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Ecological Systems Map of Gauley River National Recreation Area

Natural Resource Technical Report NPS/ERMN/NRTR—2013/671

ON THE COVER
A view of the Gauley River, Gauley River National Recreation Area; photograph by Derrick Etter.

Ecological Systems Map of Gauley River National Recreation Area

Natural Resource Technical Report NPS/ERMN/NRTR—2013/671

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Acknowledgements

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Executive Summary

This report on the ecological systems of Gauley River National Recreation Area is an addendum to a report (Largay and Sneddon 2009) that identified an approach to developing ecological systems maps from National Vegetation Classification association-level vegetation maps for the other eight parks in the Eastern Rivers and Mountains Parks. Ecological systems attributions were made in the association-level vegetation maps of Gauley River National Recreation Area using the International Terrestrial Ecological Systems Classification and spatial review. Included in this report are an ecological systems map, classification, a list of the component associations in each ecological system, and a table summarizing the acreage of each system in the park. The peer-reviewed ecological systems product provides a practical framework for monitoring and managing for the ecological integrity of vegetation in national parks. It will also be useful for broader-scale conservation planning at a regional level.

Methods used to develop the ecological systems map of GARI were similar to those employed in Largay and Sneddon (2009), with the exception of comprehensive review of each individual polygon. Such polygon by polygon review was limited to two successional forest associations (Successional Tuliptree Forest and Successional [Virginia, Pitch] Pine Forest) that can occur in more than one ecological system.

Introduction

This report briefly summarizes the methods and results of the development of an ecological systems map for Gauley River National Recreation Area (NRA). The vegetation association map of this park (Vanderhorst et al. 2010) was not yet available at the time that the Largay and Sneddon (2009) report (which included the other eight parks in the Eastern Rivers and Mountains Network [ERMN]) was nearing its conclusion. Development of the ecological systems map for Gauley River NRA was therefore completed as a separate project, yielding a complete set of ecological systems maps for the ERMN of the National Park Service (NPS).

Purpose

Fine-scale association-level maps provide detailed information on individual vegetation types. They allow resource managers to understand how much of each type is in the park, where it is, and how it is configured on the landscape. Monitoring the ecological integrity of individual associations is a daunting, if not impossible task. Furthermore, monitoring ecological integrity at this scale is generally neither desirable nor necessary.

NatureServe's Ecological Systems Classification provides a broader-scale map unit than does the association level of National Vegetation Classification. The ecological systems classification groups multiple spatially related associations that are influenced by the same ecological processes into one map unit. This project added ecological systems data to the completed association-level vegetation maps for the Gauley River NRA. This effort not only simplifies the vegetation map, it provides greater ecological context of the associations that are spatially related.

Materials and Methods

Classifying Ecological Systems

Two complementary classification systems were used to identify and describe the vegetation identified in the spatial vegetation maps for the Gauley River NRA. The vegetation map of association-level natural communities was classified and mapped at the Gauley River NRA at the association level using the US National Vegetation Classification (USNVC) (Vanderhorst et al. 2010). Associations are aggregated into broader ecological units called ecological systems using the International Terrestrial Ecological Systems Classification (NatureServe 2012).

International Terrestrial Ecological Systems Classification

An ecological system represents a recurring group of associations that are found together in similar physical environments. Ecological systems are defined, in part, by processes, such as fire or flooding, as well as the environmental features and the biological communities associated with them. Multiple environmental factors are evaluated and combined in different ways to explain the spatial pattern of associations. These include bioclimate, biogeographic history, physiography, landform, physical and chemical substrates, dynamic processes, landscape juxtaposition, and vegetation structure and composition. These factors help explain why particular associations, or natural communities, tend to be found together in a given ecological system (Comer et al. 2003).

NatureServe and its Natural Heritage program members developed the International Terrestrial Ecological System Classification to provide a feasible scale for a number of applications, such as conservation assessment and planning, management, monitoring, and species habitat modeling. Ecological systems are mid-scale units that can be mapped from remote imagery and are readily identifiable in the field. They are defined in both spatial and temporal scales. Ecological systems range in size from 10s to 1,000s of hectares and endure from 50 to 1,000 years. The temporal scale allows typical successional dynamics to be integrated into the concept of each ecological system (Comer et al. 2003).

National Vegetation Classification System

Natural communities in this document refer to the plant association level of the USNVC. The USNVC provides a complete, standardized listing and description of all the vegetation types that represent the variation in biological diversity at the community level. It is a comprehensive system that classifies all terrestrial vegetation in the country under a common framework (Grossman et al. 1998). It identifies vegetation units based on both qualitative and quantitative data at a scale that is practical for conservation.

The USNVC was adopted by the Federal Geographic Data Committee as the reporting standard for all federal agencies involved in the management of vegetation. This standardization allows for the comparison of vegetation types across political, jurisdictional, and geographic boundaries. This is incredibly important to conservation professionals working in multiple states. It provides a common language for ecological communities, thereby making it possible to assess, monitor, compare, and evaluate across jurisdictions.

Attributing Ecological Systems to Association-level Vegetation Maps

Preliminary ecological system assignments were made for all of the associations occurring in the park by referring to the International Terrestrial Ecological Systems Classification (NatureServe 2012). This classification includes a list of associations likely to occur in each system. However, the ecological systems classification is modular rather than hierarchical because some, usually common, associations occur in more than one system over their range. After acquiring the completed association-level shapefile of GARI (Vanderhorst et al. 2010), a new shapefile was created and two attribute columns, entitled E_S_NAME (Ecological System Name) and E_S_CODE (Ecological System Code), were added to the original map attribute table in ArcMap. The corresponding ecological system and ecological system code were entered into the attribute table for every vegetation polygon. In some cases, individual associations occurred within a single ecological system and the attribution was straightforward. In other cases, associations might occur in more than one ecological system, depending on their environmental setting and land use history. Polygons of those associations were reviewed to determine which ecological system was the most appropriate for that setting. Other ancillary data were used to make these assignments, including the digital aerial photos used to produce the original vegetation map, as well as referring to topographic maps.

Two successional forest types occurring at Gauley River NRA are widespread and could be found in a number of settings: Successional Tuliptree Forest and Successional (Virginia, Pitch) Pine Forest. In general, these forests are more strongly influenced by their recent land use than by their environmental setting, and are dominated by fast-growing species that become established soon after disturbance. For example, Successional Tuliptree Forest occurs at GARI in the river floodplain, on mesic slopes of the gorge, on the plateaus, and occasionally as small patches in other settings. Successional (Virginia, Pitch) Pine Forest occurs on plateaus, and less frequently on more steeper and more well-drained sites. Over time, it is likely that these two forest types will succeed into their neighboring later-successional forest types, and so were in many cases attributed with the adjacent ecological system. In other cases, especially where these forests occur in large patches and reflect widespread disturbance, their successional pathway was less clear and they were simply labeled “Ruderal Forest,” in keeping with the Northeastern Wildlife Habitat Classification legend (Gawler et al. 2008). Cultural map classes were also tagged to map classes from this wildlife habitat classification.

There were many polygons mapped at very small scale (<0.25 ha) on the original vegetation map. Some of these small polygons were associations that do not typically function as part of the surrounding ecological system, and are much more common in other ecological systems. This resulted in a number of abnormally small polygons of apparently intact and independent ecological systems. However, these polygons are too small to be regarded as separate systems. Although a polygon-by-polygon review was beyond the scope of this project, the attribution of selected small polygons (<0.25 ha) embedded in large polygons of different ecological systems were treated as inclusions and re-attributed with the surrounding ecological system. An exception was made for small polygons of disparate ecological systems on the park periphery. These were likely portions of larger polygons extending outside the park, and remained as a result of clipping the map to the park boundary. We did not treat these as inclusions. Where small patches delineated as “Disturbed Area” were embedded in Ruderal Forest, these were treated similarly, and re-attributed to the surrounding Ruderal Forest.

Results

Seven ecological systems were identified and mapped at GARI based on the vegetation map of Vanderhorst et al. (2010):

- Allegheny-Cumberland Dry Oak Forest and Woodland (CES202.359);
- Cumberland Acidic Cliff and Rockhouse (CES202.309);
- Cumberland Riverscour (CES202.036);
- South-Central Interior Large Floodplain (CES202.705);
- South-Central Interior Mesophytic Forest (CES202.887);
- South-Central Interior Small Stream and Riparian (CES202.706); and
- Southern Appalachian Oak Forest (CES202.886).

<u>Association Attributions to Ecological Systems</u>

Associations are contained within systems as follows:

Allegheny-Cumberland Dry Oak Forest and Woodland (CES202.359)

- Oak / Ericad Forest (CEGL006271)
- Cliff Top Virginia Pine Forest (CEGL007119)
- Successional (Virginia, Pitch) Pine Forest (CEGL002591)
- Successional Tuliptree Forest (CEGL007221)

Cumberland Acidic Cliff and Rockhouse (CES202.309)

- Cliff Face (two associations):
  - Dry Cliff Face (CEGL006435)
  - Common Rock Tripe Cliff Face (CEGL004387)

Cumberland Riverscour (CES202.036)

- Riparian Zone (Riverscour Shrub Prairie) (CEGL006623)
- Eastern Hemlock Floodplain Forest (CEGL006620)
- (Virginia, Pitch) Pine Floodplain Forest CEGL006624)
- American Sycamore - River Birch Riverscour Woodland (CEGL003725)
- American Water-willow Cobble Bar (CEGL004286)
- Bur-reed Marsh (CEGL004510)

South-Central Interior Large Floodplain (CES202.705)

- American Sycamore - Tuliptree - Sweetgum Floodplain Forest (CEGL004418)
- Oak - Hickory Floodplain Forest (CEGL006462)
- Successional Tuliptree Forest (CEGL007221)

South-Central Interior Mesophytic Forest (CES202.887)

- Sugar Maple - Yellow Buckeye - American Basswood Forest (CEGL005222)
- Yellow Birch Cold Cove Forest (CEGL007861)
- Eastern Hemlock - Oak - Sweet Birch / Great Laurel Forest (CEGL007543)
- Eastern Hemlock Plateau Forest (CEGL006304)
- Eastern Hemlock - Chestnut Oak / Catawba Rosebay Forest (CEGL008524)
- Successional Tuliptree Forest (CEGL007221)

Southern Appalachian Oak Forest (CES202.886)

- Oak - Hickory - Sugar Maple Forest (CEGL007268)
- Oak / Great Laurel Forest (CEGL006286)
- Oak - Hickory Forest (CEGL007267)
- Successional Tuliptree Forest
- Successional (Virginia, Pitch) Pine Forest

South-Central Interior Small Stream and Riparian (CES202.706)

- Forest Seep (CEGL007583)

Additional associations contained within systems due to “inclusions” (i.e., mapped association polygons < 0.25 ha in size; see text above for additional information):
Allegheny-Cumberland Dry Oak Forest and Woodland (CES202.359)

- Eastern Hemlock-Oak-Sweet Birch/Great Laurel Forest (CEGL007543); 1 polygon.

Cumberland Riverscour (CES202.036)

- Eastern Hemlock-Oak-Sweet Birch/Great Laurel Forest (CEGL007543); 2 polygons.

South-Central Interior Mesophytic Forest (CES202.887)

- Oak - Hickory Forest (CEGL007267); 6 polygons.
- Oak / Great Laurel Forest (CEGL006286); 1 polygon.
- Successional (Virginia, Pitch) Pine Forest; 1 polygon.

Southern Appalachian Oak Forest (CES202.886)

- Oak / Ericad Forest (CEGL006271); 1 polygon.
- Eastern Hemlock-Oak-Sweet Birch/Great Laurel Forest (CEGL007543); 8 polygons.
- Eastern Hemlock Plateau Forest (CEGL006304); 3 polygons.

Figures 1 and 2 illustrate the maps of ecological systems for the western and eastern portions of GARI, respectively. The areas of the ecological systems, semi-natural, and cultural map classes at GARI are displayed in Table 1.

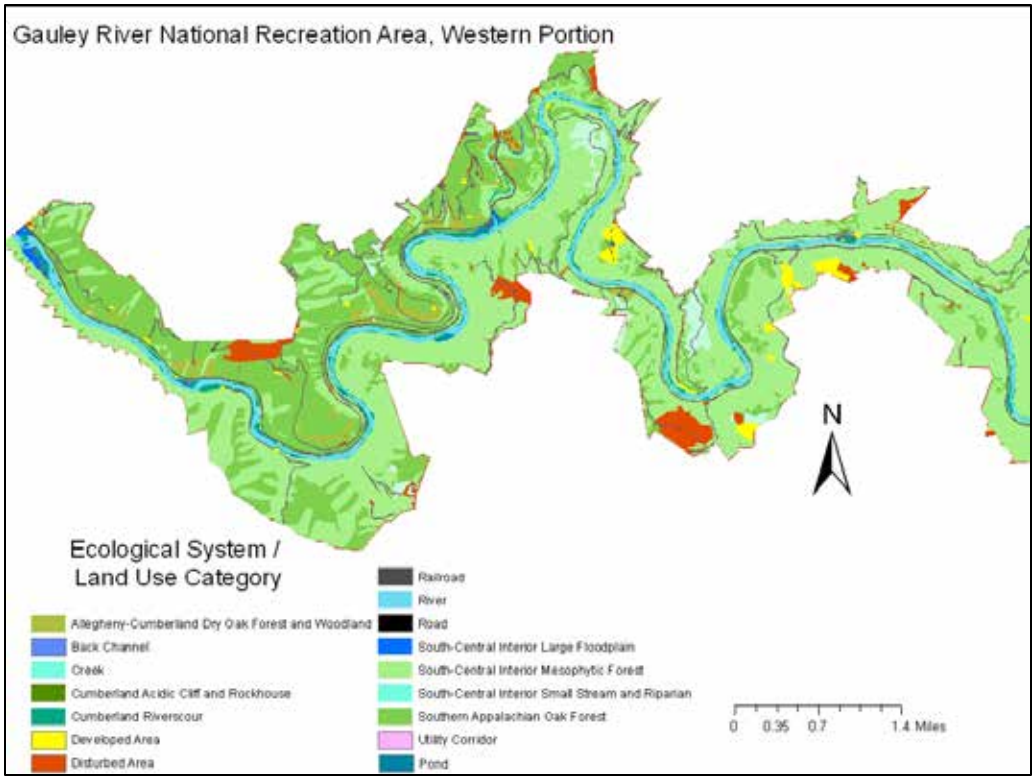

Figure 1. Ecological Systems of the western portion of Gauley River National Recreation Area

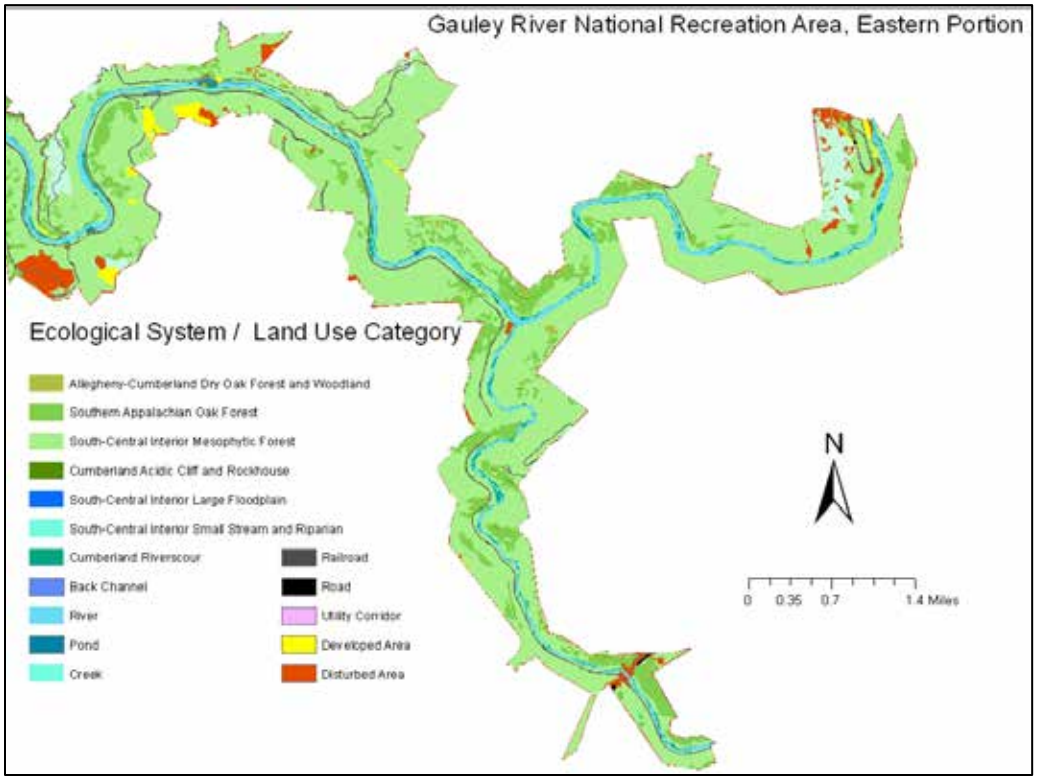

Figure 2. Ecological Systems of the eastern portion of Gauley River National Recreation Area

Table 1. Areas of ecological systems, semi-natural, and cultural map classes at Gauley River National Recreation Area.

Ecological System or Map Class	Hectares	Acres
Allegheny-Cumberland Dry Oak Forest and Woodland	81.8	202.1
South-Central Interior Mesophytic Forest	2742.5	6776.8
Southern Appalachian Oak Forest	985.1	2434.3
Ruderal Forest	117.4	290.2
Cumberland Acidic Cliff and Rockhouse	8.7	21.5
South-Central Interior Large Floodplain	11.5	28.4
South-Central Interior Small Stream and Riparian	1.2	3
Cumberland Riverscour	93	230
Back Channel	1.5	3.7
Creek	5.2	13
Pond	0.7	1.7
River	270	666.1
Developed Area	45.7	113
Disturbed Area	112.7	278.6
Railroad	27.8	68.6
Road	48.6	120.1
Utility Corridor	2.3	5.8

Discussion

This project provides an ecological system classification and map for the Gauley River NRA, complementing similar products for the other eight parks in the ERMN (Largay and Sneddon 2009). As in the original work, the association-level vegetation map (Vanderhorst et al. 2010) was updated with ecological system attributions and reviewed by Natural Heritage Program, National Park Service, and NatureServe ecologists.

The ecological systems map and association-level vegetation map complement each other and together provide baseline spatial ecological data for monitoring and comparing changes in vegetation over time. The ecological systems map offers a more cohesive management or monitoring unit than the association-level vegetation maps alone because the ecological systems concept provides ecological context to associations, and groups associations that occur together under similar or related environmental conditions. Ecological systems maps also contribute to the understanding of actual and potential vegetation cover to facilitate ecological restoration processes. These maps give context for the altered vegetation and provide more ecological information when determining target associations and desired conditions for restoration efforts.

Conclusions

With the completion of the ecological systems map of the Gauley River NRA, this project provides the ERMN with a full set of standard maps and a standardized classification at both the association and ecological system level. The addition of an ecological systems layer to the USNVC association-level vegetation maps for the park provides broad-scale vegetation classification and map units that provide ecological context to the association-level vegetation maps. As broader map classes that group similar associations, ecological systems maps can be an efficient and effective tool for developing and implementing natural resource monitoring and management strategies for the selected national parks.

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Appendix. Global descriptions of ecological systems occurring at GARI.

Forest and Woodland

CES202.359 Allegheny-Cumberland Dry Oak Forest and Woodland
Primary Division: Central Interior and Appalachian (202)
Land Cover Class: Forest and Woodland
Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Acidic Soil; Broad-Leaved Tree
National Mapping Codes: EVT 2317; ESLF 4123; ESP 1317
Concept Summary: This system encompasses dry hardwood forests on predominately acidic substrates in the Allegheny and Cumberland plateaus, and ridges in the southern Ridge and Valley. Its range is more or less consistent with the "Mixed Mesophytic Forest Region" of Braun (1950) and Greller (1988), although it is not a mesic forest type. These forests are typically dominated by *Quercus alba, Quercus falcata, Quercus prinus, Quercus coccinea,* with lesser amounts of *Acer rubrum, Carya glabra,* and *Carya alba*. Small inclusions of *Pinus echinata* and/or *Pinus virginiana* may occur, particularly adjacent to escarpments or following fire. In addition, *Pinus strobus* may be prominent in some stands in the absence of fire. It occurs in a variety of situations, including on nutrient-poor or acidic soils. Sprouts of *Castanea dentata* can often be found where it was formerly a common tree.
Comments: Related forests on more base-rich substrates may be classified as examples of Southern Ridge and Valley / Cumberland Dry Calcareous Forest (CES202.457), where this distinction may be made. Eastward and northward, this system transitions into Central Appalachian Dry Oak-Pine Forest (CES202.591). The dividing line between them is the Allegheny Front.

DISTRIBUTION

Divisions: 202:C
TNC Ecoregions: 49:C, 50:C
Nations: US
Subnations: AL, GA, KY, OH, PA?, TN, VA, WV
Map Zones: 48:C, 53:C, 57:C, 61:C, 62:C
USFS Ecomap Regions: 221E:CC, 221H:CC, 221J:CC, 231C:CC, 231D:CC, M221A:CC, M221Ba:CCC, M221Bb:CCC, M221Bc:CCC, M221Be:CCC, M221C:CC

CONCEPT

High-ranked species: Callophrys irus (G3), Canis rufus (G1Q), Carex communis var. amplisquama (G5T3), Carex polymorpha (G3), Coreopsis delphiniifolia (G3?Q), Desmodium ochroleucum (G1G2), Fothergilla major (G3), Gaylussacia brachycera (G3), Lesquerella globosa (G2), Melanoplus serrulatus (G1G3), Puma concolor couguar (G5THQ), Scutellaria montana (G3), Taenidia montana (G3), Thermopsis fraxinifolia (G3?), Thermopsis mollis (G3G4), Trillium pusillum (G3), Virginia valeriae pulchra (G5T3T4)
Environment: This system is most likely found on predominantly nutrient-poor or acidic substrates in the Allegheny and Cumberland plateaus, and ridges in the southern Ridge and Valley.
Vegetation: These forests are typically dominated by *Quercus alba, Quercus falcata, Quercus prinus, Quercus coccinea, Acer rubrum, Carya glabra,* and *Carya alba*. These occur in a variety of situations, most likely on nutrient-poor or acidic soils and, to a much lesser extent, on circumneutral soils. Sprouts of *Castanea dentata* can often be found where it was formerly a common tree. Small inclusions of *Pinus echinata* and/or *Pinus virginiana* may occur, particularly

adjacent to escarpments or following fire. In addition, *Pinus strobus* may be prominent in some stands in the absence of fire.

SPATIAL CHARACTERISTICS

Adjacent Ecological System Comments: The somewhat more mesic and/or more base-rich forests of the lower slopes of the Cumberlands and the lower slopes and valleys in the Ridge and Valley are covered by South-Central Interior Mesophytic Forest (CES202.887).
Other Comments: In Georgia, it is restricted to the northwestern corner of the state.

SOURCES

References: Braun 1950, Comer et al. 2003, Evans 1991, Eyre 1980, Greller 1988
Version: 05 May 2008 **Stakeholders:** East, Midwest, Southeast
Concept Author: R. Evans, M. Pyne, C. Nordman **LeadResp:** Southeast
CES202.887 South-Central Interior Mesophytic Forest
Primary Division: Central Interior and Appalachian (202)
Land Cover Class: Forest and Woodland
Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Forest and Woodland (Treed); Sideslope; Unglaciated; Eutrophic Soil; Broad-Leaved Deciduous Tree
National Mapping Codes: EVT 2321; ESLF 4127; ESP 1321
Concept Summary: These high-diversity, predominately deciduous forests occur on deep and enriched soils (in some cases due to, or enhanced by, the presence of limestone or related base-rich geology), in non-montane settings and usually in somewhat protected landscape positions such as coves or lower slopes. The core distribution of this system lies in the Cumberland and Allegheny plateaus, extending into the adjacent southern Ridge and Valley and portions of the Interior Low Plateau where it is located entirely south of the glacial boundary. Dominant species include *Acer saccharum, Fagus grandifolia, Liriodendron tulipifera, Tilia americana, Quercus rubra, Magnolia acuminata,* and *Juglans nigra*. *Tsuga canadensis* may be a component of some stands. Trees may grow very large in undisturbed areas. The herb layer is very rich, often with abundant spring ephemerals. Many examples may be bisected by small streams.
Comments: Southern and Central Appalachian Cove Forest (CES202.373) (Ecoregions 51 and 59) is being treated as a separate system. The concept of this type (CES202.887) is more-or-less consistent with the "Mixed Mesophytic Communities" of both the Mixed Mesophytic Forest Region and the non-coastal plain portion of the Western Mesophytic Forest Region, extending north into unglaciated portions of the Beech-Maple Forest Region, of Braun (1950) and Greller (1988). There is much variability in different examples of this system across its range, with the composition of some occurrences in the escarpment of the Cumberland Plateau approaching that of examples of Southern and Central Appalachian Cove Forest (CES202.373). The Allegheny Front is adopted as the divide between these two similar systems: material to the west goes to this system, and material to the east goes to Southern and Central Appalachian Cove Forest (CES202.373). In limited areas of the region, some stands may contain hemlock (*Tsuga canadensis*). These are noteworthy on a local basis, as the tree is less well distributed in the range of this system than it is in corresponding environments at higher elevation in the Appalachians or to the north.

DISTRIBUTION

Divisions: 202:C
TNC Ecoregions: 44:C, 49:C, 50:C, 60:C
Nations: US
Subnations: AL, GA, IL, IN, KY, NY, OH, PA, TN, VA, WV
Map Zones: 47:C, 48:C, 49:C, 53:C, 57:C, 61:C, 62:C, 63:C
USFS Ecomap Regions: 211G:CC, 221E:CC, 221F:C?, 221H:CC, 223D:CC, 223E:CC, 223F:CC, 231C:CC, 231D:CC, M221C:CC
High-ranked species: Aconitum reclinatum (G3), Actaea rubifolia (G3), Aesculus parviflora (G3), Aneides aeneus (G3G4), Arabis patens (G3), Brachythecium rotaeanum (G3G4), Bryoerythrophyllum ferruginascens (G3G4), Calystegia catesbeiana ssp. sericata (G3T3Q), Canis rufus (G1Q), Cardamine clematitis (G3), Cardamine flagellifera (G3), Carex manhartii (G3G4), Carex radfordii (G2), Carex roanensis (G2G3), Catocala marmorata (G3G4), Clematis addisonii (G1?), Collinsonia verticillata (G3G4), Delphinium alabamicum (G2), Desmognathus aeneus (G3G4), Desmognathus imitator pop. 1 (G3G4T1Q), Desmognathus santeetlah (G3G4Q), Desmognathus wrighti (G3), Diervilla rivularis (G3), Drepanolejeunea appalachiana (G2?), Entodon sullivantii (G3G4), Euphorbia purpurea (G3), Hygrohypnum closteri (G3), Lejeunea blomquistii (G1G2), Lophocolea appalachiana (G1G2Q), Marsupella emarginata var. latiloba (G5T1T2), Megaceros aenigmaticus (G2G3), Melanoplus acrophilus acrophilus (G2G3T2T3), Melanoplus cherokee (G1G3), Melanoplus divergens (G2G3), Melanoplus serrulatus (G1G3), Metzgeria fruticulosa (G2Q), Metzgeria uncigera (G3), Microtus chrotorrhinus carolinensis (G4T3), Nesticus sheari (G2?), Neviusia alabamensis (G2), Panax quinquefolius (G3G4), Pieris virginiensis (G3?), Plagiochila austinii (G3), Plagiochila caduciloba (G2), Plagiochila sharpii (G2G4), Plagiochila virginica var. virginica (G3T3), Plagiomnium carolinianum (G3), Platyhypnidium pringlei (G2G3), Plethodon aureolus (G2G3), Plethodon hubrichti (G2), Plethodon punctatus (G3), Plethodon welleri (G3), Polymnia laevigata (G3), Prosartes maculata (G3G4), Puma concolor couguar (G5THQ), Riccardia jugata (G2), Schisandra glabra (G3), Scutellaria alabamensis (G2), Scutellaria pseudoserrata (G3), Scutellaria saxatilis (G3), Silene ovata (G3), Sorex palustris punctulatus (G5T3), Speyeria diana (G3G4), Thaspium pinnatifidum (G2G3), Trechus luculentus luculentus (GHTH), Trillium lancifolium (G3), Trillium rugelii (G3), Trillium simile (G3), Triphora trianthophora (G3G4), Viola tripartita var. tripartita (G5T3), Virginia valeriae pulchra (G5T3T4)
Environment: These high-diversity deciduous forests occur on deep and enriched soils, usually in somewhat protected landscape positions such as coves or lower slopes.
Vegetation: Dominant tree species include *Acer saccharum, Fagus grandifolia, Liriodendron tulipifera, Tilia americana, Quercus rubra, Magnolia acuminata*, and *Juglans nigra*. *Tsuga canadensis* may be a component of some stands. The herb layer is very rich, often with abundant spring ephemerals.

SPATIAL CHARACTERISTICS

Heterogeneity: Most stands are purely deciduous, but *Tsuga canadensis* may be a component in limited areas of the range.
Other Comments: This system is probably of limited extent in Georgia, restricted to the northwest corner of the state. Limited, disjunct occurrences of hemlock-dominated mesic stands in southern Indiana, western Kentucky (Shawnee Hills), central Tennessee, and Cumberland Alabama are placed here (i.e., in South-Central Interior Mesophytic Forest (CES202.887)). Disjunct stands of rich mesophytic forest in unglaciated western New York and Pennsylvania are

also placed here, although it is not entirely clear whether they rise to the level of system occurrences there as opposed to being small-patch inclusions in the oak or hemlock-hardwood matrix forests. The related Appalachian (Hemlock)-Northern Hardwood Forest (CES202.593) is found to the north and east.

SOURCES

References: Braun 1950, Comer et al. 2003, Edinger et al. 2002, Evans 1991, Eyre 1980, Greller 1988

Version: 20 Aug 2007 **Stakeholders:** East, Midwest, Southeast

Concept Author: M. Pyne and R. Evans **LeadResp:** Southeast

CES202.886 Southern Appalachian Oak Forest

Primary Division: Central Interior and Appalachian (202)

Land Cover Class: Forest and Woodland

Spatial Scale & Pattern: Large patch

Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland

Diagnostic Classifiers: Forest and Woodland (Treed); Ridge/Summit/Upper Slope; Unglaciated; Broad-Leaved Deciduous Tree; Quercus - Carya

National Mapping Codes: EVT 2315; ESLF 4121; ESP 1315

Concept Summary: This system consists of predominantly dry-mesic (to dry) forests occurring on open and exposed topography at lower to mid elevations in the Southern Blue Ridge and Southern Ridge and Valley ecoregions. This is the upland forest that characterizes much of the lower elevations of these areas. Substrates of stands included in this system can range from acidic to circumneutral or basic, and the vegetation varies accordingly. Bedrock may be of any type. Soils are usually deep residual soils but are often rocky. Some shallow soils and colluvium may be present locally within the group, but shallow soils tend to produce environments that are more extreme and have a larger component of various pine species. Typically, the vegetation consists of forests dominated by oaks, especially *Quercus prinus, Quercus alba, Quercus rubra, Quercus velutina*, and *Quercus coccinea*, with varying amounts of *Carya* spp., *Nyssa sylvatica, Acer rubrum*, and other species such as *Pinus strobus* and *Fraxinus americana*. Historically, *Castanea dentata* was a dominant or codominant in many of these communities until its virtual elimination by the chestnut blight fungus (*Cryphonectria parasitica*] during the early 1900s. Some areas (usually on drier sites) now have dense evergreen ericaceous shrub layers of *Kalmia latifolia*, with *Rhododendron* spp. on more mesic sites. Some other areas have deciduous ericad layers, sometimes consisting of *Vaccinium* spp. or *Gaylussacia* spp. This system concept also includes many successional communities that have been impacted by logging or agriculture, such as types dominated by *Liriodendron tulipifera, Pinus* spp., and *Robinia pseudoacacia*. This system is naturally dominated by stable, uneven-aged forests, with canopy dynamics dominated by gap-phase regeneration. Most oaks are long-lived with typical age of mortality ranging from 200 to 400 years. Scarlet and black oaks are shorter lived with typical ages being approximately 50 to 100 years, while white oaks can live as long as 600 years.

Comments: This system is distinguished from the oak forests of the Piedmont by substantial floristic differences that probably are determined by biogeography as well as climate and topography. Compositional differences were more pronounced in the past, when *Castanea dentata* was a major species in this system and not in Piedmont oak forests. This system is distinguished from most other systems in its primary range by the canopy dominance of oaks (other than strong dominance by red oak) without a large component of yellow pines (*Pinus echinata, Pinus virginiana, Pinus pungens*) in the canopy. It shares those characteristics with

Allegheny-Cumberland Dry Oak Forest and Woodland (CES202.359), which might be thought of as a subtype of this system on the more exposed and acidic substrates. The environment is intermediate within the region in topography and moisture. Northward this system grades into Northeastern Interior Dry-Mesic Oak Forest (CES202.592), which occurs in similar environmental conditions. This southern Appalachian system is characterized by the presence, in most occurrences, of plant species of southern Appalachian affinity, such as *Magnolia fraseri, Gaylussacia ursina, Rhododendron calendulaceum*, etc.

DISTRIBUTION

Divisions: 202:C
TNC Ecoregions: 50:C, 51:C, 52:C
Nations: US
Subnations: GA, KY, NC, SC, TN, VA, WV
Map Zones: 53:C, 57:C, 59:C, 61:P
USFS Ecomap Regions: 231Aa:CCC, M221C:CC, M221D:CC
High-ranked species: Aconitum reclinatum (G3), Arabis patens (G3), Buckleya distichophylla (G3), Callophrys irus (G3), Calystegia catesbeiana ssp. sericata (G3T3Q), Canis rufus (G1Q), Cardamine flagellifera (G3), Carex communis var. amplisquama (G5T3), Carex manhartii (G3G4), Carex polymorpha (G3), Catocala herodias gerhardi (G3T3), Catocala marmorata (G3G4), Collinsonia verticillata (G3G4), Coreopsis delphiniifolia (G3?Q), Coreopsis latifolia (G3), Desmognathus imitator pop. 1 (G3G4T1Q), Desmognathus santeetlah (G3G4Q), Euphorbia purpurea (G3), Fothergilla major (G3), Gaylussacia brachycera (G3), Helianthus smithii (G2Q), Hexastylis contracta (G3), Hexastylis naniflora (G3), Hexastylis rhombiformis (G2), Hypochilus coylei (G3?), Hypochilus sheari (G2G3), Isotria medeoloides (G2), Lysimachia fraseri (G3), Lytrosis permagnaria (G3G4), Melanoplus acrophilus acrophilus (G2G3T2T3), Melanoplus cherokee (G1G3), Melanoplus divergens (G2G3), Melanoplus serrulatus (G1G3), Microtus chrotorrhinus carolinensis (G4T3), Monotropsis odorata (G3), Panax quinquefolius (G3G4), Plagiochila virginica var. virginica (G3T3), Plethodon aureolus (G2G3), Plethodon hubrichti (G2), Plethodon punctatus (G3), Plethodon shenandoah (G1), Plethodon welleri (G3), Prosartes maculata (G3G4), Puma concolor couguar (G5THQ), Pycnanthemum beadlei (G2G4), Pycnanthemum torrei (G2), Ruellia purshiana (G3), Sabatia capitata (G2), Sedum nevii (G3), Silene ovata (G3), Sisyrinchium dichotomum (G2), Sorex palustris punctulatus (G5T3), Speyeria diana (G3G4), Stygobromus sp. 17 (G2), Taenidia montana (G3), Thermopsis fraxinifolia (G3?), Thermopsis mollis (G3G4), Tortula ammonsiana (G1G3), Trillium rugelii (G3), Trillium simile (G3), Vaccinium hirsutum (G3), Viola tripartita var. tripartita (G5T3), Virginia valeriae pulchra (G5T3T4)
Environment: Occurs on open slopes, ridgetops, lower elevation peaks, and higher parts of broad valley bottoms, at low to moderate elevations. Bedrock may be of any type. Soils are usually deep residual soils, but are often rocky. Some shallow soils, colluvium, and other soils may be present locally within the system, but shallow soils tend to produce environments that are more extreme and have a larger component of *Pinus* spp. than this system. Moisture levels are intermediate for the region. Soil chemistry and topography are important determinants of different associations within the system. Topography, elevation, and soil depth are the most important factors separating this system from others.
Vegetation: Vegetation consists of forests dominated by *Quercus* species, most typically *Quercus prinus, Quercus alba*, and *Quercus coccinea*, with varying amounts of *Carya* spp., *Acer rubrum*, and other species. Less typical are stands dominated by other species, such as *Pinus*

strobus, or other hardwood species. *Castanea dentata* was once dominant or codominant in many of these forests. Subcanopies and shrub layers are usually well-developed. Some associations have dense evergreen shrub layers, while others have open shrub layers. Herbs, forbs and ferns are usually sparse to moderate in density.

Dynamics: This system is naturally dominated by stable, uneven-aged forests, with canopy dynamics dominated by gap-phase regeneration. Extreme wind or ice storms occasionally create larger canopy openings. Fire occurred fairly frequently in presettlement times, though there is some dispute whether most of the fires were natural or anthropogenic in origin (Abrams 1992, Delcourt and Delcourt 1997). Fires were usually low-intensity surface fires. The dominant species are fairly fire-tolerant, making most fires non-catastrophic. Fire may be important for favoring oak dominance over more mesophytic tree species within some of the topographic range of this system. Fire also can be expected to have a moderate effect on vegetation structure, producing a somewhat more open canopy and less dense understory and shrub layer than currently seen in most examples. Fire frequency or intensity may be important for determining the boundary between this system and both the more mesic and the drier systems. Virtually all examples have been strongly affected by the introduction of the chestnut blight, which killed all of the *Castanea dentata* trees, eliminating it as a canopy dominant. Past logging affected most occurrences by changing canopies to an even-aged, or more even-aged, structure. Extreme wind or ice storms occasionally create larger canopy openings. Virtually all examples have been strongly affected by introduction of chestnut blight, which killed all the American chestnut trees, eliminating it as a canopy dominant. The introduction, and now widespread establishment, of gypsy moth (*Lymantria dispar*) that favors oaks as food has also affected these forests by causing widespread mortality of overstory trees depending on topographic position and precipitation amounts around defoliation events. Past logging, and now lack of fire, has affected most occurrences by changing canopies to an even-aged, or more even-aged, structure with an understory of shade-tolerant but fire-intolerant species such as *Pinus strobus*, *Acer rubrum*, and *Acer pensylvanicum*. The removal of American chestnut from the overstory of these forests is thought to have benefited *Carya* spp., and their persistence and continued recruitment in contemporary oak-hickory forests may reflect fire exclusion in recent decades.

SPATIAL CHARACTERISTICS

Spatial Summary: Matrix system, covering a majority of the landscape over large areas.

Size: Occurs as a large-patch to matrix system. Contiguous bodies of tens of thousands of acres once occurred. The oak forests probably make up slightly more than 50% of the landscape in all but the higher elevations of the region. Size of existing occurrences may be strongly affected by separation distances for occurrences. A few remaining occurrences over 10,000 acres are probably present.

Heterogeneity: Though often contiguous, patches are virtually always convoluted and interfingered with other systems, especially Southern and Central Appalachian Cove Forest (CES202.373) and Southern Appalachian Low-Elevation Pine Forest (CES202.332). Small-patch systems such as rock outcrops are sometimes embedded within the system. Most occurrences are fairly homogeneous, with a single association covering large areas and seldom more than two or three associations present.

Adjacent Ecological System Comments: This system is almost always bordered by Southern and Central Appalachian Cove Forest (CES202.373) in more mesic sites. It is often bordered by Southern Appalachian Low-Elevation Pine Forest (CES202.332) on more exposed topography. It

may grade into Central and Southern Appalachian Montane Oak Forest (CES202.596) at the highest elevations. Various rock outcrop systems may be present as embedded small patches.
Other Comments: There may be some inconsistencies in where this is mapped to and/or attributed to Kentucky, West Virginia, mapzone 53, mapzone 59, and Piedmont. In Kentucky, this system is restricted to the Cumberland Mountains in the extreme southeastern corner of the state (EPA Level IV Ecoregion 69e of Woods et al. (2002)).

SOURCES

References: Abrams 1992, Comer et al. 2003, Delcourt and Delcourt 1997, Eyre 1980, Woods et al. 2002
Version: 01 Oct 2007 **Stakeholders:** East, Southeast
Concept Author: M. Schafale, R. Evans, M. Pyne, R. White **LeadResp:** Southeast

Woody Wetland

CES202.036 Cumberland Riverscour
Primary Division: Central Interior and Appalachian (202)
Land Cover Class: Woody Wetland
Spatial Scale & Pattern: Linear
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Wetland
Diagnostic Classifiers: Riverine / Alluvial; Graminoid; Short (<5 yrs) Flooding Interval; Riparian Mosaic
National Mapping Codes: EVT; ESLF 9164; ESP
Concept Summary: Examples of this riverscour-influenced system may occur on high-gradient and very high-gradient streams in the gorges of the Cumberland Plateau, the Cumberland Mountains, and the more rugged parts of the Ridge and Valley in Kentucky, Tennessee, and Alabama, and possibly in Georgia. The succession of woody plants (particularly trees) is retarded by the force of "flashy," high-velocity water traveling down the stream channels. This system may occur on flood-scoured acidic or calcareous bedrock, cobble, pebble, or sandbar substrates of sandstone, limestone, dolomite, and possibly other sedimentary and weakly metamorphosed geologies. The most distinctive parts of the system are dominated by shrubs, perennial grasses, and forbs. In some areas, a riparian woodland composed of *Betula nigra* and *Platanus occidentalis* may be a component association. Some common shrubs include *Alnus serrulata, Betula nigra, Cephalanthus occidentalis, Cornus amomum, Fothergilla major, Itea virginica, Salix caroliniana, Rhododendron arborescens, Toxicodendron radicans*, and *Juniperus virginiana var. virginiana*. Some grasses (typical of prairies) include *Andropogon gerardii, Sorghastrum nutans, Schizachyrium scoparium, Chasmanthium latifolium, Tripsacum dactyloides*, and/or *Panicum virgatum*. Forbs are diverse and variable from occurrence to occurrence. This system is affected by flood-scouring in some areas and deposition in others. There is typically a gradient from dry, nutrient-poor conditions upslope to moist and relatively enriched conditions downslope. A variety of these conditions may exist at any one site. Some areas are prone to severe drought periods that may stress or kill some (particularly woody) vegetation. Flood-scouring is a powerful and ecologically important abrasive force along the riverbanks where this system is found.
Comments: Examples of the system are sometimes called "scoured riverbank prairies," "riverside prairies," "linear prairies," "rivershore grasslands," or "scoured riverine bluff prairie." River systems where it is found include the Cumberland and its tributaries, the Obed, the Obey, Chickasaw Creek (Tennessee), the Cahaba (Alabama), the Red River Gorge (Kentucky), Rockcastle River (Kentucky), the Big South Fork of the Cumberland (Kentucky/Tennessee) and its tributaries, and others.

DISTRIBUTION

Divisions: 202:C
TNC Ecoregions: 50:C
Nations: US
Subnations: AL, GA?, KY, TN
Map Zones: 48:C, 53:C
USFS Ecomap Regions: 211E:CC, 221H:CC, 231C:CC, M221C:CC
High-ranked species: Conradina verticillata (G3), Eurybia saxicastellii (G1G2), Eurycea junaluska (G3), Fothergilla major (G3), Hymenocallis coronaria (G2Q), Iliamna remota (G1Q), Liatris microcephala (G3G4), Lindernia saxicola (G1?Q), Lysimachia fraseri (G3), Marshallia

grandiflora (G2), Myotis austroriparius (G3G4), Puma concolor couguar (G5THQ), Sida hermaphrodita (G3), Spiraea virginiana (G2), Vitis rupestris (G3), Xyris tennesseensis (G2)
Environment: Examples may occur on high-gradient and very high-gradient streams in the gorges of the Cumberland Plateau, the Cumberland Mountains, and rugged parts of the Ridge and Valley, in Kentucky, Tennessee, and Alabama, and possibly in Georgia. The succession of woody plants (particularly trees) is retarded by the force of "flashy," high-velocity water traveling down the stream channels. This system may occur on flood-scoured acidic or calcareous bedrock, cobble, pebble, or sandbar substrates of sandstone, limestone, dolomite, and possibly other sedimentary and weakly metamorphosed geologies. It is presumably more extensive and better developed in materials derived from sandstone, where the erodibility creates more material circulating in the stream to create the sandbar/gravelbar areas where the system may occur in extensive patches, and where the extremely well-drained qualities of the coarse sediments further help to retard woody plant succession.
Vegetation: Examples of this system are typically dominated by shrubs, perennial grasses, and forbs. In some areas, a riparian woodland composed of *Betula nigra* and *Platanus occidentalis* may be a component association. Some common shrub component species include *Alnus serrulata, Betula nigra, Cephalanthus occidentalis, Cornus amomum, Fothergilla major, Itea virginica, Salix caroliniana, Rhododendron arborescens, Toxicodendron radicans*, and *Juniperus virginiana var. virginiana*. More southern examples may contain *Hydrangea quercifolia, Hypericum densiflorum*, and *Morella cerifera (= Myrica cerifera var. cerifera).* Some grasses and forbs include *Andropogon gerardii, Sorghastrum nutans, Schizachyrium scoparium, Chasmanthium latifolium, Tripsacum dactyloides, Panicum virgatum, Baptisia australis, Conoclinium coelestinum (= Eupatorium coelestinum), Coreopsis pubescens, Coreopsis tripteris, Elephantopus carolinianus, Helenium autumnale, Hydrocotyle* sp., *Ludwigia leptocarpa, Lycopus* spp., *Orontium aquaticum, Osmunda regalis var. spectabilis, Oxypolis rigidior, Phlox carolina, Pityopsis graminifolia var. latifolia, Rhynchospora colorata (= Dichromena colorata), Rudbeckia laciniata*, and *Vernonia gigantea*. Patches of *Carex torta* may be present in some examples. Distinctive shoals with *Hymenocallis coronaria* and *Justicia americana* may be present as well. Some of these species are typical of prairies, and thrive in the well-lit environment.
Dynamics: This system is prone to flooding in the upper regions and deposition in the topographically lower areas. There is typically a gradient from dry acidic conditions higher on the bank to moist, fairly enriched conditions lower down may exist at any one site. It is prone to severe drought periods that may stress or kill some vegetation. Flood scouring is a powerful and ecologically important abrasive force along the riverbanks where this system is found. Soils in sandstone areas are rapidly drained Psamments, and may be restricted to the narrow interstices of tightly packed boulders, or to small crevices in bedrock exposures. Within the system the various species are distributed patchily probably due to microsite conditions.

SPATIAL CHARACTERISTICS

SOURCES

References: Bailey and Coe 2001, Comer et al. 2003, Eyre 1980, NatureServe Ecology - Southeastern U.S. unpubl. data
Version: 17 Apr 2006**Stakeholders:** East, Midwest, Southeast
Concept Author: R. Evans, M. Pyne**LeadResp:** Southeast

Mixed Upland and Wetland

CES202.705 South-Central Interior Large Floodplain
Primary Division: Central Interior and Appalachian (202)
Land Cover Class: Mixed Upland and Wetland
Spatial Scale & Pattern: Linear
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland; Wetland
National Mapping Codes: EVT; ESLF 9334; ESP
Concept Summary: This floodplain system is found in the Interior Highlands as far west as eastern Oklahoma, as well as throughout the Interior Low Plateau, Cumberlands, Southern Ridge and Valley, and Western Allegheny Plateau, and lower elevations of the Southern Blue Ridge. Examples occur along large rivers or streams where topography and alluvial processes have resulted in a well-developed floodplain. A single occurrence may extend from river's edge across the outermost extent of the floodplain or to where it meets a wet meadow or upland system. Many examples of this system will contain well-drained levees, terraces and stabilized bars, and some will include herbaceous sloughs and shrub wetlands resulting, in part, from beaver activity. A variety of soil types may be found within the floodplain from very well-drained sandy substrates to very dense clays. It is this variety of substrates in combination with different flooding regimes that creates the mix of vegetation. Most areas, except for the montane alluvial forests, are inundated at some point each spring; microtopography determines how long the various habitats are inundated. Although vegetation is quite variable in this broadly defined system, examples may include *Acer saccharinum, Platanus occidentalis, Liquidambar styraciflua*, and *Quercus* spp. Understory species are mixed, but include shrubs, such as *Cephalanthus occidentalis* and *Arundinaria gigantea ssp. gigantea*, and sedges (*Carex* spp.). This system likely floods at least once annually and can be altered by occasional severe floods. Impoundments and conversion to agriculture can also impact this system.
Comments: Montane alluvial forests may be difficult to place within this system because they share traits with both this system and Southern and Central Appalachian Cove Forest (CES202.373), at least in the southern Appalachians. This split from Central Appalachian River Floodplain (CES202.608) may appear somewhat arbitrary but is based on the freshwater systems classification, using roughly the Mid-Continental Divide. This means that Ecoregions 50 and 51 are included in this system, whereas Ecoregions 52 and 59 are considered part of Central Appalachian River Floodplain (CES202.608) (except for a small part of southernmost Ecoregion 59 in West Virginia that drains to the Ohio River).This system grades into Western Great Plains Floodplain (CES303.678) in the Crosstimbers region of east-central Oklahoma as eastern cottonwood (*Populus deltoides*) and willows (*Salix* spp.) become more dominant.

DISTRIBUTION

Divisions: 202:C, 205:C
TNC Ecoregions: 32:P, 37:C, 38:C, 39:C, 44:C, 49:C, 50:C, 51:C, 59:C
Nations: US
Subnations: AL, AR, GA, IL, IN, KY, MO, NC, OH, OK, PA, SC?, TN, VA, WV
Map Zones: 32:P, 37:P, 38:?, 43:C, 44:C, 47:C, 48:C, 49:C, 53:C, 57:C, 61:C, 62:C
USFS Ecomap Regions:
High-ranked species: Arabis georgiana (G1), Aspiromitus appalachianus (G1), Betula uber (G1Q), Canis rufus (G1Q), Catalpa bignonioides (G3G4), Catocala marmorata (G3G4), Cicindela ancocisconensis (G3), Desmognathus imitator pop. 1 (G3G4T1Q), Diervilla rivularis (G3), Eurycea junaluska (G3), Fissidens appalachensis (G2G3), Glyptemys insculpta (G3),

Gymnoderma lineare (G2), Hygrohypnum closteri (G3), Lejeunea blomquistii (G1G2), Lethe creola (G3G4), Lysimachia fraseri (G3), Marshallia grandiflora (G2), Myotis austroriparius (G3G4), Nardia lescurii (G3?), Nesticus sp. 2 (G1G3), Plethodon aureolus (G2G3), Plethodon hubrichti (G2), Plethodon punctatus (G3), Potamogeton tennesseensis (G2G3), Puma concolor couguar (G5THQ), Sagittaria secundifolia (G1), Sorex palustris punctulatus (G5T3), Speyeria diana (G3G4), Spiraea virginiana (G2), Thermopsis villosa (G3?), Trillium pusillum (G3), Vitis rupestris (G3)

Environment: This system inhabits broad floodplains along large creeks and rivers that are usually inundated for at least part of each year.

Vegetation: Vegetation varies quite widely, encompassing shrubby and herbaceous communities, as well as forested communities with a wide array of canopy types. Examples may include *Acer saccharinum, Platanus occidentalis, Liquidambar styraciflua*, and *Quercus* spp. Understory species are mixed but include shrubs, such as *Cephalanthus occidentalis* and *Arundinaria gigantea ssp. gigantea*, and sedges (*Carex* spp.).

Dynamics: Flooding dynamics are an important factor in the development and maintenance of this system.

SPATIAL CHARACTERISTICS

Size: Examples can range in size from very small (<1 acre) to hundreds of acres in larger floodplain areas.

Other Comments: In the Southern Blue Ridge this system is of limited extent, in part due to alteration of riverine systems through impoundments and agricultural and residential development. In the Interior Low Plateau of Kentucky, this system is represented in the Ecoregions of Kentucky map (Woods et al. 2002) by the Wabash-Ohio bottomlands (72a) and by the Green River-Southern Wabash Lowlands (72c).

SOURCES

References: Comer et al. 2003, Evans 1991, Eyre 1980, Woods et al. 2002

Version: 17 Jan 2006 **Stakeholders:** East, Midwest, Southeast

Concept Author: S. Menard, M. Pyne, R. Evans, R. White **LeadResp:** Midwest

CES202.706 South-Central Interior Small Stream and Riparian

Primary Division: Central Interior and Appalachian (202)

Land Cover Class: Mixed Upland and Wetland

Spatial Scale & Pattern: Linear

Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland; Wetland

National Mapping Codes: EVT; ESLF 9335; ESP

Concept Summary: This system is found throughout the Interior Low Plateau, Southern Ridge and Valley, Western Allegheny Plateau, lower elevations of the Southern Blue Ridge, and parts of the Cumberlands. Examples occur along small streams and floodplains with low to moderately high gradients. There may be little to moderate floodplain development. Flooding and scouring both influence this system, and the nature of the landscape prevents the kind of floodplain development found on larger rivers. This system may contain cobble bars with adjacent wooded vegetation and rarely have any marsh development, except through occasional beaver impoundments. The vegetation is a mosaic of forests, woodlands, shrublands, and herbaceous communities. Canopy cover can vary within examples of this system, but typical tree species may include *Platanus occidentalis, Acer rubrum var. trilobum, Betula nigra, Liquidambar styraciflua*, and *Quercus* spp. Shrubs and herbaceous layers can vary in richness and cover. Some characteristic shrubs may include *Hypericum densiflorum, Salix* spp., and *Alnus* spp. Small

seeps dominated by sedges (*Carex* spp.), ferns (*Osmunda* spp.), and other herbaceous species can often be found within this system, especially at the headwaters and terraces of streams.
Comments: This system is closely related to Central Appalachian Stream and Riparian (CES202.609) but has been distinguished based on the precepts of the Freshwater Systems classification. This system has been divided from Central Appalachian Riparian roughly by the Mid-Continental Divide. This means that Ecoregions 50 and 51 are included in this system, whereas Ecoregions 52 and 59 are considered part of Central Appalachian Riparian (except for a small part of southernmost Ecoregion 59 in West Virginia that drains to the Ohio River). In contrast to floodplain systems, this system has little to no floodplain development. In comparison with South-Central Interior Large Floodplain (CES202.705), this system typically has somewhat higher gradients, is sometimes rocky, and may experience flash floods. Stands from somewhat larger rivers have been placed here if the river lacks substantial floodplain development (e.g., the New River of West Virginia and the Ocoee Gorge of Tennessee).

DISTRIBUTION

Divisions: 202:C, 203:C
TNC Ecoregions: 43:C, 44:C, 49:C, 50:C, 51:C, 59:C
Nations: US
Subnations: AL, GA, IL, IN, KY, NC, OH, PA, SC, TN, VA, WV
Map Zones: 46:P, 47:C, 48:C, 49:C, 53:C, 57:C, 61:C, 62:C
USFS Ecomap Regions:
High-ranked species: Bryoerythrophyllum ferruginascens (G3G4), Canis rufus (G1Q), Cardamine longii (G3?), Catalpa bignonioides (G3G4), Catocala marmorata (G3G4), Cicindela ancocisconensis (G3), Desmognathus aeneus (G3G4), Desmognathus wrighti (G3), Fissidens appalachensis (G2G3), Glyptemys insculpta (G3), Gymnoderma lineare (G2), Hexastylis naniflora (G3), Hexastylis rhombiformis (G2), Hexastylis shuttleworthii var. harperi (G4T3), Isotria medeoloides (G2), Jamesianthus alabamensis (G3), Lejeunea blomquistii (G1G2), Lysimachia fraseri (G3), Marshallia grandiflora (G2), Marshallia trinervia (G3), Megaceros aenigmaticus (G2G3), Melanoplus serrulatus (G1G3), Myotis austroriparius (G3G4), Pityopsis ruthii (G1), Plethodon hubrichti (G2), Plethodon punctatus (G3), Sagittaria secundifolia (G1), Speyeria diana (G3G4), Spiraea virginiana (G2), Trillium pusillum (G3), Trillium rugelii (G3), Vitis rupestris (G3), Waldsteinia lobata (G2G3)
Environment: Found along fairly high-energy streams and rivers with steep banks, this system is subject to frequent flooding and can be subject to scouring depending upon the substrate.
Vegetation: There is wide variation in vegetation depending upon the frequency of the flooding cycle (more frequent flooding creates a better environment for forbs and shrubs, less frequent may create a better environment for the establishment of trees). Typical tree species may include *Platanus occidentalis, Acer rubrum var. trilobum, Betula nigra, Liquidambar styraciflua*, and *Quercus* spp. Shrubs and herbaceous layers can vary in richness and cover. Some characteristic shrubs may include *Hypericum densiflorum, Salix* spp., and *Alnus* spp. Small seeps dominated by sedges (*Carex* spp.), ferns (*Osmunda* spp.), and other herbaceous species can often be found within this system, especially at the headwaters and terraces of streams.
Dynamics: Flooding and seed propagule dispersal caused by flooding events are the two most important processes affecting this system. The two processes vary widely depending upon size of stream, upstream land use and topography, presence or absence of invasive exotics that may displace native community types, etc.

SPATIAL CHARACTERISTICS

Spatial Summary: Small, linear patch.
Size: Can be quite long but never very wide.

SOURCES

References: Comer et al. 2003, Evans 1991, Eyre 1980
Version: 05 Jun 2008 **Stakeholders:** East, Midwest, Southeast
Concept Author: S. Menard, M. Pyne, R. Evans, R. White, D. Faber-Langendoen **LeadResp:** Midwest

Barren

CES202.309 Cumberland Acidic Cliff and Rockhouse
Primary Division: Central Interior and Appalachian (202)
Land Cover Class: Barren
Spatial Scale & Pattern: Small patch
Required Classifiers: Natural/Semi-natural; Unvegetated (<10% vasc.); Upland
Diagnostic Classifiers: Cliff (Substrate); Acidic Soil
National Mapping Codes: EVT; ESLF 3119; ESP
Concept Summary: This sandstone cliff ecological system is found in the Cumberland Plateau and Mountain regions of the southeastern United States. Examples are extremely steep or vertical rock faces exposed along bluffs often associated with rivers. The aspect is variable but best developed on south- and west-facing sites. Plants are infrequent due to the lack of crevices capable of accumulating soil, the highly acidic nature of the bedrock, and the frequent weathering and erosion of the substrate. Lichen cover may be extensive in places, especially on the more exposed portions. These cliffs are also prone to harsh climatic conditions; frequent disturbances include drought stress and wind and storm damage. As a result, examples are characterized by sparse herbaceous cover and few, if any, trees. Vegetation consists of scattered individuals of *Asplenium montanum*, *Silene rotundifolia*, and other species rooted in crevices and erosion pockets. In some parts of its range, this system is the primary or sole habitat for rare endemic species, such as *Minuartia cumberlandensis* and *Ageratina luciae-brauniae*. This system includes a mosaic of cavelike features (often called "rockhouses") and associated sandstone box canyons in the western Appalachian foothills regions of Kentucky, Alabama, West Virginia, and possibly southeastern Ohio. Where present, the rockhouses are a prominent and diagnostic feature of the system.
Comments: It is unclear whether or not this system should range into the Interior Low Plateau. Also debatable is whether or not wet and dry cliffs should be included as well as the number of different physical settings possible. See also Southern Appalachian Montane Cliff and Talus (CES202.330).

DISTRIBUTION

Divisions: 202:C
TNC Ecoregions: 50:C
Nations: US
Subnations: AL, GA, KY, OH?, PA?, TN, VA?, WV
Map Zones: 46:C, 47:C, 48:C, 53:C, 57:C, 62:?
USFS Ecomap Regions:
High-ranked species: Ageratina luciae-brauniae (G3), Aneides aeneus (G3G4), Canis rufus (G1Q), Carex misera (G3), Dodecatheon frenchii (G3), Fontigens tartarea (G2), Heuchera alba (G2Q), Homaliadelphus sharpii (G3?), Hymenophyllum tayloriae (G2), Krigia montana (G3), Liatris helleri (G2Q), Liatris microcephala (G3G4), Mannia californica (G3?), Minuartia cumberlandensis (G2G3), Nardia lescurii (G3?), Neotoma magister (G3G4), Plagiochila austinii (G3), Plagiochila caduciloba (G2), Plagiochila eurphyllon ssp. echinata (GNRT2), Plagiochila sullivantii var. sullivantii (G2T2), Plagiochila virginica var. caroliniana (G3T2), Plagiochila virginica var. virginica (G3T3), Porella japonica ssp. appalachiana (G5?T1), Radula sullivantii (G3), Radula voluta (G3), Scopelophila cataractae (G3), Sedum nevii (G3), Tetrodontium brownianum (G3G4)

Environment: The rockhouses are the most unique and diagnostic feature of the system. These unusual geologic features are created by spray and rock-cracking from seasonal flowing waterfalls at the heads of canyons amidst thick layers of sandstone from the Pennsylvanian geologic period. The ceiling of the rockhouse may be 50 m tall, and they can be as much as 100 m deep (A. Weakley pers. comm. 2006). They require sufficient flowing water and freezing and thawing to weather the thick beds of sandstone. These conditions seem to be restricted to the western margin of the Appalachian Plateau.

Vegetation: Examples of this system usually include a vegetational mosaic that includes hemlock bluffs, sandstone cliffs, or overhangs near the base of a cliff (often with a sandy area beneath the overhang which is shaded and protected from direct rainfall, as well as gladelike vegetation at the horizontal portion of the cliffs). The rockhouses in the southern parts of the range are habitats for rare vascular plant species such as *Minuartia cumberlandensis* and *Ageratina luciae-brauniae* and sometimes support populations of rare nonvascular plants as well.

SPATIAL CHARACTERISTICS

Other Comments: Examples with rockhouses sometimes support Woodland Period archeological sites. Human use and recreational disturbance are threats to easily accessible rockhouses. The range needs to be clarified, and concept resolved against CES202.689, CES202.330, and CES202.349.

SOURCES

References: Comer et al. 2003, Evans 1991, Eyre 1980, Weakley pers. comm.

Version: 05 May 2008 **Stakeholders:** East, Midwest, Southeast

Concept Author: R. Evans **LeadResp:** Southeast

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