Forest Alliance (A.128)
Alliance (English name)	Eastern White Pine Forest Alliance

Association	*Pinus strobus* Successional Forest
Association (English name)	Eastern White Pine Successional Forest
Ecological System(s):	Appalachian (Hemlock) - Northern Hardwood Forest (CES202.593). Northeastern Interior Dry - Mesic Oak Forest (CES202.592).

GLOBAL DESCRIPTION

Concept Summary: This is an early-successional forest dominated by *Pinus strobus* (eastern white pine), typically with a very dense canopy and little understory. It is commonly associated with anthropogenic disturbance (e.g., former old fields and formerly cleared flats along streams) and could potentially occur anywhere within the range of the *Pinus strobus* Forest Alliance (A.128). Associated woody and herbaceous species vary with geography. In the northeastern states, the tree canopy is often monotypic and even-aged, with occasional associates including *Acer rubrum* (red maple), *Juniperus virginiana* (eastern redcedar), *Liriodendron tulipifera* (tuliptree) (within its range), or scattered *Quercus rubra* (northern red oak) or *Quercus velutina* (black oak). In regions where northern hardwoods are more prevalent, canopy associates include *Fraxinus americana* (white ash) and *Acer saccharum* (sugar maple). In the Southern Blue Ridge and nearby areas, typical canopy and subcanopy associates include *Liriodendron tulipifera* (tuliptree), *Acer rubrum* (red maple), *Pinus rigida* (pitch pine), and *Liquidambar styraciflua* (sweetgum), with *Tsuga canadensis* (eastern hemlock) often forming a dense shrub stratum. The understory is typically poorly developed or characterized by scattered individuals found in the canopy. The herbaceous cover is variable depending on the density of tree and shrub cover, and may be characterized by ruderal or exotic species that favor openings or disturbance. In more open stands, typical species are those associated with old fields, including *Solidago rugosa* (wrinkleleaf goldenrod), *Solidago gigantea* (giant goldenrod), *Anthoxanthum odoratum* (sweet vernalgrass), *Poa pratensis* (Kentucky bluegrass), *Schizachyrium scoparium* (little bluestem), *Elymus repens* (quackgrass), *Bromus inermis* (smooth brome), *Agrostis gigantea* (redtop), *Euthamia graminifolia* (flat-top goldentop), *Achillea millefolium* (common yarrow), and *Daucus carota* (Queen Anne's lace). In stands that are more heavily forested, typical herbs include *Aralia nudicaulis* (wild sarsaparilla), *Ageratina altissima* (white snakeroot), *Galium triflorum* (fragrant bedstraw), *Maianthemum canadense* (Canada mayflower), *Trientalis borealis* (starflower), *Mitchella repens* (partridgeberry), *Polystichum acrostichoides* (Christmas fern), and *Lycopodium* (clubmoss) species. The particular composition of the herb layer will vary with geography. The substrate is usually covered by a thick layer of pine needle duff. In the Daniel Boone National Forest of Kentucky, *Pinus strobus* (eastern white pine) is spreading from plantings, especially in the Red River Gorge.

Environmental Description: This wide-ranging successional forest is commonly associated with anthropogenic disturbance and could potentially occur anywhere within the range of the *Pinus strobus* Forest Alliance (A.128). It typically occurs on former agricultural lands and old fields that are no longer intensively mowed, plowed or managed, developing as *Pinus strobus* (eastern white pine) colonizes the open fields. Associated woody and herbaceous species vary with geography but are typically ruderal or exotic species that favor openings or disturbance.

Vegetation Description: The tree canopy ranges from woodland to forest closure, with 25–85% cover. It is often monotypic and even-aged *Pinus strobus* (eastern white pine), with occasional associates, including *Acer rubrum* (red maple), *Betula lenta* (sweet birch), *Juniperus virginiana* (eastern redcedar), or scattered *Quercus rubra* (northern red oak) or *Quercus velutina* (black oak). In regions where northern hardwoods are more prevalent, canopy associates include

Fraxinus americana (white ash) and *Acer saccharum* (sugar maple). In the Southern Blue Ridge and nearby areas, typical canopy and subcanopy associates include *Liriodendron tulipifera* (tuliptree), *Acer rubrum* (red maple), *Pinus rigida* (pitch pine), and *Liquidambar styraciflua* (sweetgum), with *Tsuga canadensis* (eastern hemlock) often forming a dense shrub stratum. The understory is poorly developed or characterized by scattered individuals found in the canopy. Shrubs are often present in the more open stands and include native species, such as *Cornus racemosa* (gray dogwood), *Rhus glabra* (smooth sumac), *Viburnum prunifolium* (blackhaw), and *Rubus* (blackberry) spp., as well as exotics, such as *Elaeagnus umbellata* (autumn olive), *Rosa multiflora* (multiflora rose), *Lonicera morrowii* (Morrow's honeysuckle), and *Berberis thunbergii* (Japanese barberry). The herbaceous cover is variable depending on the density of tree and shrub cover, and may be characterized by ruderal or exotic species that favor openings or disturbance. In more open stands, typical species are those associated with old fields, such as *Solidago rugosa* (wrinkleleaf goldenrod), *Solidago gigantea* (giant goldenrod), *Anthoxanthum odoratum* (sweet vernalgrass), *Poa pratensis* (Kentucky bluegrass), *Schizachyrium scoparium* (little bluestem), *Elymus repens* (quackgrass), *Bromus inermis* (smooth brome), *Agrostis gigantea* (redtop), *Euthamia graminifolia* (flat-top goldentop), *Achillea millefolium* (common yarrow), and *Daucus carota* (Queen Anne's lace). In stands that are more heavily forested, typical herbs include *Aralia nudicaulis* (wild sarsaparilla), *Ageratina altissima* (white snakeroot), *Galium triflorum* (fragrant bedstraw), *Maianthemum canadense* (Canada mayflower), *Medeola virginiana* (Indian cucumber), *Polystichum acrostichoides* (Christmas fern), *Trientalis borealis* (starflower), *Mitchella repens* (partridgeberry), and *Lycopodium* (clubmoss) species. The particular composition of the herb layer will vary with geography. The substrate is usually covered by a thick layer of pine needle duff.

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Pinus strobus* (eastern white pine)

Characteristic Species: *Pinus strobus* (eastern white pine).

Other Noteworthy Species:

Species	GRank	Type	Note
Achillea millefolium (common yarrow)	-	plant	exotic
Agrostis gigantea (redtop)	-	plant	exotic
Anthoxanthum odoratum (sweet vernalgrass)	-	plant	exotic
Berberis thunbergii (Japanese barberry)	-	plant	exotic
Daucus carota (Queen Anne's lace)	-	plant	exotic
Elaeagnus umbellata (autumn olive)	-	plant	exotic
Elymus repens (quackgrass)	-	plant	exotic
Lonicera morrowii (Morrow's honeysuckle)	-	plant	exotic
Rosa multiflora (multiflora rose)	-	plant	exotic

USFWS Wetland System: Not applicable.

DISTRIBUTION

Range: This successional type may be expected to occur throughout the range of the alliance (i.e., from Michigan, northern Wisconsin, northern and eastern Minnesota, extreme northeastern Iowa, and from Maine and New Hampshire south to Georgia and Tennessee, as well as in Ontario, Canada). It has been documented primarily in areas where project-specific needs have required it.

States/Provinces: CT, GA, KY, MA, MD?, ME, MI, MN, NC, NH, NJ, NY, PA, RI, SC, TN, VA, VT, WI, WV.

Federal Lands: BIA (Eastern Band of Cherokee); NPS (Big South Fork, Blue Ridge Parkway, Bluestone, Carl Sandburg Home, Delaware Water Gap, Gettysburg, Great Smoky Mountains, Marsh-Billings-Rockefeller, New River Gorge, Obed, Saint-Gaudens, Saratoga); USFS (Cherokee?, Daniel Boone, George Washington, Jefferson, Monongahela); USFWS (Great Meadows, Moosehorn).

CONSERVATION STATUS

Rank: GNA (ruderal) (11-Feb-2001).

Reasons: This forest represents successional vegetation and is thus not of high conservation concern and does not receive a conservation status rank.

CLASSIFICATION INFORMATION

Status: Standard.

Confidence: 2 - Moderate.

Comments: This successional type may be expected to occur throughout the range of the alliance but has primarily been attributed in areas where The Nature Conservancy ecoregional planning or other project-specific needs have documented its occurrence. Rangewide review should greatly expand its geographic scope.

Similar Associations:

- *Pinus strobus* Planted Forest (CEGL007178).

Related Concepts:

- *Pinus strobus / (Diphasiastrum digitatum, Lycopodium obscurum)* forest (Vanderhorst 2001b) =
- White Pine - White Oak - Chestnut Oak Type (Schmalzer and DeSelm 1982) B
- semi-natural (Chapman et al. 1989) ?

SOURCES

Description Authors: K. D. Patterson, mod. L. A. Sneddon and S. C. Gawler.

References: Chapman et al. 1989, Fleming and Coulling 2001, NRCS 2004, NatureServe Ecology - Southeastern U.S. unpubl. data, Schmalzer and DeSelm 1982, Southeastern Ecology Working Group n.d., TDNH unpubl. data, Vanderhorst 2001b, Vanderhorst et al. 2007, Vanderhorst et al. 2008.

Figure B11. An example of Successional Eastern White Pine - Tuliptree Forest from the Bluestone National Scenic River.

COMMON NAME (PARK-SPECIFIC): SUCCESSIONAL EASTERN RED-CEDAR WOODLAND

SYNONYMS
NVC English Name: **Eastern Red-cedar Forest**
NVC Scientific Name: ***Juniperus virginiana* Forest**
NVC Identifier: **CEGL006024**

LOCAL INFORMATION

Environmental Description: This successional woodland occurs on a high floodplain, alluvial terrace, and lower gorge slope previously cleared for agriculture. The site is mapped as unforested (white) on the 1912 Big Bend USGS 15' topographic map. Part of the stand is temporarily flooded by reservoir backup from Bluestone Lake. Slopes in the one mapped polygon range from 7 to 19 degrees (mean = 10.9). Elevations in the mapped polygon range from 445 to 471 m (mean = 457.3). The topographic position of the stand and canopy dominance by *Juniperus virginiana* var. *virginiana* (eastern redcedar) probably reflect the influence of calcareous bedrock on soil chemistry. Adjacent associations in the Modified Successional Floodplain Forest and Woodland map class may include Riverbank Tall Herbs (CEGL006480), Successional Box-elder Floodplain Forest (CEGL005033), Successional Black Walnut Floodplain Forest (CEGL007879), Successional Tuliptree / Northern Spicebush Forest (CEGL007220), River Birch Backwater Floodplain Forest (CEGL002086), and Sycamore - Ash Floodplain Forest (CEGL006458).
Vegetation Description: The stand is composed of short, widely spaced *Juniperus virginiana* var. *virginiana* (eastern redcedar) with deciduous saplings, shrubs, and vines forming a dense thicket, with openings occupied by weedy herbs. No plots were sampled but associated species recorded at two accuracy assessment points include the native tree *Liriodendron tulipifera* (tuliptree), the native shrub *Lindera benzoin* (northern spicebush), and the exotic shrubs *Ligustrum vulgare* (European privet) and *Rosa multiflora* (multiflora rose).
Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus virginiana* var. *virginiana* (eastern redcedar)
Tree canopy	Broad-leaved deciduous tree	*Liriodendron tulipifera* (tuliptree)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Ligustrum vulgare* (European privet)
		Lindera benzoin (northern spicebush)
		Rosa multiflora (multiflora rose)

Characteristic Species: Information not available.
Other Noteworthy Species:

Species	GRank	Type	Note
Ligustrum vulgare (European privet)	-	plant	exotic
Rosa multiflora (multiflora rose)	-	plant	exotic

Subnational Distribution with Crosswalk Data:

State	SRank	Conf	SName	Reference
WV	SNA	1		Vanderhorst et al. 2008

Local Range: One 1.61-hectare polygon of this association is mapped on the floodplain of the Bluestone River, river right, in the northern section of the park.
Classification Comments: Information not available.
Other Comments: Information not available.

Local Description Authors: J. P. Vanderhorst.
Plots: The single stand was observed but not plot sampled.
Bluestone National Scenic River Inventory Notes: Accuracy assessment points BLUE.1113 and BLUE.1114 were sampled in the mapped polygon of this association. One additional accuracy assessment point, BLUE.1343, located within a polygon of the Floodplain Forest map class at the mouth of Mountain Creek, was attributed to this association, but *Juniperus virginiana* var. *virginiana* (eastern redcedar) is not listed in the species table for this point.

GLOBAL INFORMATION

NVC CLASSIFICATION

Physiognomic Class	Forest (I)
Physiognomic Subclass	Evergreen forest (I.A.)
Physiognomic Group	Temperate or subpolar needle-leaved evergreen forest (I.A.8.)
Physiognomic Subgroup	Natural/Semi-natural temperate or subpolar needle-leaved evergreen forest (I.A.8.N.)
Formation	Conical-crowned temperate or subpolar needle-leaved evergreen forest (I.A.8.N.c.)
Alliance	*Juniperus virginiana* Semi-natural Forest Alliance (A.137)
Alliance (English name)	Eastern Red-cedar Forest Alliance
Association	*Juniperus virginiana* Forest
Association (English name)	Eastern Red-cedar Forest
Ecological System(s):	Information not available.

GLOBAL DESCRIPTION

Concept Summary: This association is a broadly defined old-field early-successional community occurring in a variety of environmental settings in the northeastern states. Canopy closure and height are variable, as are shrub and herbaceous associates. *Juniperus virginiana* (eastern redcedar) dominates the canopy layer. Common associates, typically occurring as scattered individuals, may include *Pinus strobus* (eastern white pine), *Acer rubrum* (red maple), *Liriodendron tulipifera* (tuliptree), *Quercus* (oak) spp., and *Prunus serotina* (black cherry). Shrub cover varies, with the most forested stands having little or no shrub cover. Exotic shrubs such as *Elaeagnus umbellata* (autumn olive), *Lonicera morrowii* (Morrow's honeysuckle), *Ligustrum vulgare* (European privet), and *Rosa multiflora* (multiflora rose) are characteristic, along with *Rubus* (blackberry) spp. Herbaceous cover likewise varies. Common species in the more open-canopy stands include old-field denizens such as *Schizachyrium scoparium* (little bluestem), *Festuca rubra* (red fescue), *Anthoxanthum odoratum* (sweet vernalgrass), *Agrostis gigantea* (redtop), *Andropogon virginicus* (broomsedge bluestem), *Elymus repens* (quackgrass), *Solidago rugosa* (wrinkleleaf goldenrod), *Solidago gigantea* (giant goldenrod), *Euthamia graminifolia* (flat-top goldentop), *Monarda fistulosa* (wild bergamot), *Toxicodendron radicans* (eastern poison ivy), *Achillea millefolium* (common yarrow), and *Daucus carota* (Queen Anne's lace). In dense forest stands, herbs may be absent or limited to scattered shade-tolerant species such as *Alliaria petiolata* (garlic mustard) and *Allium vineale* (wild garlic), and *Dennstaedtia punctilobula* (eastern hayscented fern). These forests are often young and result from the colonization of old agricultural fields by *Juniperus virginiana* (eastern redcedar) over native and exotic forbs and grasses. These stands may eventually succeed to other forest types as mid- and late-successional canopy species colonize and subsequently overtop the *Juniperus* (juniper).

Environmental Description: This is a broadly defined old-field early-successional community occurring in a variety of environmental settings, typically on former agricultural land and other disturbed or degraded environmental settings. Soils are mesic to dry-mesic and moderately well-drained to well-drained.

Vegetation Description: *Juniperus virginiana* (eastern redcedar) dominates the canopy layer in stands of this type, which ranges from broadly spaced woodlands to dense and nearly impenetrable thickets. Common associates, typically occurring as scattered individuals, may include *Pinus strobus* (eastern white pine), *Acer rubrum* (red maple), *Liriodendron tulipifera* (tuliptree), *Quercus* (oak) spp., and *Prunus serotina* (black cherry). Shrub cover varies according to canopy closure, with the most forested stands having little or no shrub cover. Exotic shrubs such as *Elaeagnus umbellata* (autumn olive), *Lonicera morrowii* (Morrow's honeysuckle), *Ligustrum vulgare* (European privet), and *Rosa multiflora* (multiflora rose) are most characteristic, along with *Rubus* (blackberry) spp. Herbaceous cover likewise varies. Common species in the more open-canopy stands include old-field denizens such as *Schizachyrium scoparium* (little bluestem), *Andropogon virginicus* (broomsedge bluestem), *Festuca rubra* (red fescue), *Anthoxanthum odoratum* (sweet vernalgrass), *Agrostis gigantea* (redtop), *Elymus repens* (quackgrass), *Solidago rugosa* (wrinkleleaf goldenrod), *Solidago gigantea* (giant goldenrod), *Euthamia graminifolia* (flat-top goldentop), *Monarda fistulosa* (wild bergamot), *Toxicodendron radicans* (eastern poison ivy), *Achillea millefolium* (common yarrow), and *Daucus carota* (Queen Anne's lace). In dense forest stands, herbs may be absent or limited to scattered shade-tolerant species such as *Alliaria petiolata* (garlic mustard), *Allium vineale* (wild garlic), and *Dennstaedtia punctilobula* (eastern hayscented fern).

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus virginiana* (eastern redcedar)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Lonicera morrowii* (Morrow's honeysuckle)
Tall shrub/sapling	Needle-leaved tree	*Juniperus virginiana* (eastern redcedar)
Tall shrub/sapling	Broad-leaved deciduous shrub	*Elaeagnus umbellata* (autumn olive)
Short shrub/sapling	Broad-leaved deciduous shrub	*Rosa multiflora* (multiflora rose)
		Toxicodendron radicans (eastern poison ivy)
Herb (field)	Forb	*Solidago rugosa* (wrinkleleaf goldenrod)
Herb (field)	Graminoid	*Schizachyrium scoparium* (little bluestem)

Characteristic Species: *Elaeagnus umbellata* (autumn olive), *Juniperus virginiana* (eastern redcedar), *Lonicera morrowii* (Morrow's honeysuckle), *Rosa multiflora* (multiflora rose), *Schizachyrium scoparium* (little bluestem), *Solidago rugosa* (wrinkleleaf goldenrod), *Toxicodendron radicans* (eastern poison ivy).

Other Noteworthy Species:

Species	GRank	Type	Note
Achillea millefolium (common yarrow)	-	plant	exotic
Agrostis gigantea (redtop)	-	plant	exotic
Alliaria petiolata (garlic mustard)	-	plant	exotic
Allium vineale (wild garlic)	-	plant	exotic
Anthoxanthum odoratum (sweet vernalgrass)	-	plant	exotic
Daucus carota (Queen Anne's lace)	-	plant	exotic
Elaeagnus umbellata (autumn olive)	-	plant	exotic
Elymus repens (quackgrass)	-	plant	exotic
Lonicera morrowii (Morrow's honeysuckle)	-	plant	exotic
Rosa multiflora (multiflora rose)	-	plant	exotic

USFWS Wetland System: Not applicable.

DISTRIBUTION

Range: This association is of broad distribution, occurring widely throughout the northeastern U.S. It has been documented from only a limited range but is undoubtedly more widely distributed.
States/Provinces: MA, NJ, NY, PA, VA, WV.
Federal Lands: NPS (Appomattox Court House, Bluestone, Boston Harbor Islands, C&O Canal?, Cape Cod, Delaware Water Gap, Fire Island, Fredericksburg-Spotsylvania, George Washington Birthplace, Richmond); USFS (Monongahela).

CONSERVATION STATUS

Rank: GNA (ruderal) (10-Oct-2001).
Reasons: This forest represents early-successional, modified, or silviculturally managed vegetation and is thus not of high conservation concern and does not receive a conservation status rank. This vegetation may be easily restorable by either management, time, or restoration of ecological processes.

CLASSIFICATION INFORMATION

Status: Standard.
Confidence: 3 - Weak.
Comments: This association is currently very generally defined.
Similar Associations: Information not available.
Related Concepts: Information not available.

SOURCES

Description Authors: L. A. Sneddon, mod. R. E. Zaremba, M. Pyne, S. C. Gawler.
References: Clark 1986, Eastern Ecology Working Group n.d., Sneddon and Lundgren 2001, Vanderhorst et al. 2008.

Figure B12. An example of Successional Eastern Red-cedar Woodland from the Bluestone National Scenic River.

COMMON NAME (PARK-SPECIFIC): EASTERN HEMLOCK FLOODPLAIN FOREST

SYNONYMS

NVC English Name:	**Eastern Hemlock - Northern Red Oak - (Sycamore, River Birch) / Great Laurel / Nightcaps Forest**
NVC Scientific Name:	***Tsuga canadensis - Quercus rubra - (Platanus occidentalis, Betula nigra) / Rhododendron maximum / Anemone quinquefolia* Forest [Provisional]**
NVC Identifier:	**CEGL006620**

LOCAL INFORMATION

Environmental Description: This association occurs in small patches on higher floodplains of medium-sized streams which are infrequently flooded. Along smaller streams, stands may occur in positions subject to more frequent, low-energy floods. It was probably more abundant prior to development of upper floodplains for agriculture starting in the in the late 1700s continuing through the mid-1900s. Mature stands along rivers may represent late-successional vegetation on stabilized terraces, but succession may be reversed by renewed scouring and bank erosion as rivers migrate across their floodplains. Microtopography is characterized by fluvial features including levees and swales. Slopes in mapped polygons range from 1 to 23 degrees (mean = 8.2). Elevations in mapped polygons range from 457 to 490 m (mean = 471). Unvegetated ground cover is typically dominated by litter but may also include coarse woody debris (flotsam) and exposed sand and rock in more recently flooded examples. Soils from one plot are described as temporarily flooded, well-drained, deep, stone-free sand with a thin surficial duff layer. Soils tested strongly acidic (mean pH = 4.9) with relatively high levels of K, Mn, and Zn, and relatively low levels of organic matter, estimated N release, S, Al, B, Ca, Cu, Fe, Mg, Na, and P compared to average values in the park. Adjacent associations in the Floodplain Forest and Woodland map class may include Oak - Hickory Floodplain Forest (CEGL006462), Sycamore - Yellow Buckeye Floodplain Forest (CEGL006466), Sycamore - River Birch Riverscour Woodland (CEGL003725), and Riverbank Tall Herbs (CEGL006480). Adjacent, previously farmed terraces are often occupied by Successional Eastern White Pine - Tuliptree Forest (CEGL007944), some stands of which appear to be succeeding towards Eastern Hemlock Floodplain Forest.

Vegetation Description: This association is a mixed evergreen-deciduous floodplain forest codominated by *Tsuga canadensis* (eastern hemlock) in the canopy and/or subcanopy. Canopy cover in the one plot is 40% and subcanopy cover is 50%. Codominant trees in the plot include *Tsuga canadensis* (eastern hemlock), *Acer rubrum* var. *rubrum* (red maple), and *Quercus rubra* (northern red oak). Mature stands have *Tsuga canadensis* (eastern hemlock) codominant in the canopy layer, but younger stands (represented by the single plot at Bluestone) may have dominance by this shade-tolerant species in the lower strata. Additional trees in the plot include *Liriodendron tulipifera* (tuliptree), *Betula lenta* (sweet birch), *Fagus grandifolia* (American beech), *Fraxinus pennsylvanica* (green ash), *Robinia pseudoacacia* (black locust), and *Sassafras albidum* (sassafras). Additional tree species which characterize this association as a floodplain forest, including *Platanus occidentalis* (American sycamore) and *Betula nigra* (river birch), usually occur at low cover. Shrub layers may have moderate to dense cover and are dominated by *Rhododendron maximum* (great laurel). Herb layers are sparse and species-poor but usually include a few species more typical of floodplains than of upland hemlock forests. Herbs in the

plot include *Amphicarpaea bracteata* (American hogpeanut), *Arisaema triphyllum* ssp. *triphyllum* (Jack in the pulpit), *Aristolochia macrophylla* (pipevine), *Conopholis americana* (American squawroot), *Cryptotaenia canadensis* (Canadian honewort), *Eurybia divaricata* (white wood aster), *Galium triflorum* (fragrant bedstraw), *Maianthemum canadense* (Canada mayflower), *Maianthemum racemosum* ssp. *racemosum* (feathery false lily of the valley), *Mitchella repens* (partridgeberry), *Osmorhiza claytonii* (Clayton's sweetroot), *Parthenocissus quinquefolia* (Virginia creeper), *Polygonatum pubescens* (hairy Solomon's seal), *Polystichum acrostichoides* (Christmas fern), and *Rudbeckia laciniata* var. *laciniata* (cutleaf coneflower). Vascular plant species richness in the plot is 32 species per 400 square meters.

Most Abundant Species:

Stratum	Lifeform	Species
Tree (canopy & subcanopy)	Needle-leaved tree	*Tsuga canadensis* (eastern hemlock)
Tree canopy	Broad-leaved deciduous tree	*Acer rubrum* var. *rubrum* (red maple)
		Quercus rubra (northern red oak)
Shrub/sapling (tall & short)	Broad-leaved evergreen shrub	*Rhododendron maximum* (great laurel)

Characteristic Species: *Amphicarpaea bracteata* (American hogpeanut), *Maianthemum canadense* (Canada mayflower), *Maianthemum racemosum* ssp. *racemosum* (feathery false lily of the valley), *Mitchella repens* (partridgeberry), *Rudbeckia laciniata* var. *laciniata* (cutleaf coneflower).

Other Noteworthy Species: Information not available.

Subnational Distribution with Crosswalk Data:

State	SRank	Conf	SName	Reference
WV	SNR	1	*Tsuga canadensis - Quercus rubra (Platanus occidentalis, Betula* nigra) / Rhododendron maximum / Anemone quinquefolia Forest	Vanderhorst et al. 2008

Local Range: A total of 12 polygons covering 2.93 hectares are mapped in the park. Stands occur along the Little Bluestone River, Mountain Creek (see inventory notes), and along the Bluestone River upstream from Pilot Ridge.

Classification Comments: This new association is classified based on data from seven plots from the Bluestone, Gauley, and Shavers Fork rivers in West Virginia. It has also been observed along the Greenbrier River and some of its tributaries (e.g., Anthony Creek) and from tributaries of the Shavers Fork River (e.g., Pheasant Run). It is floristically similar to upland mixed deciduous-hemlock forests (e.g., Tuliptree - Sweet Birch - Eastern Hemlock / Great Laurel Forest (CEGL007543)), but the presence of floodplain species and contrasting disturbance and successional dynamics support its recognition as a distinct association. Additional characteristic species found in plots outside Bluestone include *Betula nigra* (river birch), *Liquidambar styraciflua* (sweetgum), *Platanus occidentalis* (American sycamore), *Anemone quinquefolia* (nightcaps), and *Carex plantaginea* (plantainleaf sedge).

Other Comments: *Tsuga canadensis* (eastern hemlock) is currently threatened by the exotic insect hemlock woolly adelgid (*Adelges tsugae*). This pest was first discovered in the park in 2000 and NPS has since initiated insecticide treatment and monitoring of individual trees (J. Perez pers. comm.). Many hemlocks in the park appear stressed, but large scale mortality was not observed during the 2003–2006 vegetation surveys. This association helps maintain cool microclimates along streams which are important for cold-water fishes and other aquatic life.

Local Description Authors: J. P. Vanderhorst.

Plots: One plot was sampled: BLUE.93.

Bluestone National Scenic River Inventory Notes: One accuracy assessment point along Mountain Creek attributed to this association was originally mismapped as Successional Eastern

White Pine - Tuliptree Forest. Attribution of polygons of this stand were corrected following accuracy assessment. This error could be repeated elsewhere due to the difficulty of distinguishing aerial photo signatures of *Tsuga canadensis* (eastern hemlock) and *Pinus strobus* (eastern white pine).

GLOBAL INFORMATION

NVC CLASSIFICATION

Physiognomic Class	Forest (I)
Physiognomic Subclass	Evergreen forest (I.A.)
Physiognomic Group	Temperate or subpolar needle-leaved evergreen forest (I.A.8.)
Physiognomic Subgroup	Natural/Semi-natural temperate or subpolar needle-leaved evergreen forest (I.A.8.N.)
Formation	Temporarily flooded temperate or subpolar needle-leaved evergreen forest (I.A.8.N.e.)
Alliance	*Tsuga canadensis - (Pinus strobus)* Temporarily Flooded Forest Alliance (A.171)
Alliance (English name)	Eastern Hemlock - (Eastern White Pine) Temporarily Flooded Forest Alliance
Association	*Tsuga canadensis - Quercus rubra - (Platanus occidentalis, Betula nigra) / Rhododendron maximum / Anemone quinquefolia* Forest [Provisional]
Association (English name)	Eastern Hemlock - Northern Red Oak - (Sycamore, River Birch) / Great Laurel / Nightcaps Forest
Ecological System(s):	Information not available.

GLOBAL DESCRIPTION

Concept Summary: This association is a mixed evergreen-deciduous floodplain forest, usually with a somewhat open canopy, with *Tsuga canadensis* (eastern hemlock) prominent in the canopy and/or subcanopy. It occurs in small patches on higher floodplains of medium-sized streams which are infrequently flooded. Along smaller streams, stands may occur in positions subject to more frequent, low-energy floods. Mature stands along rivers may represent late-successional vegetation on stabilized terraces, but succession may be reversed by renewed scouring and bank erosion as rivers migrate across their floodplains. Microtopography is characterized by fluvial features including levees and swales. Codominant trees include *Tsuga canadensis* (eastern hemlock), *Acer rubrum* var. *rubrum* (red maple), and *Quercus rubra* (northern red oak). Mature stands have *Tsuga canadensis* (eastern hemlock) codominant in the canopy layer, but younger stands may have dominance by this shade-tolerant species in the lower strata. Additional trees include *Liriodendron tulipifera* (tuliptree), *Betula lenta* (sweet birch), *Fagus grandifolia* (American beech), *Fraxinus pennsylvanica* (green ash), *Robinia pseudoacacia* (black locust), and *Sassafras albidum* (sassafras). Tree species that characterize this association as a floodplain forest, including *Platanus occidentalis* (American sycamore) and *Betula nigra* (river birch), usually occur at low cover. Shrub layers may have moderate to dense cover and are dominated by *Rhododendron maximum* (great laurel). Herb layers are sparse and species-poor but usually include a few species more typical of floodplains than of upland hemlock forests, such as *Amphicarpaea bracteata* (American hogpeanut), *Arisaema triphyllum* (Jack in the

pulpit), *Cryptotaenia canadensis* (Canadian honewort), and *Rudbeckia laciniata* (cutleaf coneflower).

Environmental Description: This association occurs in small patches on higher floodplains of medium-sized streams which are infrequently flooded. Along smaller streams, stands may occur in positions subject to more frequent, low-energy floods. Mature stands along rivers may represent late-successional vegetation on stabilized terraces, but succession may be reversed by renewed scouring and bank erosion as rivers migrate across their floodplains. Microtopography is characterized by fluvial features including levees and swales. In Bluestone National Scenic River in West Virginia, this association occurs at elevations ranging from 457–490 m (1485–1600 feet). Unvegetated ground cover is typically dominated by litter but may also include coarse woody debris (flotsam) and exposed sand and rock in more recently flooded examples. Based on limited fieldwork, soils are described as temporarily flooded, well-drained, deep, stone-free sand with a thin surficial duff layer, and tested strongly acidic (mean pH = 4.9).

Vegetation Description: This association is a mixed evergreen-deciduous floodplain forest, usually with a somewhat open canopy, codominated by *Tsuga canadensis* (eastern hemlock) in the canopy and/or subcanopy. Trees along the river's edge often lean towards and eventually topple into the river as the banks are undercut. Codominant trees include *Tsuga canadensis* (eastern hemlock), *Acer rubrum* var. *rubrum* (red maple), and *Quercus rubra* (northern red oak). Mature stands have *Tsuga canadensis* (eastern hemlock) codominant in the canopy layer, but younger stands may have dominance by this shade-tolerant species in the lower strata. Additional trees include *Liriodendron tulipifera* (tuliptree), *Betula lenta* (sweet birch), *Fagus grandifolia* (American beech), *Fraxinus pennsylvanica* (green ash), *Robinia pseudoacacia* (black locust), and *Sassafras albidum* (sassafras). Tree species that characterize this association as a floodplain forest, including *Platanus occidentalis* (American sycamore) and *Betula nigra* (river birch), usually occur at low cover. Shrub layers may have moderate to dense cover and are dominated by *Rhododendron maximum* (great laurel). Herb layers are sparse and species-poor but usually include a few species more typical of floodplains than of upland hemlock forests. Herbs include *Amphicarpaea bracteata* (American hogpeanut), *Arisaema triphyllum* (Jack in the pulpit), *Aristolochia macrophylla* (pipevine), *Conopholis americana* (American squawroot), *Cryptotaenia canadensis* (Canadian honewort), *Eurybia divaricata* (white wood aster), *Galium triflorum* (fragrant bedstraw), *Maianthemum canadense* (Canada mayflower), *Maianthemum racemosum* ssp. *racemosum* (feathery false lily of the valley), *Mitchella repens* (partridgeberry), *Osmorhiza claytonii* (Clayton's sweetroot), *Parthenocissus quinquefolia* (Virginia creeper), *Polygonatum pubescens* (hairy Solomon's seal), *Polystichum acrostichoides* (Christmas fern), and *Rudbeckia laciniata* var. *laciniata* (cutleaf coneflower).

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Tsuga canadensis* (eastern hemlock)
Tree canopy	Broad-leaved deciduous tree	*Acer rubrum* (red maple)
		Betula lenta (sweet birch)
		Liriodendron tulipifera (tuliptree)
		Quercus rubra (northern red oak)
Shrub/sapling (tall & short)	Broad-leaved evergreen shrub	*Rhododendron maximum* (great laurel)
Herb (field)	Vine/Liana	*Aristolochia macrophylla* (pipevine)
Herb (field)	Forb	*Arisaema triphyllum* (Jack in the pulpit)

Characteristic Species: *Anemone quinquefolia* (nightcaps), *Betula nigra* (river birch), *Carex plantaginea* (plantainleaf sedge), *Liquidambar styraciflua* (sweetgum), *Maianthemum racemosum* ssp. *racemosum* (feathery false lily of the valley), *Mitchella repens* (partridgeberry),

Platanus occidentalis (American sycamore), *Thuidium delicatulum* (delicate thuidium moss), *Xanthorhiza simplicissima* (yellowroot).
Other Noteworthy Species: Information not available.
USFWS Wetland System: Not applicable.

DISTRIBUTION

Range: This association is currently known from floodplains of medium-sized streams west of the Eastern Continental Divide in West Virginia, including the Bluestone, Gauley, Greenbrier, and Shavers Fork rivers and their tributaries.
States/Provinces: WV.
Federal Lands: NPS (Bluestone); USFS (Monongahela).

CONSERVATION STATUS

Rank: GNR (14-Nov-2007).
Reasons: The area of this association has probably been greatly decreased by conversion of upper floodplains for agriculture and other human uses from the late 1700s through the mid-1900s. *Tsuga canadensis* (eastern hemlock) is currently threatened by the exotic insect hemlock woolly adelgid (*Adelges tsugae*). Many hemlocks are already dead in floodplains along the Greenbrier River, and this insect pest is known from the Bluestone River, while trees along the Shavers Fork still appear healthy. There are currently insufficient data to assign a numeric rank.

CLASSIFICATION INFORMATION

Status: Provisional.
Confidence: 3 - Weak.
Comments: This new association is classified based on data from seven plots from the Bluestone, Gauley, and Shavers Fork rivers in West Virginia. It has also been observed along the Greenbrier River and some of its tributaries (e.g., Anthony Creek) and from tributaries of the Shavers Fork River (e.g., Pheasant Run). It is floristically similar to upland mixed deciduous-hemlock forests (e.g., *Liriodendron tulipifera - Betula lenta - Tsuga canadensis / Rhododendron maximum* Forest (CEGL007543)), but the presence of floodplain species and contrasting disturbance and successional dynamics support its recognition as a distinct association. Additional characteristic species found in plots outside Bluestone include *Betula nigra* (river birch), *Liquidambar styraciflua* (sweetgum), *Platanus occidentalis* (American sycamore), *Anemone quinquefolia* (nightcaps), and *Carex plantaginea* (plantainleaf sedge).
Similar Associations: Information not available.
Related Concepts: Information not available.

SOURCES

Description Authors: S. C. Gawler.
References: Eastern Ecology Working Group n.d., Perez pers. comm., Vanderhorst et al. 2008.

Figure B13. An example of Eastern Hemlock Floodplain Forest from the Bluestone National Scenic River.

COMMON NAME (PARK-SPECIFIC): SUCCESSIONAL BLACK WALNUT FLOODPLAIN FOREST

SYNONYMS
NVC English Name: **Black Walnut / Wingstem Forest**
NVC Scientific Name: ***Juglans nigra / Verbesina alternifolia* Forest**
NVC Identifier: **CEGL007879**

LOCAL INFORMATION

Environmental Description: This successional forest or woodland occurs in small patches on floodplains and alluvial terraces in areas previously cleared for agriculture. Most known sites are mapped as unforested (white) on the 1912 Big Bend and 1929 Flattop USGS 15' topographic maps. Stands at lower elevations are temporarily flooded by reservoir backup from Bluestone Lake, and all stands may be subject to flooding from overbank flow and seepage from upslope. Slopes in mapped polygons of the Modified Successional Floodplain Forest and Woodland map class, which includes patches of this association, range from 0 to 30 degrees (mean = 6.5). Elevations in mapped polygons of the Modified Successional Floodplain Forest and Woodland map class range from 436 to 476 m (mean = 442). Soils from plots tested slightly acidic (mean pH = 6.1) with relatively high levels of organic matter, estimated N release, B, Ca, Cu, K, Mg, Mn, Na, P, and Zn, and relatively low levels of S, Al, and Fe compared to average values in the park. Adjacent associations in the Modified Successional Floodplain Forest and Woodland map class may include Riverbank Tall Herbs (CEGL006480), Successional Box-elder Floodplain Forest (CEGL005033), Successional Tuliptree / Northern Spicebush Forest (CEGL007220), River Birch Backwater Floodplain Forest (CEGL002086), and Sycamore - Ash Floodplain Forest (CEGL006458).

Vegetation Description: This association is a successional deciduous forest or woodland dominated by *Juglans nigra* (black walnut). Canopy cover in plots ranges from 20–70% and subcanopy cover in plots ranges from 10–30%. Associated trees include *Acer nigrum* (black maple), *Aesculus flava* (yellow buckeye), *Juglans nigra* (black walnut), *Platanus occidentalis* (American sycamore), and *Ulmus rubra* (slippery elm). Vines include *Vitis vulpina* (frost grape) and *Smilax tamnoides* (bristly greenbrier). Shrub cover in plots ranges from 6–33%. Common shrubs include *Asimina triloba* (pawpaw), *Lindera benzoin* (northern spicebush), *Corylus americana* (American hazelnut), and the exotic invasive *Rosa multiflora* (multiflora rose). Cover of herbs ranges from 10–100% and is higher in stands with open canopies. Herbs with high constancy and/or cover in plots include *Amphicarpaea bracteata* (American hogpeanut), *Apios americana* (groundnut), *Cryptotaenia canadensis* (Canadian honewort), *Dichanthelium clandestinum* (deertongue), *Packera aurea* (golden ragwort), *Polygonum scandens* var. *cristatum* (climbing false buckwheat), *Polygonum virginianum* (jumpseed), *Rudbeckia laciniata* var. *laciniata* (cutleaf coneflower), *Verbesina alternifolia* (wingstem), and *Viola striata* (striped cream violet). Vascular plant species richness in three plots ranges from 26 to 33 (mean = 30.3) species per 400-square-meter plot.

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Juglans nigra* (black walnut)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Asimina triloba* (pawpaw)
		Lindera benzoin (northern spicebush)
Herb (field)	Forb	*Verbesina alternifolia* (wingstem)

Characteristic Species: *Juglans cinerea* (butternut), *Viola striata* (striped cream violet).
Other Noteworthy Species:

Species	GRank	Type	Note
Rosa multiflora (multiflora rose)	-	plant	exotic invasive

Subnational Distribution with Crosswalk Data:

State	SRank	Conf	SName	Reference
WV	SNA	1		Vanderhorst et al. 2008

Local Range: This association is included as one of several within the Modified Successional Floodplain Forest and Woodland map class. A total of 25 polygons (81.34 hectares) of this map class are mapped in the park. Twelve accuracy assessment points in the Modified Successional Floodplain Forest and Woodland map class were attributed to this association. This represents 35% of the accuracy assessment points in this map class and is an indication of the relative abundance of this association within the map class. Known stands of Black Walnut Successional Floodplain Forest are concentrated along lower elevation floodplains of the Bluestone River which are affected by occasional reservoir backup from Bluestone Lake, but small patches also occur in previously farmed areas upstream to the mouth of Mountain Creek.
Classification Comments: Elsewhere in West Virginia (Randolph and Preston counties), this association is known from uplands on soils derived from limestone. Species composition in upland stands is remarkably similar to the plots sampled on floodplains at Bluestone, with high cover by *Lindera benzoin* (northern spicebush) and *Verbesina alternifolia* (wingstem). Occurrence in both upland and riparian habitats is consistent with the newest revision of the global description. Composition and occurrence of some black walnut stands may be the result of selection and or planting by people for nuts and/or wood, and these stands may be difficult to distinguish from natural successional stands.
Other Comments: Information not available.
Local Description Authors: J. P. Vanderhorst.
Plots: Three plots were sampled: BLUE.97, BLUE.99, and BLUE.133.
Bluestone National Scenic River Inventory Notes: Information not available.

GLOBAL INFORMATION

NVC CLASSIFICATION

Physiognomic Class	Forest (I)
Physiognomic Subclass	Deciduous forest (I.B.)
Physiognomic Group	Cold-deciduous forest (I.B.2.)
Physiognomic Subgroup	Natural/Semi-natural cold-deciduous forest (I.B.2.N.)
Formation	Lowland or submontane cold-deciduous forest (I.B.2.N.a.)
Alliance	*Juglans nigra* Forest Alliance (A.1932)
Alliance (English name)	Black Walnut Forest Alliance
Association	*Juglans nigra / Verbesina alternifolia* Forest
Association (English name)	Black Walnut / Wingstem Forest
Ecological System(s):	South-Central Interior Large Floodplain (CES202.705). Southern Interior Low Plateau Dry-Mesic Oak Forest (CES202.898). Central Appalachian River Floodplain (CES202.608).

GLOBAL DESCRIPTION

Concept Summary: This successional black walnut forest of the eastern United States occurs largely on floodplains and alluvial terraces that were cleared for agriculture or homesites, usually having a neutral to basic pH. It has been documented from various-sized drainages. The community was originally defined from former homesites in Great Smoky Mountains National Park, where this association is an open, successional forest. It has since been found on some old pasture sites, associated with former settlements, from Georgia northeast to Pennsylvania, and is potentially a wide-ranging type. The canopy can be closed to somewhat open. *Juglans nigra* (black walnut) forms at least half of the canopy and is often the sole canopy tree. Associated canopy trees vary from site to site and can include *Liriodendron tulipifera* (tuliptree), *Juglans cinerea* (butternut), *Robinia pseudoacacia* (black locust), *Fraxinus americana* (white ash), *Ulmus americana* (American elm), *Platanus occidentalis* (American sycamore), *Acer saccharum* (sugar maple), *Acer nigrum* (black maple), *Morus rubra* (red mulberry), and *Aesculus flava* (yellow buckeye). Additional tree species in the subcanopy can include *Carya cordiformis* (bitternut hickory) and *Celtis occidentalis* (common hackberry). *Sassafras albidum* (sassafras) and/or *Carpinus caroliniana* (American hornbeam) may be present as small trees. The shrub layer may or may not be well-developed; common species include *Asimina triloba* (pawpaw), *Viburnum prunifolium* (blackhaw), *Lindera benzoin* (northern spicebush), *Corylus americana* (American hazelnut), and the exotic invasive *Rosa multiflora* (multiflora rose). The herb layer is variable, often with one or a few species providing most of the cover. *Verbesina alternifolia* (wingstem) (within its range) and *Ageratina altissima* (white snakeroot) are characteristic and may be dominant; other herbs include *Amphicarpaea bracteata* (American hogpeanut), *Agrimonia pubescens* (soft agrimony), *Apios americana* (groundnut), *Cryptotaenia canadensis* (Canadian honewort), *Galium triflorum* (fragrant bedstraw), *Osmorhiza longistylis* (longstyle sweetroot), *Dichanthelium clandestinum* (deertongue), *Packera aurea* (golden ragwort), *Polygonum virginianum* (jumpseed), *Rudbeckia laciniata* (cutleaf coneflower), *Podophyllum peltatum* (mayapple), *Impatiens capensis* (jewelweed), *Circaea lutetiana* ssp. *canadensis* (broadleaf enchanter's nightshade), *Viola striata* (striped cream violet), and *Ambrosia trifida* (great ragweed). The invasive exotics *Microstegium vimineum* (Nepalese browntop), *Alliaria petiolata* (garlic mustard), and *Polygonum caespitosum* (oriental ladysthumb) can be common in this community.

Environmental Description: This community often occurs on floodplains and alluvial terraces that were cleared for agriculture or homesites along streams or on slopes, possibly in association with circumneutral soils. This community was sampled on former homesites along streams at 460–610 m (1500–2000 feet) elevation in the Smokies, as well as on ridgetops, slopes, and stream areas in the Cumberlands, Alleghenies, and Central Appalachians at 430–1070 m (1400–3500 feet). In addition, the association was sampled from the Piedmont of South Carolina in low-lying, poor-drainage areas from approximately 170–200 m (550–650 feet) in elevation. Along the Delaware River and nearby waters, the substrate varies from silt loam to gravelly sandy loams.

Vegetation Description: The canopy can be closed to somewhat open. *Juglans nigra* (black walnut) forms at least half of the canopy and is often the sole canopy tree. Associated canopy trees vary from site to site and can include *Liriodendron tulipifera* (tuliptree), *Juglans cinerea* (butternut), *Robinia pseudoacacia* (black locust), *Fraxinus americana* (white ash), *Ulmus americana* (American elm), *Platanus occidentalis* (American sycamore), *Acer saccharum* (sugar maple), *Acer nigrum* (black maple), *Morus rubra* (red mulberry), and *Aesculus flava* (yellow

buckeye). Additional tree species in the subcanopy can include *Carya cordiformis* (bitternut hickory) and *Celtis occidentalis* (common hackberry). *Sassafras albidum* (sassafras) and/or *Carpinus caroliniana* (American hornbeam) may be present as small trees. The shrub layer may or may not be well-developed; common species include *Asimina triloba* (pawpaw), *Viburnum prunifolium* (blackhaw), *Lindera benzoin* (northern spicebush), *Corylus americana* (American hazelnut), and the exotic invasive *Rosa multiflora* (multiflora rose). The herb layer is variable, often with one or a few species providing most of the cover. *Verbesina alternifolia* (wingstem) (within its range) and *Ageratina altissima* (white snakeroot) are characteristic and may be dominant; other herbs include *Amphicarpaea bracteata* (American hogpeanut), *Agrimonia pubescens* (soft agrimony), *Apios americana* (groundnut), *Cryptotaenia canadensis* (Canadian honewort), *Galium triflorum* (fragrant bedstraw), *Osmorhiza longistylis* (longstyle sweetroot), *Dichanthelium clandestinum* (deertongue), *Packera aurea* (golden ragwort), *Polygonum virginianum* (jumpseed), *Rudbeckia laciniata* (cutleaf coneflower), *Podophyllum peltatum* (mayapple), *Impatiens capensis* (jewelweed), *Circaea lutetiana* ssp. *canadensis* (broadleaf enchanter's nightshade), *Viola striata* (striped cream violet), and *Ambrosia trifida* (great ragweed). The invasive exotics *Microstegium vimineum* (Nepalese browntop), *Alliaria petiolata* (garlic mustard), and *Polygonum caespitosum* (oriental ladysthumb) can be common in this community.

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Juglans nigra* (black walnut)
Herb (field)	Forb	*Verbesina alternifolia* (wingstem)

Characteristic Species: *Cercis canadensis* (eastern redbud), *Juglans nigra* (black walnut), *Rosa multiflora* (multiflora rose), *Verbesina alternifolia* (wingstem).

Other Noteworthy Species:

Species	GRank	Type	Note
Alliaria petiolata (garlic mustard)	-	plant	invasive exotic
Microstegium vimineum (Nepalese browntop)	-	plant	invasive exotic
Polygonum caespitosum (oriental ladysthumb)	-	plant	invasive exotic
Rosa multiflora (multiflora rose)	-	plant	invasive exotic

USFWS Wetland System: Not applicable.

DISTRIBUTION

Range: This association is currently known from Georgia and the Carolinas to Tennessee and Kentucky, north to Pennsylvania and New Jersey where *Juglans nigra* (black walnut) is near the northern end of its range. It may range into adjacent states.

States/Provinces: GA, KY, NC, NJ, NY?, PA, SC, TN, VA, WV.

Federal Lands: BIA (Eastern Band of Cherokee); NPS (Appomattox Court House, Big South Fork, Blue Ridge Parkway, Bluestone, C&O Canal?, Chickamauga-Chattanooga, Colonial, Cumberland Gap, Delaware Water Gap, Great Smoky Mountains, Kings Mountain, Mammoth Cave, Ninety Six, Richmond).

CONSERVATION STATUS

Rank: GNA (ruderal) (2-Apr-2001).

Reasons: This vegetation represents vegetation created by anthropogenic disturbance and is thus not a conservation priority. Grank changed from GW to GD 2001-04-02 MP.

CLASSIFICATION INFORMATION

Status: Standard.

Confidence: 3 - Weak.

Comments: This association was originally described from Great Smoky Mountains National Park where this association can be distinguished with aerial photography.

Similar Associations:

Prunus serotina - Liriodendron tulipifera - Acer rubrum - Fraxinus americana - (Robinia pseudoacacia) Forest (CEGL006599)--is a modified successional forest that may also have a large component of *Juglans nigra* and occurs on disturbed sites, but it is largely dominated by early-successional trees in the canopy.

Related Concepts: Information not available.

SOURCES

Description Authors: K. D. Patterson, mod. R. White and S. C. Gawler.

References: NatureServe Ecology - Southeastern U.S. unpubl. data, Peet et al. unpubl. data 2002, Podniesinski et al. 2006, Southeastern Ecology Working Group n.d., TDNH unpubl. data, Vanderhorst et al. 2008.

Figure B14. An example of Successional Black Walnut Floodplain Forest from the Bluestone National Scenic River.

COMMON NAME (PARK-SPECIFIC) OAK - HICKORY FLOODPLAIN FOREST

SYNONYMS

NVC English Name:	**(Northern Red Oak, Black Oak, White Oak) / American hornbeam - (Mountain Silverbell) / Feathery False Lily-of-the-Valley Forest**
NVC Scientific Name:	***Quercus (rubra, velutina, alba) / Carpinus caroliniana - (Halesia tetraptera) / Maianthemum racemosum* Forest**
NVC Identifier:	**CEGL006462**

LOCAL INFORMATION

Environmental Description: This association occurs in small patches and linear zones in higher positions of river floodplains that are infrequently flooded, and possibly on alluvial terraces that are no longer flooded. Remaining stands are often tightly constricted between successional forests on previously farmed land uphill and more frequently flooded associations downhill. It was probably much more abundant prior to development of upper floodplains and alluvial terraces for agriculture starting in the in the late 1700s continuing through the mid-1900s. Slopes in mapped polygons of the Floodplain Forest and Woodland map class, which includes patches of this association, range from 0 to 34 degrees (mean = 8). Elevations in mapped polygons of the Floodplain Forest and Woodland map class range from 436 to 506 m (mean = 460). Ground cover is dominated by litter or may have a large component of bare soil or sand if the site was recently flooded. Flotsam piles are common. Soils in plots are described as stone-free or somewhat stony, moderately well- to well-drained sand and sandy loam derived from alluvium. Soils from plots tested very to medium acidic (mean pH = 5.0) with relatively high levels of B, Cu, Mg, and Zn, and relatively low levels of organic matter, estimated N release, S, Al, Ca, Cu, Fe, K, Mn, and Na compared to average values in the park. Adjacent associations in the Floodplain Forest and Woodland map class may include Sycamore - Yellow Buckeye Floodplain Forest (CEGL006466), Sycamore - River Birch Riverscour Woodland (CEGL003725), Eastern Hemlock Floodplain Forest (CEGL006620), and Riverbank Tall Herbs (CEGL006480). Adjacent, previously farmed, higher terraces are often occupied by Successional Eastern White Pine - Tuliptree Forest (CEGL007944).

Vegetation Description: This association is a somewhat open- to closed-canopy deciduous floodplain forest dominated by species more typical of uplands. Canopy cover in plots ranges from 10–70%. Canopy dominants include *Quercus rubra* (northern red oak) and *Quercus velutina* (black oak), or stands may be codominated by a mixture of trees, including some upland *Quercus* (oak) or *Carya* (hickory) species. Additional canopy trees in plots include *Carya alba* (mockernut hickory), *Carya cordiformis* (bitternut hickory), *Fagus grandifolia* (American beech), *Fraxinus pennsylvanica* (green ash), *Juglans nigra* (black walnut), *Liriodendron tulipifera* (tuliptree), *Platanus occidentalis* (American sycamore), *Prunus serotina* var. *serotina* (black cherry), *Quercus alba* (white oak), and *Ulmus americana* (American elm). Subcanopy cover in plots ranges from 40–60%. Additional trees found in the subcanopy include *Carpinus caroliniana* ssp. *virginiana* (American hornbeam), *Nyssa sylvatica* (blackgum), and *Acer rubrum* var. *rubrum* (red maple). Shrub cover in plots ranges from 20–80%. Shrubs in plots include *Hamamelis virginiana* (American witchhazel), *Lindera benzoin* (northern spicebush), *Viburnum prunifolium* (blackhaw), *Dirca palustris* (eastern leatherwood), and *Smilax rotundifolia* (roundleaf greenbrier). Herb cover in plots ranges from 20–50%. Herbs with high constancy in

plots include *Verbesina alternifolia* (wingstem), *Sedum ternatum* (woodland stonecrop), *Maianthemum racemosum* ssp. *racemosum* (feathery false lily of the valley), *Galium triflorum* (fragrant bedstraw), *Eurybia divaricata* (white wood aster), *Arisaema triphyllum* ssp. *triphyllum* (Jack in the pulpit), and *Amphicarpaea bracteata* (American hogpeanut). Additional common herbs include *Actaea racemosa* var. *racemosa* (black bugbane), *Symphyotrichum prenanthoides* (crookedstem aster), *Ranunculus abortivus* (littleleaf buttercup), *Carex blanda* (eastern woodland sedge), *Polygonum virginianum* (jumpseed), *Packera aurea* (golden ragwort), *Oxalis violacea* (violet woodsorrel), *Collinsonia canadensis* (richweed), and *Cryptotaenia canadensis* (Canadian honewort). Vascular plant species richness ranges from 62 to 79 (mean = 69) species per 400-square-meter plot. Cover by nonvascular plants is usually low but may include *Climacium americanum* (American climacium moss), *Polytrichum* (polytrichum moss) spp., and other mosses.

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Liriodendron tulipifera* (tuliptree)
		Quercus rubra (northern red oak)
		Quercus velutina (black oak)
Tree subcanopy	Broad-leaved deciduous tree	*Carpinus caroliniana* ssp. *virginiana* (American hornbeam)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Hamamelis virginiana* (American witchhazel)

Characteristic Species: *Maianthemum racemosum* ssp. *racemosum* (feathery false lily of the valley), *Sedum ternatum* (woodland stonecrop).

Other Noteworthy Species: Information not available.

Subnational Distribution with Crosswalk Data:

State	SRank	Rel	Conf	SName	Reference
WV	SNR	=	1		Vanderhorst et al. 2007

Local Range: This association is included as one of several associations within the Floodplain Forest and Woodland map class. A total of 48 polygons (57.11 ha) of this map class are mapped in the park. Eleven accuracy assessment points in the Floodplain Forest and Woodland map class are attributed to this association. These represent 33% of the accuracy assessment points in this map class and are an indication of the relative abundance of this association within the map class. Known stands of Oak - Hickory Floodplain Forest are scattered along the Bluestone River and are concentrated along the Little Bluestone River.

Classification Comments: This association was first described from the New River Gorge (Vanderhorst et al. 2007), but the original name has been changed and the concept broadened to encompass similar forests along the Bluestone and Gauley rivers. *Halesia tetraptera* (mountain silverbell) has high constancy in stands along the New River but is absent from stands along the Bluestone and Gauley rivers.

Other Comments: Information not available.

Local Description Authors: J. P. Vanderhorst.

Plots: Three plots were sampled: BLUE.14, BLUE.58, and BLUE.106.

Bluestone National Scenic River Inventory Notes: Information not available.

GLOBAL INFORMATION

NVC CLASSIFICATION

Physiognomic Class	Forest (I)
Physiognomic Subclass	Deciduous forest (I.B.)
Physiognomic Group	Cold-deciduous forest (I.B.2.)
Physiognomic Subgroup	Natural/Semi-natural cold-deciduous forest (I.B.2.N.)
Formation	Temporarily flooded cold-deciduous forest (I.B.2.N.d.)
Alliance	*Acer saccharum* - *Carya cordiformis* Temporarily Flooded Forest Alliance (A.302)
Alliance (English name)	Sugar Maple - Bitternut Hickory Temporarily Flooded Forest Alliance
Association	*Quercus (rubra, velutina, alba) / Carpinus caroliniana - (Halesia tetraptera) / Maianthemum racemosum* Forest
Association (English name)	(Northern Red Oak, Black Oak, White Oak) / American hornbeam - (Mountain Silverbell) / Feathery False Lily-of-the-Valley Forest
Ecological System(s):	Information not available.

GLOBAL DESCRIPTION

Concept Summary: This association is a closed-canopy to somewhat open-canopy deciduous floodplain forest on the highest positions of river floodplains. These alluvial terraces are infrequently flooded and some are possibly no longer flooded. Low frequency and low energy of flooding is evidenced by the development of litter layers and organic-enriched soil horizons. Soils are well-drained sands and sandy loams, and soil moisture regime may be somewhat dry. The soils are slightly acidic and have relatively high cation levels. Slopes range from level to steep. The canopy is frequently composed of very large-diameter, tall trees, with species more typical of uplands. Dominant trees in the canopy include *Quercus rubra* (northern red oak), *Quercus velutina* (black oak), *Quercus alba* (white oak), *Liriodendron tulipifera* (tuliptree), and *Acer saccharum* (sugar maple). Additional trees which may occur in the canopy and subcanopy include *Acer rubrum* (red maple), *Carya alba* (mockernut hickory), *Carya cordiformis* (bitternut hickory), *Carya ovata* (shagbark hickory), *Fagus grandifolia* (American beech), *Fraxinus pennsylvanica* (green ash), *Juglans nigra* (black walnut), *Magnolia acuminata* (cucumber-tree), *Magnolia tripetala* (umbrella-tree), *Nyssa sylvatica* (blackgum), *Platanus occidentalis* (American sycamore), *Prunus serotina* var. *serotina* (black cherry), and *Ulmus americana* (American elm). The small tree *Halesia tetraptera* (mountain silverbell) is dominant in some areas as a well-developed tall-shrub layer and may extend into the tree subcanopy. Additional shrubs include *Carpinus caroliniana* (American hornbeam), *Dirca palustris* (eastern leatherwood), *Hamamelis virginiana* (American witchhazel), *Lindera benzoin* (northern spicebush), *Smilax rotundifolia* (roundleaf greenbrier), and *Viburnum prunifolium* (blackhaw). Characteristic herbs include *Ageratina altissima* (white snakeroot), *Amphicarpaea bracteata* (American hogpeanut), *Arisaema triphyllum* (Jack in the pulpit), *Cynoglossum virginianum* (wild comfrey), *Dichanthelium boscii* (Bosc's panicgrass), *Eurybia divaricata* (white wood aster), *Galium circaezans* (licorice bedstraw), *Galium triflorum* (fragrant bedstraw), *Hydrastis canadensis* (goldenseal), *Maianthemum racemosum* (feathery false lily of the valley), *Packera aurea* (golden ragwort), *Sedum ternatum* (woodland stonecrop), and *Verbesina alternifolia* (wingstem).

Environmental Description: This association occurs in small patches on the highest positions of river floodplains which are infrequently flooded and possibly on alluvial terraces which are no longer flooded. The largest patches occur on large point bars which have developed along inside bends of large meanders. Evidence of flooding includes fluvial topography, accumulations of rocks on the upstream side of tree bases, and some flotsam. Low frequency and low energy of flooding is evidenced by the development of litter layers and organic-enriched soil horizons. Soils are stone-free or somewhat stony, moderately well- to well-drained sands and sandy loams derived from alluvium, and soil moisture regime may be somewhat dry. Soil chemistry analyzed from six plots indicates slightly acidic soils (mean pH = 5.8 at New River and 5.0 at Bluestone) and relatively high levels of some nutrients (Ca, Mg, Zn) and relatively low levels of organic matter compared to soils of most upland forests in the area. Slopes range from level to steep. Elevations of mapped stands range from 267 to 506 m.

Vegetation Description: This association is a closed-canopy to somewhat open-canopy deciduous floodplain forest dominated by tree species more typical of uplands. Many of the stands are composed of very large-diameter, tall trees. Dominant trees in the canopy include *Quercus rubra* (northern red oak), *Quercus velutina* (black oak), *Quercus alba* (white oak), *Liriodendron tulipifera* (tuliptree), and *Acer saccharum* (sugar maple). Additional trees which may occur in the canopy and subcanopy include *Acer rubrum* (red maple), *Carya alba* (mockernut hickory), *Carya cordiformis* (bitternut hickory), *Carya ovata* (shagbark hickory), *Fagus grandifolia* (American beech), *Fraxinus pennsylvanica* (green ash), *Juglans nigra* (black walnut), *Magnolia acuminata* (cucumber-tree), *Magnolia tripetala* (umbrella-tree), *Nyssa sylvatica* (blackgum), *Platanus occidentalis* (American sycamore), *Prunus serotina* var. *serotina* (black cherry), and *Ulmus americana* (American elm). The small tree *Halesia tetraptera* (mountain silverbell) is dominant in some areas as a well-developed tall-shrub layer and may extend into the tree subcanopy. Additional shrubs include *Carpinus caroliniana* (American hornbeam), *Dirca palustris* (eastern leatherwood), *Hamamelis virginiana* (American witchhazel), *Lindera benzoin* (northern spicebush), *Smilax rotundifolia* (roundleaf greenbrier), and *Viburnum prunifolium* (blackhaw). Characteristic herbs include *Ageratina altissima* (white snakeroot), *Amphicarpaea bracteata* (American hogpeanut), *Arisaema triphyllum* (Jack in the pulpit), *Cynoglossum virginianum* (wild comfrey), *Dichanthelium boscii* (Bosc's panicgrass), *Eurybia divaricata* (white wood aster), *Galium circaezans* (licorice bedstraw), *Galium triflorum* (fragrant bedstraw), *Hydrastis canadensis* (goldenseal), *Maianthemum racemosum* (feathery false lily of the valley), *Packera aurea* (golden ragwort), *Sedum ternatum* (woodland stonecrop), and *Verbesina alternifolia* (wingstem). Vascular plant species richness in the 7 sampled plots (200 square meters) ranges from 16 to 79 (mean at New River = 32; mean at Bluestone = 69).

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Acer saccharum* (sugar maple)
		Liriodendron tulipifera (tuliptree)
		Quercus alba (white oak)
		Quercus rubra (northern red oak)
		Quercus velutina (black oak)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Halesia tetraptera* (mountain silverbell)

Characteristic Species: *Acer rubrum* (red maple), *Ageratina altissima* (white snakeroot), *Arisaema triphyllum* (Jack in the pulpit), *Carpinus caroliniana* (American hornbeam), *Carya ovata* (shagbark hickory), *Cynoglossum virginianum* (wild comfrey), *Dichanthelium boscii* (Bosc's panicgrass), *Dirca palustris* (eastern leatherwood), *Fagus grandifolia* (American beech), *Galium circaezans* (licorice bedstraw), *Galium triflorum* (fragrant bedstraw), *Halesia tetraptera*

(mountain silverbell), *Hamamelis virginiana* (American witchhazel), *Hydrastis canadensis* (goldenseal), *Lindera benzoin* (northern spicebush), *Magnolia acuminata* (cucumber-tree), *Magnolia tripetala* (umbrella-tree), *Maianthemum racemosum* (feathery false lily of the valley), *Nyssa sylvatica* (blackgum), *Packera aurea* (golden ragwort), *Parthenocissus quinquefolia* (Virginia creeper).
Other Noteworthy Species: Information not available.
USFWS Wetland System: Palustrine.

DISTRIBUTION
Range: This association is currently known only from West Virginia along the New, Bluestone, and Gauley rivers.
States/Provinces: WV.
Federal Lands: NPS (Bluestone, Gauley River, New River Gorge).

CONSERVATION STATUS
Rank: GNR (5-Jun-2006).
Reasons: More information is needed to determine a global rank. This association is likely to have been reduced from its original extent by clearing for agriculture or houses.

CLASSIFICATION INFORMATION
Status: Standard.
Confidence: 3 - Weak.
Comments: This association has canopy composition similar to *Quercus prinus - (Quercus rubra) - Carya* spp. / *Oxydendrum arboreum - Cornus florida* Forest (CEGL007267), but it is differentiated by its occurrence on floodplains and by the abundance of *Halesia tetraptera* (mountain silverbell) and other mesophytic species in the understory.
Similar Associations: Information not available.
Related Concepts: Information not available.

SOURCES
Description Authors: J. P. Vanderhorst, mod. S. C. Gawler.
References: Eastern Ecology Working Group n.d., Vanderhorst et al. 2007, Vanderhorst et al. 2008.

Figure B15. An example of Oak - Hickory Floodplain Forest from the Bluestone National Scenic River.

COMMON NAME (PARK-SPECIFIC): RIVER BIRCH BACKWATER FLOODPLAIN FOREST

SYNONYMS starthere
NVC English Name: **River Birch - Sycamore Forest**
NVC Scientific Name: ***Betula nigra - Platanus occidentalis* Forest**
NVC Identifier: **CEGL002086**

LOCAL INFORMATION

Environmental Description: This association occurs in small patches in backwater positions of floodplains in areas previously cleared for agriculture. Most known sites are mapped as unforested (white) on the 1912 Big Bend and 1929 Flattop USGS 15' topographic maps. Today, stands are temporarily flooded by reservoir backup from Bluestone Lake and may also be subject to occasional low-energy flooding from downstream overbank flow and seepage from upslope. Low-energy reservoir backup is responsible for heavy fine sediment deposits visible on the ground and sometimes on plant foliage. There is often shallow standing water and sometimes deeper backwater ponds or sloughs are embedded within this community. Most areas would qualify as jurisdictional wetlands. Slopes in plots range from 0 to 3 degrees. Elevations range from 436 to 445 m. Unvegetated ground cover is dominated by litter and areas of bare soil where litter has washed away. There is essentially no ground cover by rocks. Soils in plots are described as temporarily flooded, deep, dark-colored, poorly to well-drained silty loam and sandy loam derived from alluvium. Hydric soil indicators noted in plots include saturated soil, high water table, low soil chroma, and oxidation-reduction features. Soils from plots tested extremely to strongly acidic (mean pH = 4.87) with relatively high levels of organic matter, estimated N release, S, B, Ca, Cu, Fe, Mg, Na, P, and Zn, and relatively low levels of Al, K, and Mn compared to average values in the park. Adjacent associations in the Modified Successional Floodplain Forest and Woodland map class may include Riverbank Tall Herbs (CEGL006480), Successional Box-elder Floodplain Forest (CEGL005033), Successional Black Walnut Floodplain Forest (CEGL007879), Successional Tuliptree / Northern Spicebush Forest (CEGL007220), and Sycamore - Ash Floodplain Forest (CEGL006458).
Vegetation Description: This association is an open- to closed-canopy floodplain forest typically dominated by *Betula nigra* (river birch) in association with other disturbance-tolerant, wetland indicator species. Canopy cover in plots ranges from 20–90%, strongly dominated by *Betula nigra* (river birch) in most plots. One plot with canopy cover dominated by *Platanus occidentalis* (American sycamore) (with *Betula nigra* (river birch) in the subcanopy) occurs on slightly higher ground adjacent to lower areas dominated by *Betula nigra* (river birch). Additional canopy associates include the trees *Acer rubrum* var. *rubrum* (red maple), *Fraxinus pennsylvanica* (green ash), and *Ulmus americana* (American elm), and vines *Toxicodendron radicans* (eastern poison ivy) and *Vitis aestivalis* var. *bicolor* (summer grape). Subcanopy cover in plots ranges from 5–30%, composed of the canopy trees with *Betula nigra* (river birch) most abundant. Shrub cover in plots ranges from 1–100%. Highest shrub cover occurs in a plot with dense growth of the exotic invasive *Rosa multiflora* (multiflora rose). Native species in the shrub layers include *Carpinus caroliniana* ssp. *virginiana* (American hornbeam), *Lindera benzoin* (northern spicebush), *Alnus serrulata* (hazel alder), and *Cornus amomum* (silky dogwood), in addition to vines and saplings of trees already listed. Herb cover in plots ranges from 20–90%. Common native herbs include *Polygonum virginianum* (jumpseed), *Verbesina alternifolia*

(wingstem), *Boehmeria cylindrica* (smallspike false nettle), *Pilea pumila* var. *pumila* (Canadian clearweed), *Onoclea sensibilis* (sensitive fern), *Leersia virginica* (whitegrass), *Impatiens capensis* (jewelweed), *Galium triflorum* (fragrant bedstraw), *Carex amphibola* (eastern narrowleaf sedge), *Verbesina occidentalis* (yellow crownbeard), *Agrostis perennans* (upland bentgrass), *Amphicarpaea bracteata* (American hogpeanut), *Packera aurea* (golden ragwort), and *Glyceria striata* (fowl mannagrass). Exotic herbs are also abundant and include *Lysimachia nummularia* (creeping jenny), *Alliaria petiolata* (garlic mustard), and *Urtica dioica* ssp. *dioica* (stinging nettle). Vascular plant species richness in three plots with complete floristics ranges from 33 to 62 (mean = 44) species per 400-square-meter plot. Cover by nonvascular plants in plots ranges from 0–10%. Nonvascular species identified from one plot include *Amblystegium serpens* (amblystegium moss), *Brachythecium salebrosum* (brachythecium moss), *Bryhnia novae-angliae* (New England bryhnia moss), *Climacium americanum* (American climacium moss), *Hygrohypnum ochraceum* (hygrohypnum moss), *Lophocolea heterophylla*, *Plagiomnium ciliare* (plagiomnium moss), *Steerecleus serrulatus* (steerecleus moss), and *Thuidium delicatulum* (delicate thuidium moss).

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Acer rubrum* var. *rubrum* (red maple)
		Fraxinus pennsylvanica (green ash)
		Platanus occidentalis (American sycamore)
Tree subcanopy	Broad-leaved deciduous tree	*Betula nigra* (river birch)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Lindera benzoin* (northern spicebush)
		Rosa multiflora (multiflora rose)
Herb (field)	Forb	*Lysimachia nummularia* (creeping jenny)
		Polygonum virginianum (jumpseed)
		Verbesina alternifolia (wingstem)

Characteristic Species: *Arisaema dracontium* (green dragon), *Boehmeria cylindrica* (smallspike false nettle), *Leersia virginica* (whitegrass), *Onoclea sensibilis* (sensitive fern).

Other Noteworthy Species:

Species	GRank	Type	Note
Alliaria petiolata (garlic mustard)	-	plant	exotic
Carex amphibola (eastern narrowleaf sedge)	-	plant	WV state-critically imperiled
Lysimachia nummularia (creeping jenny)	-	plant	exotic
Rosa multiflora (multiflora rose)	-	plant	exotic
Urtica dioica ssp. *dioica* (stinging nettle)	-	plant	exotic

Subnational Distribution with Crosswalk Data:

State	SRank	Conf	SName	Reference
WV	SNR	1		Vanderhorst et al. 2008

Local Range: This association is included as one of several within the Modified Successional Floodplain Forest and Woodland map class. A total of 25 polygons (81.34 ha) of this map class are mapped in the park. No accuracy assessment points are attributed to this association, possibly indicating that it does not cover much area within the map class. This association appears to be entirely restricted to areas affected by occasional reservoir backup from Bluestone Lake, which is most evident at elevations below about 445 m (1460 feet).

Classification Comments: The global description treats this association as a natural vegetation type, but its occurrence at Bluestone appears to be dependent on an artificial flooding regime created by reservoir backup from Bluestone Lake. Otherwise, the local description from Bluestone is consistent with the global concept. Backwater stands of *Betula nigra* (river birch) have also been observed along other West Virginia waterways (e.g., Muddelty Creek in Nicholas

County), but the natural status of hydroperiods affecting these stands has not been determined. Along the Bluestone, Gauley, and New rivers, *Betula nigra* (river birch) is also an important component of the natural Sycamore - River Birch Riverscour Woodland (CEGL003725), which occurs along river shorelines subject to frequent high-energy flooding.
Other Comments: Information not available.
Local Description Authors: J. P. Vanderhorst.
Plots: Six plots were sampled: BLUE.18, BLUE.62, BLUE.73, BLUE.112, BLUE.116, and BLUE.124.
Bluestone National Scenic River Inventory Notes: Information not available.

GLOBAL INFORMATION

NVC CLASSIFICATION

Physiognomic Class	Forest (I)
Physiognomic Subclass	Deciduous forest (I.B.)
Physiognomic Group	Cold-deciduous forest (I.B.2.)
Physiognomic Subgroup	Natural/Semi-natural cold-deciduous forest (I.B.2.N.)
Formation	Temporarily flooded cold-deciduous forest (I.B.2.N.d.)
Alliance	*Betula nigra - (Platanus occidentalis)* Temporarily Flooded Forest Alliance (A.280)
Alliance (English name)	River Birch - (Sycamore) Temporarily Flooded Forest Alliance
Association	*Betula nigra - Platanus occidentalis* Forest
Association (English name)	River Birch - Sycamore Forest
Ecological System(s):	Central Appalachian River Floodplain (CES202.608). Ozark-Ouachita Riparian (CES202.703). North-Central Interior Floodplain (CES202.694). South-Central Interior Small Stream and Riparian (CES202.706).

GLOBAL DESCRIPTION

Concept Summary: This river birch - sycamore forest community is found throughout the east-central United States. Stands commonly occur along stream and small riverbanks, shores of ponds, and in swampy forests. Alluvial soils which support this natural community are relatively deep, moist, well-drained, and often sandy on the surface. *Betula nigra* (river birch) and *Platanus occidentalis* (American sycamore) are the typical dominants. They are fast-growing, relatively short-lived, and do not tolerate excessive shade at any stage of growth. *Betula nigra* (river birch) prefers acidic soils and is often the dominant tree found along streams affected by acidic mine drainage. A wide range of canopy species are present, both common bottomland species (e.g., *Ulmus americana* (American elm), *Acer rubrum* (red maple), *Acer negundo* (boxelder), *Fraxinus pennsylvanica* (green ash), *Quercus* (oak) spp., and *Celtis laevigata* (sugarberry)) and mesophytic species from nearby uplands and terraces (e.g., *Juglans nigra* (black walnut), *Prunus serotina* (black cherry), and *Fraxinus americana* (white ash)). Vines that may reach into the canopy include *Toxicodendron radicans* (eastern poison ivy) and *Vitis aestivalis* var. *bicolor* (summer grape). A variety of wetland species may be found on more poorly drained sites. Stands are subjected to frequent, fast, short-duration flooding, which contributes to a typically thin understory. Native species in the shrub layer include *Carpinus caroliniana* ssp. *virginiana* (American hornbeam), *Lindera benzoin* (northern spicebush), *Alnus serrulata* (hazel alder), and *Cornus amomum* (silky dogwood); the exotic *Rosa multiflora* (multiflora rose) may be prevalent

at some sites. Commonly encountered herbaceous species include *Saururus cernuus* (lizard's tail), *Amphicarpaea bracteata* (American hogpeanut), *Arisaema dracontium* (green dragon), *Boehmeria cylindrica* (smallspike false nettle), *Carex amphibola* (eastern narrowleaf sedge), *Glyceria striata* (fowl mannagrass), *Impatiens capensis* (jewelweed), *Leersia virginica* (whitegrass), *Onoclea sensibilis* (sensitive fern), *Symphyotrichum ontarionis* (bottomland aster), *Pilea pumila* (Canadian clearweed), *Polygonum virginianum* (jumpseed), *Verbesina alternifolia* (wingstem), and *Verbesina occidentalis* (yellow crownbeard). Exotic herbs are abundant at some sites and include *Lysimachia nummularia* (creeping jenny), *Alliaria petiolata* (garlic mustard), and *Urtica dioica* ssp. *dioica* (stinging nettle).

Environmental Description: *Betula nigra* (river birch) requires soils near field capacity throughout the year but is relatively intolerant of flooding. *Platanus occidentalis* (American sycamore) is also intolerant of flooding during the growing season and will die if the entire tree is inundated for more than two weeks. The absence of this community in the lower Mississippi River Alluvial Plain is attributed to this intolerance, as is its most common location on levees of smaller rivers. Depending on hydroperiod, the community may be found on natural levees or on flats behind the levee. The community is more common along small streams and blackwater streams than along alluvial floodplains, largely because of the higher sustained flow rates of these larger rivers. It is also found along flowages of larger rivers. Along the Bluestone River in West Virginia, where the community is influenced by reservoir backup as well as the usual seasonal flooding, soils in plots are described as temporarily flooded, deep, dark-colored, poorly to well-drained silty loam and sandy loam derived from alluvium. Hydric soil indicators include saturated soil, high water table, low soil chroma, and oxidation-reduction features. Soils from plots tested extremely to strongly acidic (mean pH = 4.87) with relatively high levels of organic matter, estimated N release, S, B, Ca, Cu, Fe, Mg, Na, P, and Zn, and relatively low levels of Al, K, and Mn, compared to average values in the area.

Vegetation Description: *Betula nigra* (river birch) and *Platanus occidentalis* (American sycamore) are the typical dominants in this association with other disturbance-tolerant, wetland indicator species. They are fast-growing (especially as young trees), relatively short-lived, and do not tolerate excessive shade at any stage of growth. *Betula nigra* (river birch) prefers acidic soils and is often the dominant tree found along streams affected by acidic mine drainage. A wide range of canopy species are present, both common bottomland species (e.g., *Ulmus americana* (American elm), *Acer rubrum* (red maple), *Acer negundo* (boxelder), *Fraxinus pennsylvanica* (green ash), *Quercus* (oak) spp., and *Celtis laevigata* (sugarberry)) and mesophytic species from nearby uplands and terraces (e.g., *Juglans nigra* (black walnut), *Prunus serotina* (black cherry), and *Fraxinus americana* (white ash)). Vines that may reach into the canopy include *Toxicodendron radicans* (eastern poison ivy) and *Vitis aestivalis* var. *bicolor* (summer grape). A variety of wetland species may be found on more poorly drained sites. Stands are subjected to frequent, fast, short-duration flooding, which contributes to a typically thin understory. Native species in the shrub layer include *Carpinus caroliniana* ssp. *virginiana* (American hornbeam), *Lindera benzoin* (northern spicebush), *Alnus serrulata* (hazel alder), and *Cornus amomum* (silky dogwood); the exotic *Rosa multiflora* (multiflora rose) may be prevalent at some sites. Commonly encountered herbaceous species include *Saururus cernuus* (lizard's tail), *Amphicarpaea bracteata* (American hogpeanut), *Arisaema dracontium* (green dragon), *Boehmeria cylindrica* (smallspike false nettle), *Carex amphibola* (eastern narrowleaf sedge), *Glyceria striata* (fowl mannagrass), *Impatiens capensis* (jewelweed), *Leersia virginica* (whitegrass), *Onoclea sensibilis* (sensitive fern), *Symphyotrichum ontarionis* (bottomland aster),

Pilea pumila (Canadian clearweed), *Polygonum virginianum* (jumpseed), *Verbesina alternifolia* (wingstem), and *Verbesina occidentalis* (yellow crownbeard). Exotic herbs are abundant at some sites and include *Lysimachia nummularia* (creeping jenny), *Alliaria petiolata* (garlic mustard), and *Urtica dioica* ssp. *dioica* (stinging nettle). This forest harbors a number of ubiquitous species and tends to extend into and mix with adjacent communities, resulting in numerous transitional variants. Occurrences may have a rather high percentage of standing dead trees. There may be remnant snags from previous earlier successional communities of cottonwood - black willow forests (TNC 1995a).

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Betula nigra* (river birch),
		Liquidambar styraciflua (sweetgum)
		Liriodendron tulipifera (tuliptree)
		Platanus occidentalis (American sycamore)
		Populus deltoides (eastern cottonwood)
Tree subcanopy	Broad-leaved deciduous tree	*Carpinus caroliniana* (American hornbeam)
		Salix nigra (black willow)
Shrub/sapling (tall & short)	Vine/Liana	*Berchemia scandens* (Alabama supplejack)
		Campsis radicans (trumpet creeper)
		Toxicodendron radicans (eastern poison ivy)
		Vitis riparia (riverbank grape)
Tall shrub/sapling	Broad-leaved deciduous tree	*Asimina triloba* (pawpaw)
Herb (field)	Forb	*Boehmeria cylindrica* (smallspike false nettle)
		Geranium maculatum (spotted geranium)
		Impatiens capensis (jewelweed)
		Laportea canadensis (Canadian woodnettle)

Characteristic Species: Information not available.

Other Noteworthy Species:

Species	GRank	Type	Note
Alliaria petiolata (garlic mustard)	-	plant	exotic
Ambystoma maculatum (spotted salamander)	-	animal	
Buteo lineatus (red-shouldered hawk)	-	animal	
Corythucha ciliata (sycamore lace bug)	-	animal	
Dryocopus pileatus (pileated woodpecker)	-	animal	
Empidonax virescens (Acadian flycatcher)	-	animal	
Ligustrum sinense (Chinese privet)	-	plant	exotic
Lonicera japonica (Japanese honeysuckle)	-	plant	exotic
Lysimachia nummularia (creeping jenny)	-	plant	exotic
Microstegium vimineum (Nepalese browntop)	-	plant	exotic
Neovison vison (American mink)	-	animal	
Nerodia erythrogaster erythrogaster (redbelly watersnake)	-	animal	
Nerodia erythrogaster flavigaster (yellowbelly watersnake)	-	animal	
Parula americana (northern parula)	-	animal	
Procyon lotor (raccoon)	-	animal	
Rosa multiflora (multiflora rose)	-	plant	exotic
Seiurus motacilla (Louisiana waterthrush)	-	animal	
Triadica sebifera (tallowtree)	-	plant	exotic
Urtica dioica ssp. *dioica* (stinging nettle)	-	plant	exotic

USFWS Wetland System: Palustrine.

DISTRIBUTION

Range: This river birch - sycamore forest community is found throughout the east-central United States, ranging from south-central Ohio west to Iowa, south to Arkansas and Mississippi, and east to West Virginia.
States/Provinces: AR, IA:SU, IL, IN, KY, MO, OH:S4, OK, ON?, TN, WV.
Federal Lands: NPS (Bluestone, Buffalo River?); USFS (Daniel Boone, Ouachita, Ouachita (Mountains), Ozark, Shawnee?, Wayne).

CONSERVATION STATUS

Rank: G5 (22-Jun-1998).
Reasons: The community is widespread and common.

CLASSIFICATION INFORMATION

Status: Standard.
Confidence: 2 - Moderate.
Comments: As currently described, this association and *Betula nigra - Platanus occidentalis / Alnus serrulata / Boehmeria cylindrica* Forest (CEGL007312) appear to be conceptually overlapping regional variants (north versus south). These two defined associations need to be reconciled. In Kentucky, this association (CEGL002086) would be found on the northern part of Daniel Boone National Forest, in contrast to CEGL007312, which is more southern. Other bottomland hardwood communities contain river birch in the canopy but at lower densities. It may be helpful to require that *Betula nigra* (river birch) contribute at least 50% (80%?) of the tree density to be placed in this community. This forest harbors a number of ubiquitous species and tends to extend into and mix with adjacent communities, resulting in numerous transitional variants. Both *Betula nigra* (river birch) and *Platanus occidentalis* (American sycamore) are also associated with highly disturbed sites: the former with coal mine drainage, and the latter with strip mine sites. The community described herein is naturally occurring on largely undisturbed sites, although it may occur under an artificial flooding regime created by reservoir backup (e.g., the Bluestone River in West Virginia). Backwater stands of *Betula nigra* (river birch) have also been observed along other West Virginia waterways, but the natural status of hydroperiods affecting these stands has not been determined. Along the Bluestone, Gauley, and New rivers, *Betula nigra* (river birch) is also an important component of *Platanus occidentalis - Betula nigra / Cornus amomum / (Andropogon gerardii, Chasmanthium latifolium)* Woodland (CEGL003725), which occurs along river shorelines subject to frequent high-energy flooding.
Similar Associations:

- *Acer negundo* Forest (CEGL005033).
- *Betula nigra - Platanus occidentalis / Alnus serrulata / Boehmeria cylindrica* Forest (CEGL007312).
- *Betula nigra - Platanus occidentalis / Impatiens capensis* Forest (CEGL006184).
- *Platanus occidentalis - Betula nigra / Cornus amomum / (Andropogon gerardii, Chasmanthium latifolium)* Woodland (CEGL003725).

Related Concepts:

- *Acer negundo - Platanus / Rhus [Toxicodendron] radicans* community (Voigt and Mohlenbrock 1964) ?
- *Betula nigra - Acer saccharinum / Pilea* community (Voigt and Mohlenbrock 1964) =
- *Platanus occidentalis - Betula nigra* Forest (Walton et al. 1997) ?
- Eastern Broadleaf Forests (Kuchler 1964) B

- IIA7b. River Birch - Sycamore Riverfront Forest (Allard 1990) =
- Palustrine: Forested Wetland: Riparian (TNC 1985) B
- Palustrine: Palustrine Forested Wetland (Cowardin et al. 1979) B
- R13cII4a. *Betula nigra - Platanus occidentalis* (Foti 1994a) ?
- River Birch - Red Maple, HR (Pyne 1994) ?
- River Birch - Sycamore: 61 (Eyre 1980) =
- River Birch Floodplain Forests (Anderson 1996) =
- UNESCO FORMATION CODE: I.B.3d (UNESCO 1973) B

SOURCES

Description Authors: S. Landaal, mod. S. C. Gawler.

References: Allard 1990, Anderson 1996, Blair and Hubbell 1938, Braun 1950, Bruner 1931, Burns and Honkala 1990b, Campbell 1988, Campbell 1989a, Clark and Benforado 1980, Clark and Hutchinson 1994, Cowardin et al. 1979, Dickson and Segelquist 1978, Duever and Brinson 1984a, Evans 1991, Eyre 1980, Faulkner and Patrick n.d., Flinchum 1977, Foti 1994a, Foti 1994b, Foti et al. 1994, Fralish 1987, Fralish 1988b, Fralish et al. 1991, Gettman 1974, Hoagland 2000, INAI unpubl. data, Illinois Nature Preserve Commission 1973, Klimas et al. 1981, Kuchler 1964, McNab and Avers 1994, McWilliams and Rosson 1990, Merz 1958, Midwestern Ecology Working Group n.d., Miller and Tehon 1929, Nelson 1985, ONHD unpubl. data, Pell and Rettig 1983, Powell 1985, Putnam 1951, Putnam et al. 1960, Pyne 1994, SAF 1967, Schafale and Weakley 1990, TDNH unpubl. data, TNC 1985, TNC 1995a, Thornbury 1965, UNESCO 1973, Vanderhorst et al. 2008, Voigt and Mohlenbrock 1964, Walton et al. 1997, Wharton 1978, Wharton et al. 1982, White and Madany 1978, Wistendahl 1980.

Figure B16. An example of River Birch Backwater Floodplain Forest from the Bluestone National Scenic River.

COMMON NAME (PARK-SPECIFIC) **SYCAMORE - YELLOW BUCKEYE FLOODPLAIN FOREST**

SYNONYMS
NVC English Name: **Sycamore / Yellow Buckeye Forest**
NVC Scientific Name: ***Platanus occidentalis / Aesculus flava* Forest**
NVC Identifier: **CEGL006466**

LOCAL INFORMATION

Environmental Description: This association occurs in small patches on floodplains with a natural hydroperiod characteristic of medium-sized rivers of West Virginia's west slope (Ohio River basin). Stands are probably flooded multiple times (in any season) in most years, but floods are probably of relatively low energy and short duration. Stands occur on islands, riverfront levees, undulating terraces, and in backchannel positions. Slopes in mapped polygons of the Floodplain Forest and Woodland map class, which includes patches of this association, range from 0 to 34 degrees (mean = 8). Elevations in mapped polygons of the Floodplain Forest and Woodland map class range from 436 to 506 m (mean = 460). Microtopography is characterized by fluvial features such as swales, berms, washouts, and elevated root clumps. Unvegetated ground cover is dominated by litter but also includes significant wood flotsam piles, bare soil, and standing water in depressions. Soils in plots are described as temporarily flooded, somewhat poorly to well-drained, deep sand and sandy loam derived from alluvium. Soils from plots tested medium to slightly acidic (mean pH = 5.9) with relatively high levels of Ca, Cu, Fe, Mg, Mn, and Zn, and relatively low levels of organic matter, estimated N release, S, Al, B, K, and P compared to average values in the park. Adjacent associations in the Floodplain Forest and Woodland map class may include Oak - Hickory Floodplain Forest (CEGL006462), Sycamore - River Birch Riverscour Woodland (CEGL003725), Eastern Hemlock Floodplain Forest (CEGL006620), and Riverbank Tall Herbs (CEGL006480). Adjacent, previously farmed, higher terraces are often occupied by Successional Eastern White Pine - Tuliptree Forest (CEGL007944).

Vegetation Description: This association is a somewhat open- to closed-canopy deciduous floodplain forest characterized by a tall canopy of *Platanus occidentalis* (American sycamore) over a subcanopy of *Aesculus flava* (yellow buckeye). Canopy cover in plots ranges from 30–70%. In addition to the dominant *Platanus occidentalis* (American sycamore), which often form a line of large trees along the riverbank, canopies in plots include *Acer rubrum* var. *rubrum* (red maple), *Acer saccharum* var. *saccharum* (sugar maple), *Fraxinus pennsylvanica* (green ash), and *Liriodendron tulipifera* (tuliptree). Subcanopy cover in plots ranges from 20–50%, usually strongly dominated by *Aesculus flava* (yellow buckeye). Abundance of *Aesculus flava* (yellow buckeye), a species only moderately tolerant of flooding, may be attributed to short duration of floods and/or availability of well-drained microsites where it can become established and persist. The spring aspect of this forest can be striking, with early leaf-out by *Aesculus flava* (yellow buckeye) prominent under a tall, still-leafless canopy of *Platanus occidentalis* (American sycamore). Cover in the shrub layers of plots ranges from 15–60%, including saplings of tree species. Common species in the shrub layers include *Asimina triloba* (pawpaw), *Carpinus caroliniana* ssp. *virginiana* (American hornbeam), *Lindera benzoin* (northern spicebush), and *Viburnum prunifolium* (blackhaw). This community may be especially susceptible to invasion by the exotic shrub *Rosa multiflora* (multiflora rose). Herb cover in plots ranges from 60–70%, but

some observed areas have lower herb cover associated with heavy shading or long standing water. Common native herbs include *Verbesina alternifolia* (wingstem), *Amphicarpaea bracteata* (American hogpeanut), *Rudbeckia laciniata* var. *laciniata* (cutleaf coneflower), *Dichanthelium clandestinum* (deertongue), *Elymus hystrix* var. *hystrix* (eastern bottlebrush grass), *Leersia virginica* (whitegrass), *Galium triflorum* (fragrant bedstraw), *Packera aurea* (golden ragwort), *Cryptotaenia canadensis* (Canadian honewort), *Chasmanthium latifolium* (Indian woodoats), *Boehmeria cylindrica* (smallspike false nettle), and *Pilea pumila* var. *pumila* (Canadian clearweed). Exotic herbs in plots include *Alliaria petiolata* (garlic mustard), *Hesperis matronalis* (dames rocket), *Hypericum perforatum* (common St. Johnswort), and *Prunella vulgaris* (common selfheal). Vascular plant species richness ranges from 40 to 65 (mean = 54.6) species per 400-square-meter plot.

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Platanus occidentalis* (American sycamore)
Tree subcanopy	Broad-leaved deciduous tree	*Aesculus flava* (yellow buckeye)
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Lindera benzoin* (northern spicebush)
Herb (field)	Forb	*Amphicarpaea bracteata* (American hogpeanut)
		Boehmeria cylindrica (smallspike false nettle)
		Pilea pumila var. *pumila* (Canadian clearweed)
		Verbesina alternifolia (wingstem)

Characteristic Species: *Elymus hystrix* var. *hystrix* (eastern bottlebrush grass), *Packera aurea* (golden ragwort).

Other Noteworthy Species:

Species	GRank	Type	Note
Alliaria petiolata (garlic mustard)	-	plant	exotic
Hesperis matronalis (dames rocket)	-	plant	exotic
Hypericum perforatum (common St. Johnswort)	-	plant	exotic
Rosa multiflora (multiflora rose)	-	plant	exotic

Subnational Distribution with Crosswalk Data:

State	SRank	Conf	SName	Reference
WV	SNR	1		Vanderhorst et al. 2008

Local Range: This association is included as one of several associations within the Floodplain Forest and Woodland map class. A total of 48 polygons (57.11 ha) of this map class are mapped in the park. Ten accuracy assessment points in the Floodplain Forest and Woodland map class are attributed to this association. This represents 30% of the accuracy assessment points in this map class and is an indication of the relative abundance of this association within the map class. Stands of this association are scattered along the Bluestone River at elevations above 445 m, upstream from areas affected by reservoir backup from Bluestone Lake.

Classification Comments: This association has now been documented in West Virginia along the Bluestone, Cheat, Greenbrier and Tygart Valley rivers, a range spanning over 200 air km. Its occurrence along other west slope (Ohio drainage) West Virginia rivers is expected, but it will not occur on the east slope (Atlantic drainage) of the mountains because *Aesculus flava* (yellow buckeye) does not occur there. It is most similar to Sycamore - Ash Floodplain Forest (CEGL006458) which occurs downstream along the New River. Differences between these two associations are best explained by river size, duration of flooding, and availability of well-drained microsites which can support *Aesculus flava* (yellow buckeye) and other species less tolerant of flooding. Floristic differences, other than abundance of *Aesculus flava* (yellow buckeye), are subtle, and plots from Bluestone ordinate and cluster in intermediate species space between plots of Sycamore - Ash Floodplain Forest from New River and plots of Sycamore -

Yellow Buckeye Floodplain Forest from the other rivers. In a two-group analysis, species with highest indicator value for the Sycamore - Yellow Buckeye Floodplain Forest throughout its range include *Prunus serotina* var. *serotina* (black cherry), *Carya cordiformis* (bitternut hickory), *Leersia virginica* (whitegrass), and *Symphyotrichum prenanthoides* (crookedstem aster). Species with highest indicator value for the Sycamore - Ash Floodplain Forest include *Carpinus caroliniana* ssp. *virginiana* (American hornbeam), *Smilax rotundifolia* (roundleaf greenbrier), *Toxicodendron radicans* (eastern poison ivy), *Halesia tetraptera* (mountain silverbell), *Robinia pseudoacacia* (black locust), and *Fraxinus pennsylvanica* (green ash).
Other Comments: Information not available.
Local Description Authors: J. P. Vanderhorst.
Plots: Three plots were sampled: BLUE.41, BLUE.80, and BLUE.104.
Bluestone National Scenic River Inventory Notes: Information not available.

GLOBAL INFORMATION

NVC CLASSIFICATION

Physiognomic Class	Forest (I)
Physiognomic Subclass	Deciduous forest (I.B.)
Physiognomic Group	Cold-deciduous forest (I.B.2.)
Physiognomic Subgroup	Natural/Semi-natural cold-deciduous forest (I.B.2.N.)
Formation	Temporarily flooded cold-deciduous forest (I.B.2.N.d.)
Alliance	*Platanus occidentalis - (Liquidambar styraciflua, Liriodendron tulipifera)* Temporarily Flooded Forest Alliance (A.289)
Alliance (English name)	Sycamore - (Sweetgum, Tuliptree) Temporarily Flooded Forest Alliance
Association	*Platanus occidentalis / Aesculus flava* Forest
Association (English name)	Sycamore / Yellow Buckeye Forest
Ecological System(s):	Central Appalachian River Floodplain (CES202.608).

GLOBAL DESCRIPTION

Concept Summary: This floodplain forest community has been documented from rivers of West Virginia's Ohio River drainage (the western slope), including the Cheat, Greenbrier, Tygart Valley, and Bluestone rivers. It occupies stabilized terraces and levees subject to periodic overbank flooding. The microtopography is complex, with levee development along the river's edge, and swales and flatter terraces behind the levees. The alluvial soils are derived primarily from acidic sandstones and shales and range from silt to sandy loams. Measured soil pH is 4.5–6.3. The vegetation is characterized by a tall canopy of *Platanus occidentalis* (American sycamore) with *Liriodendron tulipifera* (tuliptree) and/or *Fagus grandifolia* (American beech) over a subcanopy of *Aesculus flava* (yellow buckeye). *Prunus serotina* (black cherry) and *Acer saccharum* (sugar maple) are common codominants. *Platanus occidentalis* (American sycamore) is often concentrated as a line along the immediate river's edge. *Carpinus caroliniana* (American hornbeam) is a typical small tree and *Lindera benzoin* (northern spicebush) a typical shrub. *Asimina triloba* (pawpaw) and *Viburnum prunifolium* (blackhaw) are associated shrubs. *Hydrophyllum virginianum* (Shawnee salad), *Mertensia virginica* (Virginia bluebells), *Elymus hystrix* (eastern bottlebrush grass), *Packera aurea* (golden ragwort), *Symphyotrichum prenanthoides* (crookedstem aster), and *Viola cucullata* (marsh blue violet) are characteristic herbs. *Verbesina alternifolia* (wingstem), *Amphicarpaea bracteata* (American hogpeanut),

Boehmeria cylindrica (smallspike false nettle), and *Pilea pumila* var. *pumila* (Canadian clearweed) are frequent and may be abundant in the herb layer. The exotic herbs *Microstegium vimineum* (Nepalese browntop) and *Glechoma hederacea* (ground ivy) are sometimes locally abundant, and *Alliaria petiolata* (garlic mustard), *Hesperis matronalis* (dames rocket), *Hypericum perforatum* (common St. Johnswort), and *Prunella vulgaris* (common selfheal) may also be present.

Environmental Description: This association occurs in small patches on floodplains with a natural hydroperiod characteristic of medium-sized rivers of West Virginia's west slope (Ohio River basin). Stands are probably flooded multiple times (in any season) in most years, but floods are probably of relatively low energy and short duration. Stands occur on islands, riverfront levees, undulating terraces, and in backchannel positions. Microtopography is characterized by fluvial features such as swales, berms, washouts, and elevated root clumps. Unvegetated ground cover is dominated by litter but also includes significant wood flotsam piles, bare soil, and standing water in depressions. Soils in Bluestone River plots are described as temporarily flooded, somewhat poorly to well-drained, deep sand and sandy loam derived from alluvium. Soils from plots tested medium to slightly acidic (mean pH = 5.9) with relatively high levels of Ca, Cu, Fe, Mg, Mn, and Zn, and relatively low levels of organic matter, estimated N release, S, Al, B, K, Na, and P, compared to average values in the area.

Vegetation Description: This association is a somewhat open- to closed-canopy deciduous floodplain forest characterized by a tall canopy of *Platanus occidentalis* (American sycamore) over a subcanopy of *Aesculus flava* (yellow buckeye). Canopy cover in three plots along the Bluestone River is 30–70%. In addition to the dominant *Platanus occidentalis* (American sycamore), which often forms a line of large trees along the riverbank, canopies include *Acer rubrum* var. *rubrum* (red maple), *Acer saccharum* var. *saccharum* (sugar maple), *Fraxinus pennsylvanica* (green ash), and *Liriodendron tulipifera* (tuliptree). The subcanopy is usually strongly dominated by *Aesculus flava* (yellow buckeye). Abundance of *Aesculus flava* (yellow buckeye), a species only moderately tolerant of flooding, may be attributed to short duration of floods and/or availability of well-drained microsites where it can become established and persist. The spring aspect of this forest can be striking, with early leaf-out by *Aesculus flava* (yellow buckeye) prominent under a tall, still-leafless canopy of *Platanus occidentalis* (American sycamore). Common species in the shrub layers include *Asimina triloba* (pawpaw), *Carpinus caroliniana* ssp. *virginiana* (American hornbeam), *Lindera benzoin* (northern spicebush), and *Viburnum prunifolium* (blackhaw). This community may be especially susceptible to invasion by the exotic shrub *Rosa multiflora* (multiflora rose). The herb layer is usually well-developed, but some areas have lower herb cover associated with heavy shading or long standing water. Common native herbs include *Verbesina alternifolia* (wingstem), *Amphicarpaea bracteata* (American hogpeanut), *Rudbeckia laciniata* var. *laciniata* (cutleaf coneflower), *Dichanthelium clandestinum* (deertongue), *Elymus hystrix* var. *hystrix* (eastern bottlebrush grass), *Leersia virginica* (whitegrass), *Galium triflorum* (fragrant bedstraw), *Packera aurea* (golden ragwort), *Cryptotaenia canadensis* (Canadian honewort), *Chasmanthium latifolium* (Indian woodoats), *Boehmeria cylindrica* (smallspike false nettle), and *Pilea pumila* var. *pumila* (Canadian clearweed). Exotic herbs in plots include *Alliaria petiolata* (garlic mustard), *Hesperis matronalis* (dames rocket), *Hypericum perforatum* (common St. Johnswort), and *Prunella vulgaris* (common selfheal). Vascular plant species richness in 12 West Virginia plots ranges from 19 to 80 (mean = 42) species per 200-square-meter plot.

Most Abundant Species:

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Platanus occidentalis* (American sycamore)
Tree subcanopy	Broad-leaved deciduous tree	*Aesculus flava* (yellow buckeye)

Characteristic Species: *Acer rubrum* var. *rubrum* (red maple), *Acer saccharum* var. *saccharum* (sugar maple), *Aesculus flava* (yellow buckeye), *Asimina triloba* (pawpaw), *Carpinus caroliniana* ssp. *virginiana* (American hornbeam), *Fraxinus pennsylvanica* (green ash), *Lindera benzoin* (northern spicebush), *Platanus occidentalis* (American sycamore), *Viburnum prunifolium* (blackhaw).

Other Noteworthy Species:

Species	GRank	Type	Note
Alliaria petiolata (garlic mustard)	-	plant	exotic
Glechoma hederacea (ground ivy)	-	plant	exotic
Hesperis matronalis (dames rocket)	-	plant	exotic
Hypericum perforatum (common St. Johnswort)	-	plant	exotic
Microstegium vimineum (Nepalese browntop)	-	plant	exotic
Rosa multiflora (multiflora rose)	-	plant	exotic

USFWS Wetland System: Not applicable.

DISTRIBUTION

Range: This association is currently documented only from West Virginia but is probably more extensive.

States/Provinces: WV.

Federal Lands: NPS (Bluestone).

CONSERVATION STATUS

Rank: GNR (18-Jul-2006).

Reasons: Information not available.

CLASSIFICATION INFORMATION

Status: Standard.

Confidence: 3 - Weak.

Comments: At Camp Dawson, the overstory composition is similar to the mixed mesophytic forests on adjacent upland colluvial slopes, but *Prunus serotina* (black cherry) is more abundant and *Tilia americana* (American basswood) less abundant or absent in this type. Understory differences are more distinct, with weedy species reflecting the flooding disturbance regime. More documentation of this type is needed. This association has now been documented in West Virginia along the Bluestone, Cheat, Greenbrier and Tygart Valley rivers, a range spanning over 200 air km. Its occurrence along other west slope (Ohio River drainage) West Virginia rivers is expected, but it will not occur on the east slope (Atlantic drainage) of the mountains because *Aesculus flava* (yellow buckeye) does not occur there. It is most similar to *Platanus occidentalis - Fraxinus pennsylvanica / Carpinus caroliniana / Verbesina alternifolia* Forest (CEGL006458) which occurs downstream along the New River. Differences between these two associations are best explained by river size, duration of flooding, and availability of well-drained microsites which can support *Aesculus flava* (yellow buckeye) and other species less tolerant of flooding. Floristic differences, other than abundance of *Aesculus flava* (yellow buckeye), are subtle. In a two group analysis, species with highest indicator value for this association (CEGL006466) throughout its range include *Prunus serotina* var. *serotina* (black cherry), *Carya cordiformis* (bitternut hickory), *Leersia virginica* (whitegrass), and *Symphyotrichum prenanthoides* (crookedstem aster). Species with highest indicator value for CEGL006458 include *Carpinus*

caroliniana ssp. *virginiana* (American hornbeam), *Smilax rotundifolia* (roundleaf greenbrier), *Toxicodendron radicans* (eastern poison ivy), *Halesia tetraptera* (mountain silverbell), *Robinia pseudoacacia* (black locust), and *Fraxinus pennsylvanica* (green ash).
Similar Associations: Information not available.
Related Concepts:

- Mature floodplain forest (Vanderhorst 2001a) B

SOURCES
Description Authors: J. Vanderhorst and S. C. Gawler.
References: Eastern Ecology Working Group n.d., Vanderhorst 2001a, Vanderhorst and Streets 2006, Vanderhorst et al. 2008.

Figure B17. An example of Sycamore - Yellow Buckeye Floodplain Forest from the Bluestone National Scenic River.

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As the nation's primary conservation agency, the Department of the Interior has responsibility for most of our nationally owned public land and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

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